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Organisation of
Eastern Caribbean States

OHCP GRADE 4 SCIENCE

INTRODUCTION

The study of science encompasses knowledge, processes and values. Scientifically literate persons will foster an attitude of caring not only for themselves, but as responsible citizens, for the world around them. Their decision-making will be enhanced by a systematic study of the structure and behavior of the physical and natural world through observation and experiment. In learning science, students benefit from leveraging and evaluating available technological tools to study and therefore understand the world and their relationship to it.

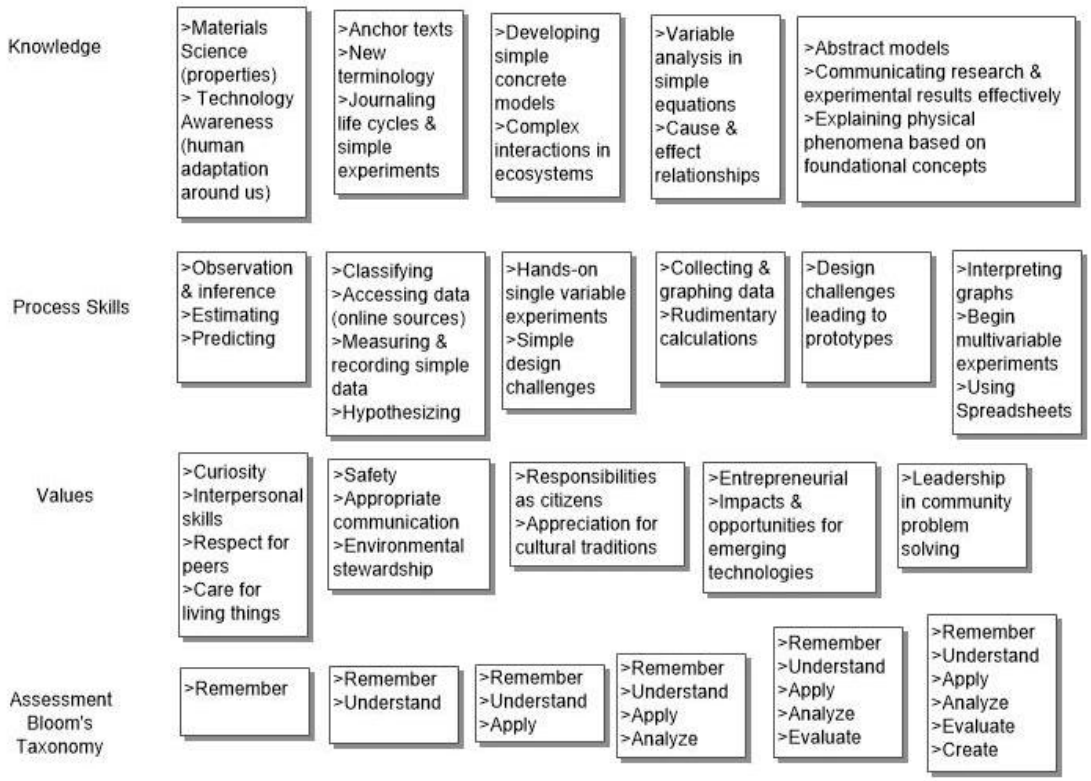
The following Innovation Configuration Map is designed to assist teachers as they continue to develop the pedagogy that supports the curriculum. It illustrates the key features of research informed best practices that might serve as a guide to teachers as they seek to engage with the curriculum with the goal of having *"Every Learner Succeed"*.

Stages of Pedagogical Practice

Practice Area	No Implementation	Beginning Implementation	Moderate Implementation	Strong Implementation
Constructivist Pedagogy	Teacher-centered delivery of lessons	Evidence of hands-on activities	Evidence of teacher-scaffolded investigations that necessarily involve teacher-student & student-student discussions. Minds-on learning.	Active lessons that begin with questions about the world (and inherent discussions) that are socially relevant & invoke cultural perspectives.
Building Process Skills	Lessons that rely solely on the recall of knowledge	Students are involved in experiments	The processes of science & 21st century skills are highlighted in student-centered activities. (e.g., observing, inferring, hypothesizing, measuring, graphing etc. & researching, critical thinking, communicating)	Evidence that the lesson, within active authentic learning contexts (real world questions) involves tracking & evaluating student growth in the processes of science & 21st century skills.
Integrating Subjects	Attention to subject focused topics rather than student outcomes	Reading about science topics & collecting/tabulating data.	Emphasizing **literacy** (Reading anchor texts, researching, listening, writing & communicating). Emphasizing science studies that invoke **social** concern & discussion. Emphasizing the collection, interpretation & communication of **numbers** as an account of science investigation	Science Investigations that begin with socially relevant questions that require numerical analysis &, in communication of results, invoke quality discussions that develop literacy skills.
Empowering learning with	No technology tools evident. Teacher-led	Use of simple technologies to motivate learners. These may or	Use of technologies to access enhanced types of learning that place	Use of digital pictures, video, simulations & probes to pose authentic

Practice Area	No Implementation	Beginning Implementation	Moderate Implementation	Strong Implementation
Instructional Technology	instruction accessing traditional resources; primarily textbook-based instruction	may not activate new ways of learning.	the student at the center of constructing knowledge. (e.g. student-led simulation activities, use of computer probes to collect data, logic exercises with coding)	real-world questions as a basis for discussions & developing process skills.
Integrating Technology as "a way of adapting"	No evidence of problem solving in any context	Simple activities that challenge students to think about the problem solving that has led to human adaptation in the world. This necessarily involves developing an awareness of technology around us	Activities that emphasize design challenges that rely on careful planning, prototyping & testing.	Lessons that invoke problem solving to design solutions in response to community problems.

Progression of Students' Knowledge Skills & Values P-6



Grade Level Expectations for Skills and Attitudes[1]:

A Summary of Skills to be Demonstrated by Learners at the End of Grade 4

In the development of inquiry; problem identification, design and solution; learners should demonstrate the following:

Observing	Use as many senses as are appropriate to safely and accurately acquire knowledge.
Measuring	Use simple devices to collect reliable information.
Manipulating	Set up and use simple experiments to establish patterns.
Recording	Use a variety of methods to effectively report activities and results.
Classifying	Use named criteria to group objects and events.
Communicating	Use all sources of information to procure knowledge and information.
Inferring	Set up and use strategies to search for patterns in measurements and events.
Interpreting Data	Identifying likely changes when one or more variable is manipulated.
Experimenting	Identify methods that may be used to gather knowledge and information.
Predicting	Use simple ideas and methods to develop ways to make predictions.
Hypothesizing	Make informed 'guesses' about what is likely to occur in an investigation.
Problem Solving	Give a variety of possible solutions to problems.
Designing	Select appropriate methods and materials to make models and gadgets.

A Summary of Attitudes to be Developed by Learners at the End of Grade 4

In the activities throughout Grade 4, learners are encouraged to develop the attitudes required for positively interacting with scientific and technological ideas and concepts. At the end of the Grade, these are some of the attitudes that should be evident:

Curiosity	Ask valuable questions about things trending in their society which relate to science and technology
Inventiveness	Produce innovative ideas about how to accomplish a task or investigation.
Respect for Evidence	Reach conclusions by insistence on verifiable evidence.
Persistence	Move relentlessly towards a conclusion in an investigation against all odds.
Respect for living things	Treat all living things with concern and respect - no cruelty to living animals especially.
Cooperation	Work effectively in groups, accepting responsibility for their part of the task.
Respect for safety	Accept safety instructions and responsibility for self-safety.

Energy

Introduction to the Subject: The study of science encompasses knowledge, processes and values. Scientifically literate persons will foster an attitude of caring not only for themselves, but as responsible citizens, for the world around them. Their decision-making will be enhanced by a systematic study of the structure and behavior of the physical and natural world through observation and experiment. In learning science, students benefit from leveraging and evaluating available technological tools to study and therefore understand the world and their relationship to it.

Strand (Topic): Energy

The study of energy is most relevant given the increasing demands humans put on natural resources to power our technological needs. The knowledge of potential energy sources and how we interconvert energy positions our students to be innovative as they look to a comfortable sustainable future.

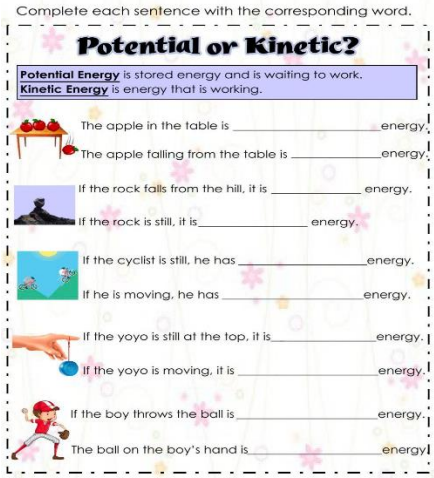
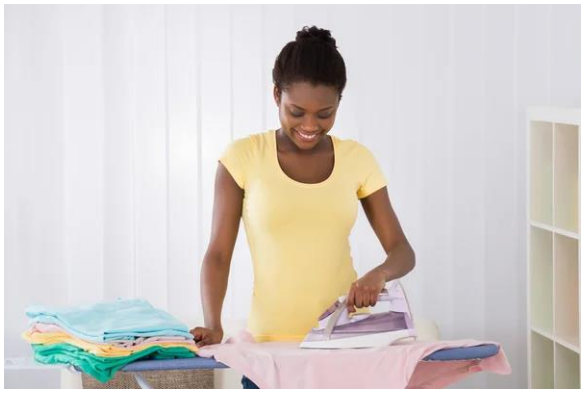
Essential Learning Outcome 1: Use evidence to construct an explanation relating the speed of an object to the energy of that object.

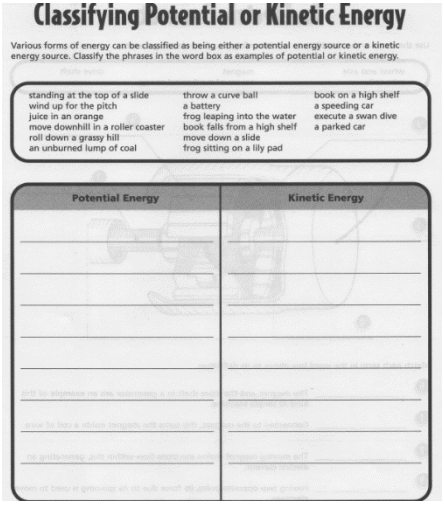
[Assessment Boundary: Assessment does not include quantitative measures of changes in the speed of an object or on any precise or quantitative definition of energy.]

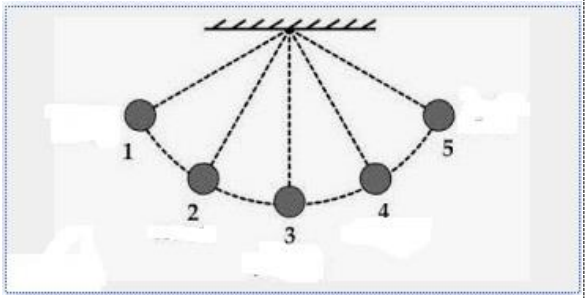
Grade Level Expectations: Refer to grade level expectations at the beginning of this curriculum document.

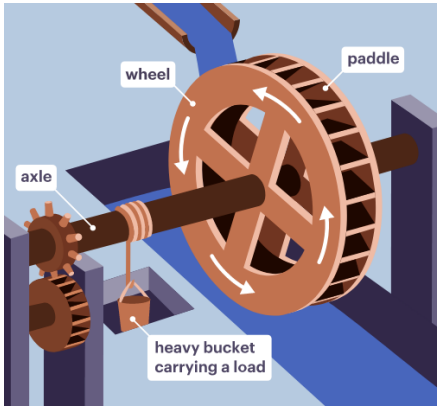
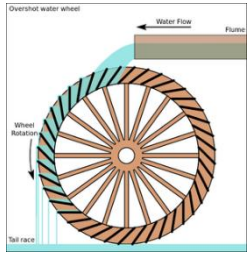
Specific Curriculum Outcomes	Inclusive Assessment Strategies:	Inclusive Learning Strategies:
Learners are expected to: **<u>Knowledge</u>** ● Define the terms: ○ Energy ○ Hydropower ○ Turbine ○ Water wheel ○ Potential Energy ○ Kinetic Energy ○ Speed ○ Solar Power ○ Geothermal Power ○ Tidal Power ○ Wind Power	**Energy is Used Everywhere** Students should make a poster showing all the uses of energy in society. The poster should also include pictures of the different types of renewable energy (solar, geothermal, hydro, wind, tidal) and some description of why we need to move from traditional fossil fuels to alternate sources of energy. This should include a table of consumption of energy from their country. *Rubric* Examples of Energy use – 5 marks Examples of energy sources – 5 marks Description of energy problem - 5 marks Consumption data or graphs-5 marks Neatness, Grammar, Punctuation – 5 marks	**<u>What is Energy?</u>** Let us examine the following pictures that show everyday activities that are done at home and at school. What is needed to perform these activities? 

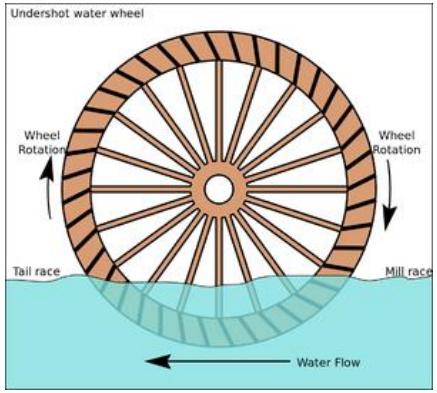
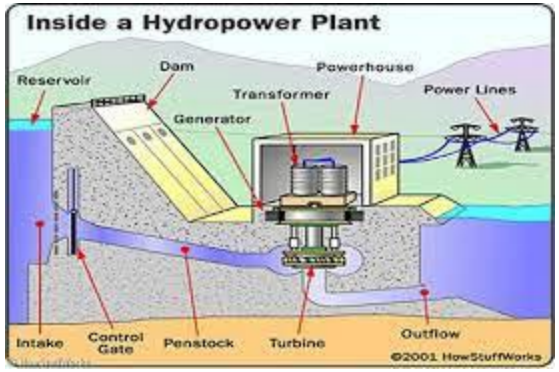
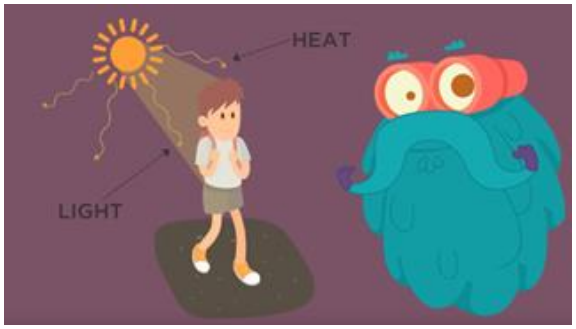
Specific Curriculum Outcomes	Inclusive Assessment Strategies:	Inclusive Learning Strategies:
○ Pendulum ○ Axle ○ Channel Markers ○ Shoals • List activities that require energy • Identify food as a source of energy. • Compare the distance that cars travel when released different heights on an incline. • Explain how the speed of an object affects the energy the object possesses • Distinguish between potential energy and kinetic energy. • Give examples of potential energy and kinetic energy • Demonstrate ways in which motion can be changed (start movement, increase or decrease speed) (ST 2 PS FMS 1) • Identify devices that use moving water as energy sources. (ST 2 PS EN 4) **Skills** • Suggest ways of minimizing error when measuring time taken (number of trials, averaging)	**Vocabulary** What does the word potential mean when it refers to the voltage potential of 12 volts in a battery? (*the battery has the ability to do work that involves a requirement of 12 volts- maybe a light, a car, a boat etc.)* The word kinetic is used to describe many products that involve motion. An example is running shoes like the one below that has kinetic in its name.  Retrieved from: https://www.asics.com/us/en-us/gel-quantum-kinetic/p/ANA_1203A270-021.html Have students search the internet for products in our world that use the word kinetic linked to motion. **Why do Objects at a Height have Potential Energy? (Can students answer this?)** *Objects at a height are naturally pulled to the ground by gravity and therefore they have potential energy to do work as they fall. If a rock is dropped from a ladder onto a mango by mistake, there may be a dent in the mango. The rock in falling does work on the mango when it impacts it.*	Retrieved from: https://www.angi.com/articles/should-i-convert-my-electric-stove-gas.htm What is this family doing together? (*Cooking*) Have you ever cooked with your family? (*Yes/No*) What is being used to cook? (*Stove*) What does a Stove need to work? (*Uses gas/electricity*)  Retrieved from: : https://www.freepik.com/premium-ai-image/girl-holds-flashlight-dark-room_45657162.htm What is the girl holding in her hand? (*flashlight*) Why do you think she is holding this flashlight? (*She is in a dark place*) Have you ever used a flashlight? (*Yes/No*) How does it work (*Uses batteries to provide light*) 

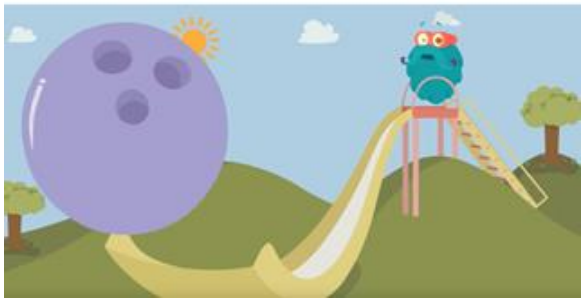
Specific Curriculum Outcomes	Inclusive Assessment Strategies:	Inclusive Learning Strategies:
• Observe the speed of objects and people. • Use a ruler accurately to measure distance. • Measure the time taken for objects to move from one point to another. • Predict how the height and distance affect the speed of an object as it descends an inclined plane. • Communicate their results to their peers. • Construct an incline plane with rudimentary materials. • Investigate how the height and angle of an inclined plane affect the distance and speed of an object. • Plotting motion data • Interpreting graphs • Extrapolating from graphs • Investigate the ways in which different forces can change the speed and direction of a moving object. (ST 4 PS FMS 1) • Classify different kinds of motion depending on what causes the motion- gravity. (ST 4 PS FMS 2) • Determine experimentally that varying the mass of an object,	**Worksheets on Potential and Kinetic energy**  Complete each sentence with the corresponding word. **Potential or Kinetic?** **Potential Energy** is stored energy and is waiting to work. **Kinetic Energy** is energy that is working. The apple in the table is _____ energy. The apple falling from the table is _____ energy. If the rock falls from the hill, it is _____ energy. If the rock is still, it is _____ energy. If the cyclist is still, he has _____ energy. If he is moving, he has _____ energy. If the yoyo is still at the top, it is _____ energy. If the yoyo is moving, it is _____ energy. If the boy throws the ball is _____ energy. The ball on the boy's hand is _____ energy Retrieved from https://www.liveworksheets.com/w/en/science/358056  Determine if the picture is illustrating Kinetic or Potential Energy. Coal Stretched String Dynamite LIVEWORKSHEETS	Retrieved from : https://www.pinterest.com/pin/268527196504623967/ What are the two girls doing? (*playing with a toy car*) How do you think they are able to make the toy car move? [Draw students' attention to the solar panel on the top] (*Uses sunlight/ use solar panel to work*)  Retrieved from :https://depositphotos.com/photo/female-hands-ironing-clothes-109796552.html What is the lady doing? (ironing) What is needed for the iron to operate? (electricity)

Specific Curriculum Outcomes	Inclusive Assessment Strategies:	Inclusive Learning Strategies:
and height from which it is dropped will vary the force exerted by the object. (ST 6 PS FMS 7) • Given problems, be able to design and construct simple gadgets -water wheel. (ST 2TE TM 1) **Attitudes/Values** • Appreciate that the relationship between motion and energy can be seen in the everyday activities we do and in the environment around us. • Demonstrate persistence in obtaining accurate and reliable data. • Show Interest/Curiosity in gathering data. • Demonstrate respect for collecting accurate and reliable scientific data. • Work collaboratively and cooperatively in groups. • Practice safety when conducting experiments. • When conducting practical and group work, display sensitivity and offer assistance to peers who may have physical or learning challenges.	**Retrieved from:** https://www.liveworksheets.com/w/en/science/1529937  **Classifying Potential or Kinetic Energy** Various forms of energy can be classified as being either a potential energy source or a kinetic energy source. Classify the phrases in the word box as examples of potential or kinetic energy. standing at the top of a slide; wind up for the pitch; juice in an orange; move downhill in a roller coaster; roll down a grassy hill; an unburned lump of coal; throw a curve ball; a battery; frog leaping into the water; book falls from a high shelf; move down a slide; frog sitting on a lily pad; book on a high shelf; a speeding car; execute a swan dive; a parked car Potential Energy | Kinetic Energy **Potential Energy** / **Kinetic Energy** Standing at the top of a slide / Move down a slice Sind up for the pitch / Throw a curve ball A battery / Execute a swan dive Juice in an orange / Move downhill in a roller coaster An unburned lump of coal / Frog leaping into the water Frog sitting on a lily pad / Roll down a grassy hill Book on a high shelf / Book falls from a high shelf A parked car / A speeding car **Answer Key** Retrieved from: https://www.literacymn.org/sites/default/files/curriculum/unit2.11_energy.pdf	 Retrieved from: https://www.ocregister.com/2016/08/14/miller-usain-bolt-brings-showmanship-to-olympics-in-a-flash/ Who is the man in the picture? (Usain Bolt, the fastest man alive, he is from Jamaica) What is he doing? (running) What does he need in order to be able to move and run? (food as energy) Teacher documents the item and what is required to work (stove - gas/electricity; flashlight- batteries/dry cells; toy car - solar power; iron- electricity; athlete -food) Students, what do all these activities need to take place? (*They require energy*) What is energy needed for? (*work, activities*) Can you do the following activities without energy? • Riding a bike • Running around the field • Cleaning the chalkboard • Sweeping the classroom

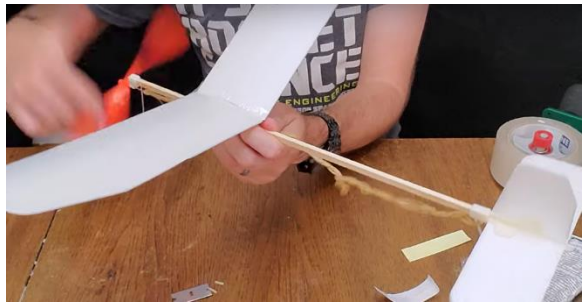
Specific Curriculum Outcomes	Inclusive Assessment Strategies:	Inclusive Learning Strategies:
• Participate actively in classroom discussions. • Natural resources are not likely t to last forever so judicious use and looking for renewable sources ls advisable. (ST 2 STSE 3) • Recognize that resources should be used wisely since many of them are non-renewable. (ST 5 TE UT 2) • Abuse and overuse of non-renewable resources lead to depletion and should indicate to policy makers that the urgent search for and use of renewable resources is critical. (ST 6 STSE 2) • Understand that countries progress if the people are involved in innovative and creative activities-water wheels for power. (ST 3 TE NT 3)	**Potential Energy and Kinetic Energy Interchange When Gravity Acts on an Object** As a bob (weight) is released on a pendulum the potential energy of position begins to convert to kinetic energy of motion. As the pendulum bob swings back up again, it gains potential energy back. Show students the pendulum picture below and pose the following questions.  Retrieved from: https://www.quora.com/Where-is-the-potential-energy-in-a-pendulum Questions about the swinging pendulum: 1) At which numbered point(s) do you think the potential energy of the swinging weight is highest? (1 & 5) 2) At which numbered point(s) do you think the kinetic energy of the swinging weight is highest? *(3)* 3) At which numbered point(s) do you think potential energy and kinetic energy could be similar? *(2 & 4)* *4)* After you release the pendulum bob (weight) and it begins to swing downward, does it ever regain totally the potential energy it had in the beginning? If not, why not? (*The pendulum weight will swing back and forth until it rests in the middle.*	What other activities do you do that require energy? [*Write down on the chalk board activities that require energy that the students do.*] When you are performing these activities, what are you doing? (*Work*) Where do you get the energy you need to do work? (*From the food we eat*) **Energy** is often defined as the ability to do work**.** **Recognizing Different Types of Energy** In certain parts of world like China they have created energy using water. Look at this picture of the Three Gorges Dam. It took many years to build and produces the most energy of any hydropower dam in the world. Hydro means water; yes, we get power from water!  Retrieved from: https://en.wikipedia.org/wiki/Three_Gorges_Dam#/media/File:ThreeGorgesDam-China2009.jpg This technology is actually very old. For many years, settlers in countries around the world have decided to build their homes near water so they could access power.

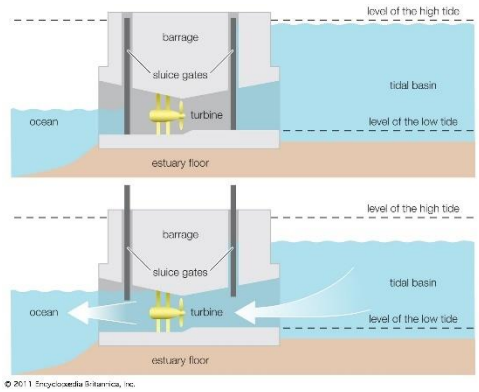
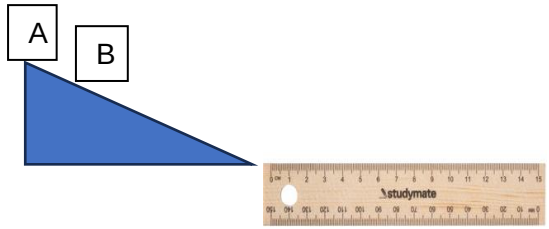
Specific Curriculum Outcomes	Inclusive Assessment Strategies:	Inclusive Learning Strategies:
	This is because air friction causes the initial amount of energy to be slowly lost so that less is available to convert to kinetic energy. **Make a Waterwheel to Harness Energy** Depending on where you have the water falling on the wheel you can change the direction of the wheel. Can you identify places in your community where water wheels have been used to create a renewable energy?  Retrieved from: https://stileapp.com/au/library/publishers/stile/compilations/science/75556821-1a2f-4b47-a1a3-83f2dfe79fb0/preview/32-water-wheels/w2aI Teacher Note: Pending availability of resources, the students can make a water wheel from simple materials using the instructions at the link above.	The water in a river above a waterfall can fall downward and turn a wheel. In the picture below you can see water has been directed from above to turn this wheel if the wheel is attached to an axle in the centre, it can create energy to do work like grinding grain or lifting a load.  Retrieved from: https://energyeducation.ca/encyclopedia/Waterwheel At the top of the wheel ***before*** the waterfalls, we say the water has **potential energy** to do work- sometimes referred to as energy of position. The word potential means it has the possibility to do work. Let me use that word in a sentence "My students have the potential to be wonderful parents and productive citizens!" We sometimes hear that word used around batteries for our radio or flashlight. That is because the battery has the potential to do work; play music through a speaker or light a lightbulb! When the water is pulled downward by gravity, it begins to have a new type of **energy of motion called kinetic energy.** In modern hydropower they use special wheels called **turbines** to take the energy from large volumes of flowing water.

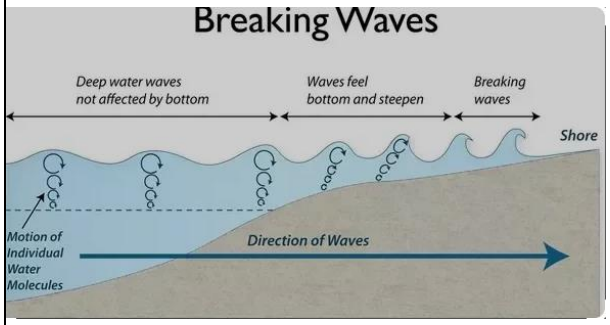
Specific Curriculum Outcomes	Inclusive Assessment Strategies:	Inclusive Learning Strategies:
	Culminating Challenge Question: Students, if we were to put a waterwheel in a local stream like shown below, which day (#1 or #2) do you think could produce the most energy? Explain why? Day #1: Hot summer day with a trickle of water in our stream Day #2: In the rainy season, when the water rushes down from hillsides. (*Day #2: the stream will have fast moving water so it will turn the wheel more quickly- this should make more energy)*  Retrieved from: https://energyeducation.ca/encyclopedia/Waterwheel So, students you are telling me **the faster something moves the more energy it has to do work?** Think of your friend throwing a football at you. As you catch a slow toss it feels different than a fast toss. That is	 Retrieved from https://www.micro-hydro-power.com/hydro-turbine-generator/ The turning wheel is connected to something called a generator that creates electricity from the kinetic energy of the moving water. **Video Resource for Potential and Kinetic Energy** Let us now watch a video where we can learn more about energy. Listen carefully to the two main types of energy. https://youtu.be/Q0LBegPWzrg?si=mixpy9IyS5hr9e8O (4:13 mins) Kinetic and Potential energy stops at 2:13 mins 

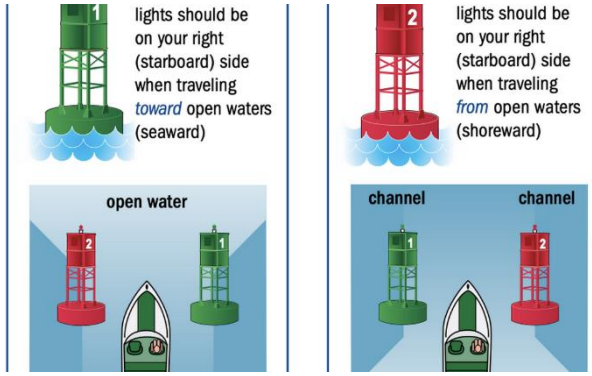
Specific Curriculum Outcomes	Inclusive Assessment Strategies:	Inclusive Learning Strategies:
	because your friend gave the ball more energy in a fast toss when they released it towards you. **Integrating Mathematics** Peter sets up his toy train on the railroad tracks he has in a straight line. He has a tool to measure the speed the train is traveling in centimeters/second when he pushes it to go. He set a box at the end of the ramp for the train to crash into. He measures in centimeters how far the train pushes the box and records the data in a table. Plot a graph of the **speed** of the train (x axis) versus. the distance the box traveled (y axis) ***Questions*** 1. What did you notice about the shape of the graph? (*It rises to the right*) 2. What does the graph imply about the relationship between speed and distance? (*as speed increases the distance the box moves also increases- they have a direct relationship*) 3. Multiple choice question:	  What are the two main types of energy mentioned in the video? (*Kinetic Energy and Potential Energy*) What did you learn about kinetic energy? What did you learn about potential energy? Students share their initial understanding. **<u>Other Examples of Potential and Kinetic Energy</u>** There are two types of energy: <u>Potential Energy</u>: stored energy, energy ready to go. Example, stretching a rubber band, a race car at the starting line, a rock that rests at the top of a cliff.

Speed of the train (cm/s)	Distance the box moves (cm)
30	1.5
40	1.9
50	3.0
60	4.2
70	7.5

Specific Curriculum Outcomes	Inclusive Assessment Strategies:	Inclusive Learning Strategies:
	What would happen to the distance the box moves if the train increased in speed beyond 70 cm/s? Possible Answers: a. The box would move the same distance as a train moving at 70 cm/s. b. The box would move a shorter distance. c. The box would move a longer distance. d. The box would move the same distance as a train moving at 30 cm/s. **Correct answer:** c. The box would move a longer distance. Explanation: *Peter's investigation was testing how the distance a box moved would change as the speed of a toy train increased or decreased. The pattern within the data table shows that the higher the rate of the train, the further the box moved. An inference can be made that the higher something's speed is, the more energy it has. Higher amounts of energy will result in a more significant change of motion for the object it is acting on. When the speed decreases, the distance the box moves also decreases. There is a direct relationship between speed and energy. So if he were to increase the speed of the train, the box would move a longer distance.* Scenario retrieved verbatim from: https://www.varsitytutors.com/4th_grade_science-help/explain-how-an-object-s-speed-relates-to-its-energy **Extension Activities** **Energy, Speed and Ocean Waves** The regular tides in the ocean possess energy as they move in and out of the shoreline. In some parts of the world, the tidal difference between high and low tide	Kinetic Energy: is energy at work example releasing a rubber band, a rock falling from a cliff Teacher will provide students with rubber bands. Stretch your rubber band between your fingers. What kind of energy does the stretched rubber band possess? (Answer: *when the elastic band was stretched it gained potential energy. We know this because your hand had to do some work to stretch the elastic band.*) Release your rubber band, causing it to shoot across the room. What kind of energy is now present when the rubber band is released? (caution students not to release in the direction of classmates or their own faces) An elastic band when twisted can build up potential energy; enough to spin a propeller on a light-weight wooden plane. The winding of the elastic builds potential energy and the release that spins the propeller is kinetic energy of motion.  Retrieved from: https://youtu.be/hPf4d7-2G9Q A sling shot also involves stretching a rubber band to build potential energy and then releasing it with a pebble enclosed to quickly attain kinetic energy of motion. **Linking Speed and Energy**

Specific Curriculum Outcomes	Inclusive Assessment Strategies:	Inclusive Learning Strategies:
	coupled with the resultant rush of water is enough that turbines can be lowered in the water and turned to create **tidal power**. This is an example of renewable resource in that tides are constantly changing day and night without any effort on our part! Students should do internet research to find out where tidal power projects have been successful in the world.  Retrieved from: https://www.wtsenergy.com/glossary/tidal-energy/ **Why Do Waves Crash on the Shore?** Waves have a lot of energy as they come to shore. The speed of the wave depends on currents and wind. But the top of the wave and bottom of the wave can change in speed especially as the water at the bottom of the wave brushes up against the sand in the shallows.	Students, I am sure you have heard the word speed before. If I told you that a red car was traveling faster than a blue car, which car likely has the greater speed? (*The red car would have the greater speed*) **Speed is the distance travelled in a period of time**. The car that goes the same distance in a shorter time will always be the higher speed. Materials: stack of books, smooth wooden ramp, toy car, watch to measure time, ruler. NOTE: Can be done as a teacher demonstration or by individual class groups. We are going to release a car to roll down a ramp from different positions and measure how far it travels from the bottom of the ramp in the same amount of time (e.g. 10 seconds-measure by stopwatch)  If you had to guess students, which car would go the fastest, the one released from point A or point B? (*point A*). If you had to guess students, which car would go the furthest, the one released from point A or point B? (*point A*). Which car would have the largest potential energy? (*point A car because it is the highest)* So let us try this and confirm our prediction. Over 10 seconds

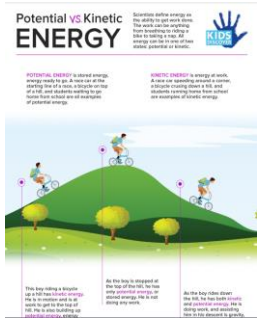
Specific Curriculum Outcomes	Inclusive Assessment Strategies:	Inclusive Learning Strategies:
	 Retrieved from: https://www.quora.com/Can-waves-break-in-the-middle-of-the-ocean As a wave nears shore and the depth of water starts to decrease, the frictional effect of the seabed slows the bottom of the wave, and when the point is reached when the top of the wave has a greater speed, it overtakes the bottom of the wave, and the wave will break. It has been found that a wave will break in water that is a depth of 1.3 the wave height. Ask students two questions about waves on their community beaches. 1. Why do we sometimes see waves breaking far out to sea on a windy day? (*if the wind is high enough, it increases the speed of the top of the wave so it topples over the slower bottom of the wave*) 2. Often we see **channel markers** near the entrance to boat landings that guide fishers safely into the harbor. Around these areas we may also see waves breaking. Why would that happen there? (*Channel markers usually show wee shallow areas are located which are dangerous for boats. These shallow areas sometimes called **shoals** will slow the speed of the bottom of the wave and cause the faster top of the wave to topple over.*)	Release from point A – distance traveled= _____cm Release from point B – distance traveled= _____cm **Teacher notes** We know that the car released from point A went a further distance in the same amount of time (10 secs) so it is going faster than the car released from point B. We also know that because point A is higher, the car released from there has more potential energy. As the car goes down the ramp, all the potential energy is converted to kinetic energy of motion. Our final conclusion is: The car released from point A will have the higher speed and the higher potential energy and that car goes the farthest. This means energy and speed are directly related, the higher potential energy the higher the speed. The earth's gravity we feel every day (referred to as weight) causes objects at a height to have the ability to fall to the ground. This type of contained ability is called "**Potential Energy**". As something begins to move it has speed and takes on a new type of energy of motion called **Kinetic Energy**. Motion can be described in terms of speed, and it requires energy in order to set something in motion. Therefore, speed is related to energy.

Specific Curriculum Outcomes	Inclusive Assessment Strategies:	Inclusive Learning Strategies:
	 Retrieved from: https://www.miamiherald.com/news/local/article265443276.html	

Additional Resources and Materials

13 Lesson Plan Ideas to Teach Potential and Kinetic Energy: https://www.sciencebuddies.org/blog/potential-kinetic-energy-lessons

Potential and Kinetic Energy
https://kidsdiscover.blob.core.windows.net/kdoassets/uploads/infographics/Potential-Kinetic-Energy-Infographic-Kids-Discover.pdf



PE/KE Activities: https://littlebinsforlittlehands.com/potential-and-kinetic-energy/

Additional Useful Content Knowledge for the Teacher:

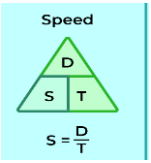
Linking Speed and Energy: https://enjoy-teaching.com/speed-and-energy/

Questions students may ask: https://www.varsitytutors.com/4th_grade_science-help/explain-how-an-object-s-speed-relates-to-its-energy

Tidal Power: https://www.repsol.com/en/energy-and-the-future/future-of-the-world/tidal-power/index.cshtml

Opportunities for Subject Integration:

Art and Craft: Making charts depicting the various forms and types of energy. Constructing gadgets like toy cars to be used during experiments.
Language Arts: Writing an expository essay about energy. Formulating poems and songs about energy.
Mathematics: Calculating speed. using the equation. Calculating distance and time.



Students will construct a line graph of incline height versus time taken for a car to travel the predetermined distance. (graph should show higher angle increases speed).

Ratio

Physical Education: timing students to determine the fastest runners to represent their house at sports. Using the stopwatch appropriately

Converting Energy to Motion

Cross-Curricular Focus: Physical Science

You use energy every day. Energy is the ability to cause change. Any time you move, you are using energy. When you bounce a ball or ride a bike, you use energy from your body to make the ball or the bike move. Your parents cook food for you to eat. They use heat energy to change the food from raw to cooked.

Not all energy is used as soon as you get it. Sometimes energy is **stored** to be used later. Stored energy can be chemical energy stored in a battery or in your body. It can also be potential energy. Potential energy is based on the position of the object. A ball at the top of a hill has potential energy. A soccer player standing ready to kick a ball has potential energy, too.

Energy of **motion** is also called kinetic energy. Potential energy **converts**, or changes into, kinetic energy when the thing or person begins to move. When the ball starts rolling down hill, kinetic energy is at work. When the soccer player kicks the ball, kinetic energy is at work there, too.

Energy often changes forms. When you switch on the light, electricity converts into light. When you eat, chemical energy from your food converts into thermal and mechanical energy that allows you to move and work. When you switch on a cell phone, chemical energy from the cell phone's battery converts into sound energy and light energy.

Name: _____

Answer the following questions based on the reading passage. Don't forget to go back to the passage whenever necessary to find or confirm your answers.

1) What is energy?

_____

_____

2) Energy that is based on an object's position is called

_____

_____

3) What is another name for energy of motion?

_____

_____

4) What is another way to say "changes into"?

_____

_____

5) What is kinetic energy?

_____

_____

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Name: Key

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the ability to cause change

2) Energy that is based on an object's position is called
potential energy

3) What is another name for energy of motion?
kinetic energy

4) What is another way to say "changes into"?
converts

5) What is kinetic energy?
energy of motion

retrieved from: https://studylib.net/doc/18110278/energy-to-motion

Students can construct various gadgets to be used in class activities. Some locally made toys are based on the principles of energy conversion of potential to kinetic energy. The Kabouwé is a traditional truck made in Saint Lucia and Dominica, from scraps of wood and some are made large enough that a child can sit in. Children would ride them on slopes or hillsides. This toy is called Roller in Grenada. Potential energy at the top of the slope provides the momentum to take them to the bottom at top speeds. Most often they are pushed with a stick. SVG: box cars made from old banana crates or banana "trunk".

Elements from Local Culture, Technology, TVET, Environment that are integrated:
Students can construct various gadgets to be used in class activities.

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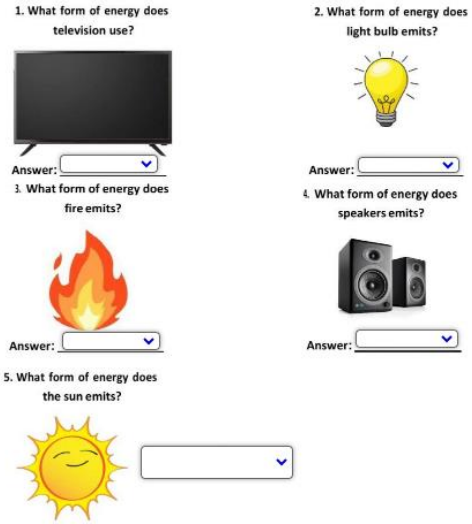
Essential Learning Outcome 2: Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.

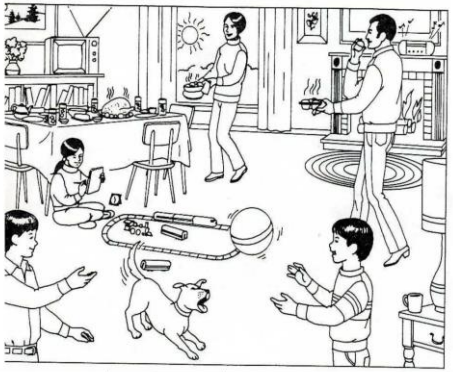
[Assessment Boundary: Assessment does not include quantitative measurements of energy.]

Grade Level Expectations: Refer to grade level expectations at the beginning of this curriculum document.

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies

Learners are expected to:
 	
Knowledge
• Define the terms:
  ○ energy
  ○ light energy
  ○ sound energy
  ○ heat energy
  ○ energy transfer
  ○ energy transformation
  ○ fibre optics
  ○ battery
  ○ tsunami
  ○ biomass
  ○ oil consumption
 	
• Give examples of ways that energy is transferred.
• Give examples of how energy is transformed.
• Explain how fibre optics is an example of transfer of energy
• Identify the sun as a source of energy.
	Identifying Forms of Energy
	
	Name _____ Date _____
	DIFFERENT FORMS OF ENERGY
	WORKSHEET
	Draw an example of object that used or emitted the energy forms below.
	
	FORM OF ENERGY / EXAMPLE / EXAMPLE OBJECT
	LIGHT ENERGY — Light bulb, sun
	SOUND ENERGY — music
	ELECTRICAL ENERGY — battery, computer
	KINETIC ENERGY — falling apple, car move
	HEAT ENERGY — fire, iron, microwave
	
	Retrieved from https://www.worksheeto.com/post_energy-light-heat-sound-worksheets_446/
		Students, I am sure you have heard the word energy before. Has a parent or teacher ever asked you to do something and you have replied "I just don't have the energy!"
		What do you mean when you say that?
		(*I am tired, my body is sore, it is too late in the day*)
		A simple definition of **energy is the ability to do work.**
		
		Besides the energy we can produce (physical work) by eating a balanced diet, getting exercise and caring for our health, there are other types of energy all around us!
		
		Where do you see energy around us in everyday life?
		(lights, motion, heat, sound, waves)
		
		Energy exists in many forms. Based on the pictures below, are you able to guess the forms of energy?

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
• Describe how sounds can be made. • Distinguish between natural and manmade sources of light. (ST 2 ESS SS 2) • Identify and explain ways in which technology (especially energy-related) has enhanced lives of people past and present. (ST 2 PS EN 7) • Identify and name natural and human-made objects that emit light. (ST 3 PS EN 1) • Describe, with examples, the ways in which heat, and light are used by humans in everyday activities. (ST 3 PS EN 3) • Describe the ways in which solar energy is used in the home (heat, electricity, air conditioning) (ST 3 PS EN 6) • Discuss simple examples of energy transformation. (ST 3 PS EN 8) • List examples of fuels used in their country in the home, transportation and production of materials. (ST 3 PS EN 4)	*Possible answers for:* *Light energy (lamp, candle, flashlight)* *Sound energy (radio, drum, guitar, television)* *Electric energy (phone, vacuum, fan)* *Kinetic energy (person walk, bird flying, rolling ball)* *Heat energy (hair dryer, toaster)* **Identifying Energy Sources** 	(The students will be engaged in a guided discussion in order to arrive at the answers.)  Retrieved from: https://www.liveworksheets.com/w/en/science/1770567 Possible responses: (*1. heat, sound, light, electrical* *2. light, heat, electrical 3. heat, light, sound, 4. sound, electrical, heat 5. light, heat)* As a supplement to this formative assessment, teachers that have access to technology may show this video and ask students to identify at least 5 forms of energy. https://www.youtube.com/watch?v=SNd1c4i5MYg (3.14 mins)

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
Skills • Observe and interpret teacher demonstrations of energy transfer. • Infer that energy can be transformed from one form to another. • Exercise internet research skills. • Communicate internet research results/understanding through text and graphics • Create a bar graph from oil consumption data. • Construct a simple circuit. • Construct simple flowcharts to represent simple energy transformations. • Design and draw a timeline to show how technology (energy-related) has changed over time. (ST 4 PS EN 3) • Identify and name the parts of a simple electrical circuit and demonstrate by setting up one. (ST 5 PS EN 1) • Compare at least two devices that provide heat and light using selected criteria. (St 4 PS EN 4) • Compare devices that burn different fuels from the	Retrieved from: https://www.kidsacademy.mobi/printables/physical-science-energy-sources/ **Energy Transformation** Name _____ In Class & At Home Period ____ Assignment *Illustrations of Energy and Energy Transformations* Using the picture, find as many forms of energy as you can. Following the chart below, color the parts of the illustration where you might find each of the four forms of energy. You may find more than one example of each. There will be a prize for 1st, 2nd, and 3rd place. Form of energy / Color Electrical energy — yellow Thermal (heat) energy — red Chemical energy — blue Mechanical energy — green **BONUS CHALLENGE**: Number any energy transformations you can identify. Record the type of transformation and the steps in the table at the bottom of the page. You may use the back of this sheet if you need more room.  Number on Diagram / Type of Transformation / Steps (Types of Energy) *ex. chemical → mechanical*	**Forms of Energy** **We will focus on four forms of energy.** **1. Sound Energy** Sound is the movement of energy through substances in waves. Sound occurs when a force causes an object to vibrate. These vibrations create sound waves. Sound energy is used in radios, IPods, and for the generation of music. Sound is used for communication by animals including humans **2. Light Energy** Light is a form of energy that allows us to see. The sun is the ultimate source of light energy (called solar energy. Solar energy can be used to cook, keep warm, dry clothes and create electricity.) but there are other forms of light energy such as light given off by a candle or an electric bulb. We can use light energy to see or to power objects such as solar calculators or solar panels that can be used to generate electricity. Plants need light energy to produce their own food. **3. Electrical Energy** Electrical energy is the movement of charged particles. Electrical energy comes from other forms of energy that are changed. We commonly use this form of energy to power things in our homes. Examples of electrical energy include objects that run on batteries. Batteries create a flow of particles (electricity) when a circuit is

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
amount of pollution they cause. (ST 5 ESS ER 8) • Compare the amount of air pollution in two named areas. (ST 5 ESS ER 9) • Describe and discuss how burning (of fossil fuels) can cause air pollution. (ST 6 ESS ER 4) **Attitudes/Values** • Appreciate the importance of energy transformation/conversion in the home and in the community. • Be persistent in conducting research on energy. • Understand that human production processes make goods and products (from energy) which may impact the environment. (ST 5 PS MM 4) • Understand that technological processes (that use energy) including manufacturing and construction may have impact on our lives. (ST 5 TE NT 5) • Recognize that resources should be used wisely since	Retrieved from https://formspal.com/pdf-forms/other/illustrations-of-energy-transformations/ **What Fuels are Used for Energy in Your Community** Students should work in groups to create a one-page graphic organizer showing all the different fuels that are used in their community for transportation, heating, industry etc. **Negative Affects of Burning Fossil Fuels for Energy** The teacher should divide the class into two opposing teams to have a debate about the pollution impacts of burning fossil fuels (oil, diesel, natural gas, coal). **The question**: Can we tolerate the amount of pollution generated by burning fossil fuels given the extreme need in our communities for inexpensive energy? In the discussion, the teacher should challenge students to consider: 1) the levels of pollution that different fuels generate. Are some tolerable and others not? 2) Where is air pollution most prevalent in their communities (i.e. streets, industry, farms etc.). Where is it tolerable and where should it be most avoided?	complete. Lightning is an example of a natural form of electrical energy. 4. **Thermal or Heat Energy** Thermal energy is a form of energy that we often refer to as heat energy. Thermal energy is caused by the increased activity of the molecules (or tiny parts) that make up an object. When these particles vibrate very rapidly, heat is produced. Our greatest source of thermal energy is the Sun. We use thermal energy to heat our water and our homes. Some examples of thermal energy include a campfire, water boiling on a stove, and an oven. **How Does Energy Get Transferred?** **Teacher demonstrations** **Example 1: Motion of waves** Fill a large tub with water. Put a small floating boat at one end. At the other end of the tub agitate the water using a flat plastic cover. Ask the students why the boat at the other end of the tub begins to move? (*The energy you put into the wave travels across the water and is felt by the boat in its movement.*) Reiterate- energy can travel! **Example 2: Sound is a wave** Access a small drum (or stretch the latex of a balloon over a large jar top and fasten the sides so that you have a membrane covering the bottle.) Place a small amount of sand on the top of the drum skin. Next to the drum play a sound from a radio or music player (or tuning fork if you have one). Ask the students why the sand on the drum skin begins to jump? (*Sound is a form of energy as a wave and as it travels by the drum skin it passes energy to the membrane causing it to vibrate.*) Reiterate- energy can travel!

<table>
<tr><th>Specific Curriculum Outcomes</th><th>Inclusive Assessment Strategies</th><th>Inclusive Learning Strategies</th></tr>
<tr>
<td>many of them are non-renewable. (ST 5 TE UT 2)
• Show Interest/Curiosity in the uses of fibre optics to human life.
• After research, respect the multiple uses of fibre optics.
• Demonstrate restraint to avoid overuse of energy.
• Work collaboratively and cooperatively in groups.
• Stewardship/Respect for Living Things and the need for energy.
• Take safety precautions to prevent long term and short-term health issues associated with energy conversions.
• When conducting practical and group work, display sensitivity and offer assistance to peers who may have physical or learning challenges.
• Participate actively in classroom discussions.
• Appreciate the role of human-made devices that provide heat and light in our daily lives. (ST 4 PS EN 1)</td>
<td>Heat and Light as Energy Sources
Student response paragraph:
In times gone by, fire was an important form of energy that provided heat and light. Compare the forms of heat and light that we enjoy today on the basis of cost, convenience and sustainability.
Have students fill in the table below and be prepared to discuss these factors.

<table>
<tr><td>Source</td><td>cost</td><td>convenience</td><td>sustainability</td></tr>
<tr><td>Fire</td><td></td><td></td><td></td></tr>
<tr><td>Flashlight</td><td></td><td></td><td></td></tr>
<tr><td>House lamp</td><td></td><td></td><td></td></tr>
<tr><td>Electric heat</td><td></td><td></td><td></td></tr>
<tr><td>Oil fired furnace heat</td><td></td><td></td><td></td></tr>
<tr><td>Coal</td><td></td><td></td><td></td></tr>
</table>

Research Tsunamis
Students should be asked to look up information on the internet regarding tsunamis.
In a one-page response paper, have students explain what a tsunami is using a drawn picture if they wish. They must answer the question “how does a tsunami demonstrate the transfer of energy? (Violent motion in the earth’s crust creates a wave that travels a long distance and is felt in the form of wave surges on the beach and resultant flooding.)
Rubric:
Explanation of the tsunami (5 marks)
Explanation of the energy transfer (5 marks)</td>
<td>Example 3: Heat energy
Cut a 15 cm piece of metal coat hangar and dip one end in hot wax from a burning candle. Let the wax solidify. Hold the hangar at one end and heat the middle of the metal with a candle flame. Ask students why the wax melted.?
(Eventually, the heat energy will be transferred along the metal and cause the wax at the end to get soft and melt.
Reiterate- energy can travel!
Ask students if they have ever seen a pot or fry pan with a rubber or plastic handle? What is the purpose? (to prevent he transferred heat energy from heating up your hand)

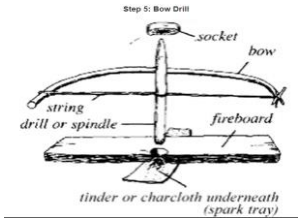
<u>Brief history on fire- An Example of Energy transformation- motion to heat</u>

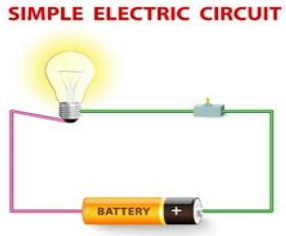
We are fortunate to have matches and stoves in order for us to cook our delicious meals, but do you know how far back we have been using fire? (cavemen days or 300 000 to 400 000 years ago)

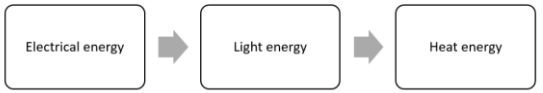
Back in the days, people had to be creative in order to survive and making fire was one of them.

In order to create fire, ancient humans converted motion (which requires work and hence energy) to heat.

Can you make a fire without matches or kerosene?
Take a look at the video below, will you be able to make a fire on your own to survive in the wild?</td>
</tr>
</table>

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
	Research the Ear Drum Students should be asked to look up information on the internet regarding the anatomy of the ear drum using a drawn picture if they wish. In a one-page response paper, have students explain how an ear drum works to allow us to hear sounds. They must answer the question "how does an ear drum demonstrate the transfer of energy? (*sound waves are created by motion and this wave energy passes through the air and into our ears where the wave causes the ear drum to vibrate and signal unique sounds recognized by the brain)*) Rubric: Explanation of the ear drum (5 marks) Explanation of the energy transfer (5 marks) **Research the Toaster** Students should be asked to look up information on the internet regarding a common household bread toaster using a drawn picture if they wish. In a one-page response paper, have students explain what properties of the elements in the toaster make it a good choice compared to other metals. They must answer the question "how does the nichrome element demonstrate the transformation of energy?" (*The nichrome alloy element has a high resistance so when the element has electricity passed through, it gets very hot. Electrical energy is transformed into heat energy.)* Rubric: Explanation of how a toaster operates (5 marks) Explanation of the energy transformation (5 marks)	 Retrieved from: https://www.youtube.com/watch?v=bxjqz2_-Zc4 (2.00 mins) Tools which were used to make fire Retrieved from: https://www.youtube.com/watch?v=bxjqz2_-Zc4  **More Examples of Energy Transformations** **Student experiment** Materials: batteries (dry cells), connecting wires, switch, light bulb, flashcards (with the terms: electrical, heat, light)

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
	Research the Sugar Cane Press Students should be asked to look up information on the internet regarding the use of animals to squeeze sugar from cane. e.g. Retrieved from: https://www.flickr.com/photos/127184668@N03/52315791127/  In a one-page response paper, using a drawn picture if they wish, explain how the sugar was removed from the cane using an animal. They must answer the question "how does food and water fed to the animal transform the energy? (*The animal in getting nutrients has the ability to do the work of turning the cane press when it walks around the machine. When a piece of cane is directed into the press, the motion compresses the cane thereby releasing the sugar)* Rubric:	Students will be placed in mixed ability groups and given materials to build a circuit. Students will be asked to use the materials provided to make the bulb light. The students will play with the materials and eventually build a circuit.  When is the circuit an open circuit? (*The switch is open*) Students please leave your circuit open. What form of energy is present in the open circuit? (***electrical potential energy***) We call it this because the battery has potential to do work as soon as we give it an opportunity. Students, please close your circuit. Let us leave it on for a minute. What happened to the bulb? (*It lit up*) What form of energy was produced? (*Light energy*) Place your hand around the bulb. What do you feel? (*Heat/ bulb is hot*) What form of energy was produced? (*Heat energy*) What energy was present before we put on our switch/complete the circuit? (*electrical potential energy*) What happens to this energy? (*changed form*) What new forms of energy were produced? (*heat and light*) We have just observed that energy transformation took place. What do you think is energy transformation? The teacher will have the students formulate a definition for energy transformation. (*Changing of energy from one form to another.*)

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
	Explanation of how the cane press operates (5 marks) Explanation of the energy transformation (5 marks) **Research Biomass** In a one-page response paper, using a drawn picture if they wish, explain the sources of biomass that might be used for energy in the Caribbean region. They must answer the question "how does the biomass get transformed into usable energy?" (*there are a whole host of bioproducts of plants and food that can be heated to burn giving us energy that can be sued for heating or steam production to turn turbines)* Rubric: Explanation the sources of biomass (5 marks) Explanation of the energy transformation (5 marks) Useful Teacher Reference: https://education.nationalgeographic.org/resource/biomass-energy/ **Extension Activities** **Careers in Energy** Discuss with students the importance of careers in maintaining current energy sources and innovation in exploring renewable energy. Ask invited speakers to share the career paths and daily work lives of those involved in energy careers. **Cost of Renewable Energy** It is easy to suggest that we should be careful of using up our non-renewable resources such as coal and oil and natural gas. Students should do research	We can develop a flowchart to represent the energy transformation that took place. Students can be given the three forms of energy and the arrows on flash cards and can be asked in their groups to create the flowchart.  More Examples of Energy Transformations Materials: Electric kettle, tea, sugar, milk, cell phone, ice, towel, flashlight, flash cards, markers. The teacher will set up the following workstations around the classroom and/or around the school in order for students to observe, write down the energy transformations/conversions and then create flow charts. Guiding questions can be posed to the students/placed at the workstations to help them identify the energy conversions such as • What form of energy is powering up the object/device? • What energy form of energy is being generated when this device/object is being used? • If the object was left on/used for a long time, what would happen to it? Workstation 1: Using an electric kettle to boil water for making tea *Energy transformation observed:* *electrical energy → heat energy → sound energy* Workstation 2: Using the cellphone to play a video. *Energy transformation observed:* *chemical potential energy →Electrical energy → light energy→ sound energy and heat energy*

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
	on the internet to answer some of the more difficult questions in the region such as: 1) What are the relative upfront costs of renewable energies such as solar power or wind power 2) Can the average person afford renewable energy? 3) What are the job implications for moving away from oil? 4) What are the environmental dangers and resultant costs of continued oil use in terms of extraction and transport? 5) Are humans prepared to be more energy conscious or are we too comfortable to reverse our high energy consumption trends? The class could be divided into groups where each group got one of the aforementioned questions. Students could be asked to prepare an essay to answer these or a class presentation digitally or through a poster. **Energy Consumption** Students will use the data below to create a bar graph showing the number of barrels of oil consumed daily by the identified countries in the Caribbean. Note to students the dramatic difference in consumption for bigger countries worldwide.	Workstation 3: Use a remote-control car *Energy transformation observed:* ***Chemical Potential energy → electrical energy →kinetic energy → sound energy → heat energy*** Workstation 4: Using a fan to cool the room *Energy transformation observed:* ***Electrical energy → kinetic → sound energy and heat energy*** Alternatively: A video demonstrating various energy transformations can be played. Students can identify the energy transformations and create the flow charts based on the examples from the video. The video reveals the flow charts for each example. 

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies

Country	Barrels per day
Dominica	**1301**
St. Vincent & Grenadines	**1619**
St. Kitts & Nevis	**1700**
Grenada	**2000**
Saint Lucia	**3099**
Antigua & Barbuda	**5001**
United Kingdom	1,583,896
India	4, 443,000
China	12,791,553
U.S.A	19,687,287

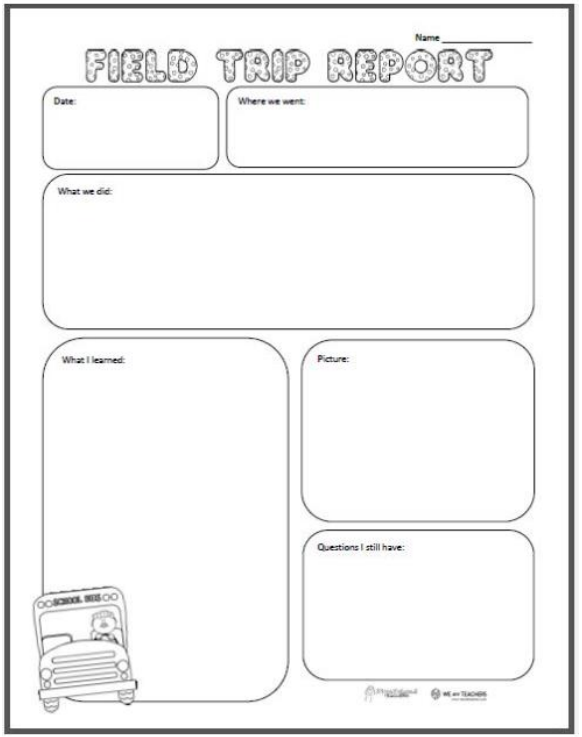
Data set: https://www.worldometers.info/oil/oil-consumption-by-country/

Inclusive Learning Strategies:

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		All images retrieved from: https://youtu.be/PKm4ZVNmJyQ?si=fN0tINMfOEipKkjH (4:10 mins) The video has 8 examples of energy transformations. Each group can be given different transformations to prepare the flowcharts. - playing a guitar - light a bulb - light a matchstick - use a bow and arrow - Using an electric kettle - Riding a roller coaster - Using an electric bell - Using a drill to put a nail/screw **Importance of Energy Transformations at home and in the community** Did you know that energy transformations have been utilized over the centuries so that people can do work? ***Remember energy can't be created or destroyed only transformed.*** Let us watch a video that looks at examples of energy transformations in everyday life over the centuries. Can you identify some new examples of energy transformations from the video? Why are these transformations important. https://youtu.be/9wxbT2g1jtM?si=GsdCumFO1Na7eAQf (5:46 mins) **Note**: For those teachers without access to technology, please show students pictures of the following energy transformations and get them to explain what is happening: ➢ A person eating a mango as they work in the field *(food converted to work)*

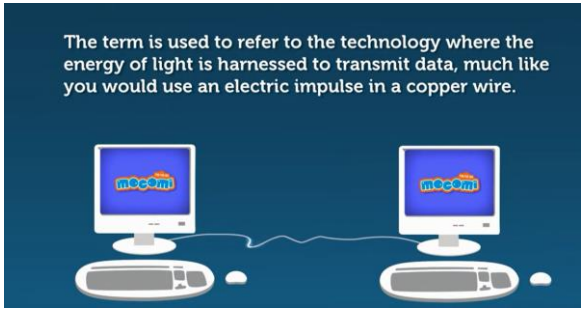
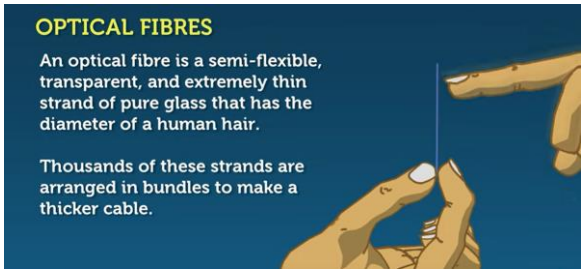
Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		➢ A person drawing back the string on a bow to fire an arrow (*motion of pulling on bow creates forward speed of the arrow-energy transformed form putting tension in the bow*) ➢ Wind energy turns the fins on a windmill or water turns the paddles on a water wheel. (*The wind or water turns a wheel which can be used as energy for pumping water, grinding grain, lifting objects, creating electricity. Etc.)* These are examples of **renewable resources** because they continue to flow naturally with no additional work on our part and they should last forever unlike oil or natural gas which eventually will be entirely used up- then what do we do for energy? ➢ Sunlight shines on a coconut tree. (*the energy from the sun is converted into food in the form of a coconut which can further be used by humans as food in order to do work*) ➢ Wood is burned to create heat. (*the wood has stored chemicals that are capable of being ignited as a fire and to produce heat as a biproduct of combustion)* Materials: pictures/ video footage of industries, factories, businesses in your community. Energy is needed for all activities. Students will be engaged in a classroom discussion by posing the following questions. Pictures of the industries and businesses can be present to stimulate discussion. ● What activities do we use energy for at home and in our community? ● What industries/ businesses are present in your community? Where do they get their energy from? ● How is it stored so it can be drawn from when needed? ● How is the energy used? Is it used in only one form? The teacher will use a graphic organizer to record the information from the discussion.

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		People that Work with Energy- Class Visit Invite technicians, experts working in various industries to discuss energy transformations that take place and how energy is used in the workplace etc. OR **Field Trip to various business and industries** where students learn about the energy transformations and how the energy is stored and utilized as well as the negative effects of energy transformations to the body and the environment. Example: paint factory, bakery. The students can fill out the graphic organizer while on the field trip/ listening to the professionals speak about energy.

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		 Retrieved from : https://squareheadteachers.com/2015/06/08/field-trip-report-free-printable/ The teacher will elaborate on the following that ties the questions together and highlights the importance of energy transformations: The question will be posed to students: Can the constant conversion energy from one form to another have any negative effects? The teacher will guide the discussion using the local businesses and industries for suitable examples.

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		The negative effects of energy transformations can be added to the graphic organizer. **Energy Transformations and advances in Technology** The teacher will pose the following question to the students: Can we bend light? Materials: plastic bottle, laser pointer, drill/ice pick, water The teacher can demonstrate fibre optics by: ● drilling a hole through a plastic bottle about half-way up the bottle. ● Fill the bottle with water and turn down the lights. ● Shine a cheap laser pointer light through the side of the bottle directly across the bottle to the opposing hole. ● As the water leaves the bottle through that open hole, you can see the light internally reflecting down the water stream exactly like a glass fibre. We can bend light energy! The students can be shown the following video that demonstrates the bending of light. https://www.youtube.com/watch?v=hBQ8fh_Fp04 **(1:18 min)**

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		 Teacher will ask the questions after students view the video: Light bends when it moves from one medium to another e.g. when it moves from air to water. is the name given to the bending of light. What name is given to the bending of light? *(Refraction).* Light refraction power fibre optic cables. Optical fiber is a very thin strand of pure glass which acts as a waveguide for light over long distances What are fibre optics important? *(Fibre Optics have the ability to use light to transform energy more efficiently.)* Some discussion points: Refraction and energy transformations are important concepts that engineers apply in developing technology and advances in science. Light refraction emerges as a captivating phenomenon central to the functionality of fiber optic cables. One of the key advantages of fiber optic cables is their superior energy efficiency compared to traditional copper cables. Fiber optic cables

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		transmit data using light signals, which require significantly less energy compared to electrical signals used in copper cables. Thus, the transformation of energy is more efficient for use. Video that explains how fibre optic work and the uses of fibre optics https://youtu.be/o5t6evogJbg?si=ZPnG_8bCExMsvamg (3:58)   What energy is transferred with the use of fibre optics based on the video? (*Light energy is utilized and so energy is transferred from light energy to electrical energy or to transmit signals*)

Additional Resources and Materials
Modern Energy Sources: https://www.energy.gov/energy-sources
Sources of Energy: https://byjus.com/physics/natural-sources-of-energy/
Historical Energy Sources: https://www.sciencelearn.org.nz/resources/1636-energy-sources-through-time-timeline

Additional Useful Content Knowledge for the Teacher:

Energy is needed for most of the activities we engage in every day. We obtain our energy from the food we eat. Plants obtain their energy by using the energy from the sun (solar energy). Energy is also needed for transportation, to drive industry and even for entertainment. Energy is needed to power most of the devices and the technology that we take for granted. In order for efficient use energy must be stored and be readily drawn upon when needed. Usually, energy is transformed from one form to another so that it can be used in a variety of ways.

https://en.islcollective.com/english-esl-worksheets/forms-of-energy/19744#&gid=1&pid=3

Opportunities for Subject Integration:
Language Arts - Composition: *Write an essay as to which form of energy they believe is most important.*
Arts and Craft*: create working musical instruments to create sound.*
Health and Family Life *-*

1. *The benefits of the various types of energy example the use of heat or thermal heat for cooking which can prevent various illnesses*
2. *Safety when working with the various forms of energy, for example heat, electrical safety.*
3. *Research the negative effects of energy transfer on human health.*

Social Studies*: Design and draw a timeline to show how technology (energy - related) has changed over time. / Social issues associated with dirty energy*

Making simple toys at home:

How to make a drone**: https://www.youtube.com/watch?v=jrFBko3k49w**

How to Make a Mini Robot bug: https://www.youtube.com/watch?v=TFkUan5Uujs

How to make cars: https://www.youtube.com/watch?v=eT68ne9TwsA

SVG: Bamboo joint

Elements from Local Culture, Technology, TVET, Environment that are integrated:

Making simple toys at home:

How to make a drone**: https://www.youtube.com/watch?v=jrFBko3k49w**

How to Make a Mini Robot bug: https://www.youtube.com/watch?v=TFkUan5Uujs

How to make cars: https://www.youtube.com/watch?v=eT68ne9TwsA

Items of Inspiration (teaching tips, inspirational passages, connections to educational research):
Research on devices (energy - related) has changed over time. The benefits of such devices to man.
Research on the uses of fibre optics.

Essential Learning Outcome 3: Ask questions and predict outcomes about the changes in energy that occur when objects collide
[Clarification Statement: Emphasis is on the change in the energy due to the change in speed, not on the forces, as objects interact.]
[Assessment Boundary: Assessment does not include quantitative measurements of energy.]

Grade Level Expectations: Refer to grade level expectations at the beginning of this curriculum document.

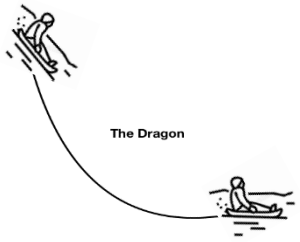
Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies:

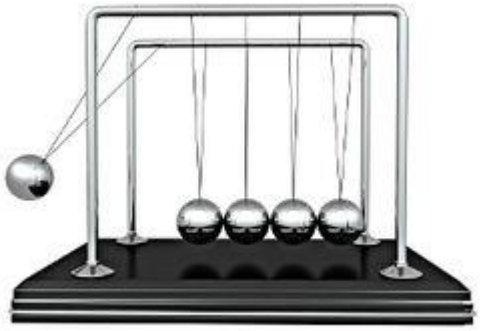
Learners are expected to:
 	
Knowledge
• Define the terms:
  ○ collide
  ○ mass
  ○ speed
  ○ energy transfer
• Explain how the changes in the speeds affect the energy transfer of objects when they collide.
• Account for energy changes as a result of the change in speed and in differences in the masses of objects
• Explain that when object collide, energy is transferred
• Describe how the energy of objects changes when they collide
• Demonstrate ways in which motion can be changed. (ST 2 PS FMS 1)
• Discuss simple examples of energy transformation. (ST 3 PS EN 8)
	Terminology: Energy and Collision
	Select a word from the box below to complete the sentences below.
	
	transformation fast direction
	motion decrease energy
	more kinetic lose
	
	1. Objects that move have this type of energy _____
	2. _____ cannot be created nor destroyed, but it can be transformed
	3. During energy _____, energy is transferred between objects or changes form.
	4. In some collisions, objects bounce back or go off in another _____ instead of becoming deformed. In other collisions, objects are deformed or stick together.
		
		Retrieved from: https://caribbeanbookblog.wordpress.com/wp-content/uploads/2013/12/piaye-bridge.jpg
		
		Storms that involve high winds and rain can sometimes create surges in waterways like streams and rivers. The increased volume of water can cause streams to run more quickly. This rushing water can do serious damage as it runs into (**collides**) with riverbanks, vegetation and bridges. The photograph shows the damage after a storm. What do you think happened to the bridge (*The bridge was washed away.)* What do you think **collided** with the bridge? (*water, trees, debris)*

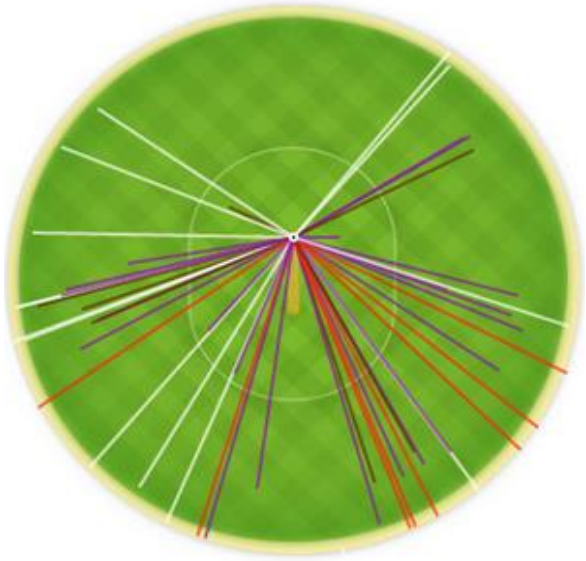
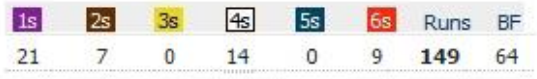
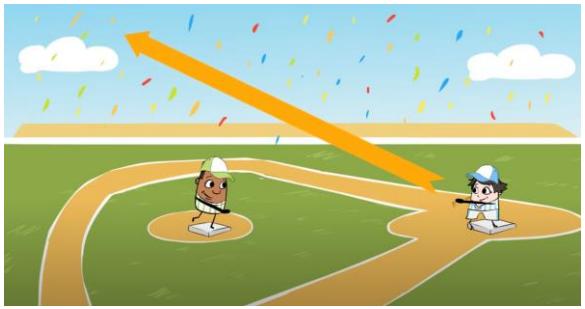
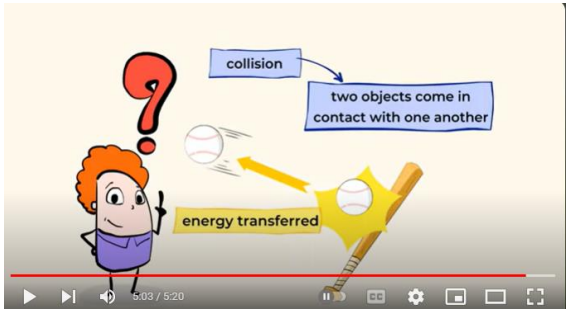
Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies:
• Describe and demonstrate the forces of push and pull. (ST 3 PS FMS 1) **Skills** • Predict how the energy of objects are affected by collisions • Observe the collision of objects with different speeds and different masses • Infer that the larger the mass of an object the greater the energy transfer during a collision. • Investigate the ways in which forces can change the speed and direction of a moving object. (ST 4 PS FMS 1) **Attitudes/Values** • Appreciate why the effect of object collision is a consideration in the engineering/technology design process • Collaboration & Cooperation • Stewardship/Respect for Living Things • Practice safety measures when conducting various activities.	5. The speed and energy of both objects will always_____ when two objects collide Answer Key 1. kinetic 2. energy 3. transformation 4. direction 5. decrease Retrieved and adapted from: https://www.teacherspayteachers.com/Product/Energy-Collision-Quiz-4370800?st=9be4698bb37cbd03c53888b5eeba81b3 **Terminology and Comprehension** Look at the paragraph below. Read carefully and select the most appropriate word below to complete each sentence. **heat energy mass speed** When two objects collide, _____ is transferred. Objects with larger _____ travelling at a greater _____ will transfer the most energy. Energy is also lost in the collision as _____. **Answers** When two objects collide, **(***ENERGY***)** is transferred. Objects with larger (*MASS*) travelling at a greater	**Review of Concepts That Relate to Collisions** Mass Ask students: What is mass? (*The amount of matter in an object.*) Students, in this picture, do you think a heavier mass like a desk, requires more or less energy to move than a book? (*more energy required to move heavier mass*).  Retrieved from: https://www.youtube.com/watch?v=KBzszSr6MWk **Speed** Ask students: If you are running faster than your friend, over the same distance, who has less speed? (*my friend)* If the teacher has access to technology they might show this review video to students

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies:
• When conducting practical and group work, display sensitivity and offer assistance to peers who may have physical or learning challenges. • Participate actively in classroom discussions.	(*SPEED*) will transfer the most energy. Energy is also lost in the collision as (*HEAT*). **Testing Transfer of Knowledge with Scenario Challenges** A car and a truck collide that are going in opposite directions. Set up 4 scenarios for students predict the results by:  Retrieved from: https://www.shutterstock.com/image-photo/yellow-car-accident-collide-blue-truck-1051133627 (The teacher should demonstrate sensitivity to students who were in accidents or knew persons involved in accidents.) a) drawing pictures of before and after the collision and b) writing a sentence that describes the likely result	 Retrieved from https://www.youtube.com/watch?v=5JW8fUU9yEQ (4:38 mins) Briefly explain that energy is the ability to do work or make things happen and that there are different types of energy, such as kinetic energy (energy of motion) and potential energy (stored energy). Distribute objects that have kinetic energy (e.g., a moving car, a bouncing ball) and objects that have potential energy (e.g., a stretched rubber band, a raised hammer). After, explain that during a collision, energy can change from one type to another or can be transferred between objects. **Effect of speed on energy** Two students should be asked to stand 2 meters apart with Person 1 with their back to Person 2. Person 2 with a ball of crushed paper,

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies:
	a. both are going the same speed and mass the same *(They collide, stick together and there is loss of energy through heat and deformed bumpers on collision)* b. both are going the same speed but a heavier truck. *(The truck pushes the car backward maintaining some motion and energy, some energy lost as heat and crumpled bumpers)* c. both vehicles have the same mass, but the truck is moving faster. *(The truck pushes the car backward maintaining some motion and energy, some energy lost as heat and crumpled bumpers)* d. car slower and lighter; truck faster and heavier: *(The truck pushes the car backward maintaining motion and energy, some energy lost as heat and crumpled bumpers)* Many years ago, most car bumpers were made of metal but many today are plastic with foam inside. Do you know why foam bumpers might be a good idea when thinking about collisions? (*Foam bumpers absorb better some of the impact of the collision so the car frame itself doesn't get damaged*) As time passes, engineers and technologists design cars so that on impact the metal and foam in the structure will absorb energy while protecting the occupants of the vehicle. This in turn helps save the lives of the passengers inside.	marshmallow or ping pong ball in hand should throw the object slowly at the back of the Person 1. Ask Person 1 what it felt like? (*it felt like a small impact on my back*) Person 2 should retrieve the object and once again throw it at the back of Person 1 but with greater speed. Ask Person 1 how it felt this time? (*the impact was harder)* Ask the pair: In which case did Person 1 feel more energy as the object hit their back (*the second instance*) In which case did Person 2 throw the object with greater speed? (*the second instance*) Closure: so, we can say that higher speed can be equated with higher energy. Testing for application: In the rushing water example above, which water way is likely to have more destructive power (energy), a) a slow trickling stream or b) a fast-overflowing river? (***b***) So that means the speed of the water is directly related to the energy it possesses to exert damage upon collision with the riverbanks or anything it is path. ***Simulation to Reinforce the Concept*** If the teacher has access to technology, have students view the simulation at the link below: https://contrib.pbslearningmedia.org/WGBH/conv16/conv16-int-rollercoaster/index.html How does speed change with energy? (*Objects which move faster have more energy*).

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies:
	Scenario - Group Work Below is a short scenario. In groups of threes, read the scenario together and come up with a solution. Glen and his friend London are going sledding at a local park. There are two hills to choose from, "The Bunny Slopes," which are small hills and lots of flat surfaces, and "The Dragon," which is a steep hill and not for beginners. If London goes first and reaches the bottom and Glen crashes into him from behind on "The Dragon," what would happen to the motion of their sleds? What does the outcome depend upon? A) If Glen (sled) is heavier than London (sled)? B) If London (sled) is heavier than Glen (sled)? C) How will these scenarios (A & B) compare with respect to London's final position?  *The outcome depends on the mass of the sled and rider and the speed they are travelling.*	**Variables in a Collision** When a collision occurs the energy that each object had to begin with, is **transformed** and redistributed. Begin by asking students if they have ever witnessed or experienced a collision, such as two vehicles crashing head-on? Ask them what determines which vehicle gets the most damage? (*the bigger vehicle less damage, the slower vehicle more damage*) Conclusions: Faster vehicles have more energy; heavier vehicles have more energy. Returning to paired object throwing activity above… If I allowed your partner to throw a cricket ball at your back with the same speed instead of a ball of paper, how would it feel? (*it would hurt*). Would you agree the heavier ball at the same speed will have more energy? We call that energy of motion **Kinetic energy.** *Simulation to Explore Variables* For teachers with access to technology, have students visit the following simulation and investigate variables based on the questions provided below: (***or teacher projected demonstration)*** (https://phet.colorado.edu/sims/html/collision-lab/latest/collision-lab_all.html) ➢ Click on the >intro< icon ➢ Vary the mass of the balls by using the pink and blue sliders- press the play button and see what happens to the balls- what conclusion can you make about the mass of the ball and its energy? (*the heaver ball when put in motion*

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies:
	Likely outcome ***1) London will be pushed forward and Glen will continue a very short distance after the collision*** ***2) London will be pushed forward and Glen will stop quite abruptly.*** ***3) London will be pushed further when Glen (sled) is heavier.*** **Energy Transfer During Collison**  Retrieved from: https://science.howstuffworks.com/innovation/inventions/newtons-cradle.htm This apparatus is called Newton's Cradle (some schools have access to one of these or it can be seen in operation online: https://www.youtube.com/watch?v=0LnbyjOyEQ8 (0:52 mins)	*has more energy than the smaller ball because upon collision the small ball moves backwards*) ➢ Under the collision box you will see a *normal* and *slow* radio button. Change this choice and you will change the speed of the balls. Investigate how mass and speed combine to influence the result of the impact of the two balls. (*the faster and heavier ball will always push the lighter and slower ball backwards because it has more* ***kinetic energy***) **Application/ Transfer of Knowledge** A **collision** is when two objects hit each other and during a collision, the distribution and form of energy can change.  Retrieved from: https://www.shutterstock.com/image-photo/car-crash-accident-on-road-city-573342697 Where does the energy go that each vehicle had as they moved towards each other just before the collision? (the energy is used up to 1) collapse the bumper & metal in the front of the vehicle, 2) push the lighter or slower vehicle backwards or 3) create heat energy caused by the friction of bumpers colliding.

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies:
	As the one left ball swings downward, the energy is transferred through collisions of each of the balls so the far-right ball is sent in an outward motion. This continues back and forth for some time. Ask students why it doesn't continue indefinitely? (*The energy loss through collision is real and eventually it depletes to zero.*) **The Energy Necessary for a Longer Cricket Ball Distance**   	**Reviewing the Concepts in a Video** Click on the link below to watch a short video on transfer of energy in collisions.   Retrieved from: https://www.youtube.cRevom/watch?v=c-St70_J8Xg (5:21 mins)

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies:
	Retrieved from: https://espncricinfo.com/ci/content/stats/index.html The graph above shows the runs scored by a cricketer in a game and the distribution of runs scored. 1. How many fours were scored in the match? (*14*) 2. How many sixes were scored? (*9*) 3. In which instance does the cricketer apply more energy to the bat to hit a six or a four? Give reasons for your answer. (*More energy is applied for a six since the ball moves a greater distance*). Why might there be fewer 4's? (*fewer cricketers have the strength to exert enough energy for a longer distance hit)*	

Additional Resources and Materials

Converting Energy to Motion worksheet: https://www.k12reader.com/worksheet/converting-energy-to-motion/view/

Design of a Bumper for a Car: https://www.sciencebuddies.org/blog/teach-types-of-energy

Energy transfer: https://www.generationgenius.com/energy-transfer-and-collisions-lesson-for-kids/

Simulation Collisions for Advanced Students: https://www.physicsclassroom.com/Physics-Interactives/Momentum-and-Collisions/Collision-Carts/Collision-Carts-Interactive

Bumper car STEM Challenge: https://www.science-sparks.com/bumper-car-stem-challenge/

Additional Useful Content Knowledge for the Teacher:

Collisions: https://www.slps.org/cms/lib/MO01001157/Centricity/Domain/13280/untitled.pdf
Collisions & Energy: https://www.youtube.com/watch?v=Cxkeoq1ie38 (4:15 mins)
Forces & Motion (Collision) https://www.youtube.com/watch?v=Cxkeoq1ie38 (2:03 mins)

Opportunities for Subject Integration:

Mathematics - calculating mass of various objects and speed

Arts and Craft - create a model to demonstrate how collision happens
Composition - write a short poem on collision
Health and Family Life: safety measure to be taken to avoid collisions

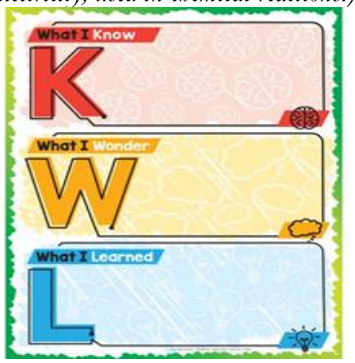
Students can create devices or gadgets to demonstrate collision and its effects. Visit by a safety officer or police officer to give a talk on road safety and avoiding collisions.
See: Bumper car STEM Challenge: https://www.science-sparks.com/bumper-car-stem-challenge/
SVG: Local sports where objects or persons may collide like football, rugby, tennis, marbles, etc.

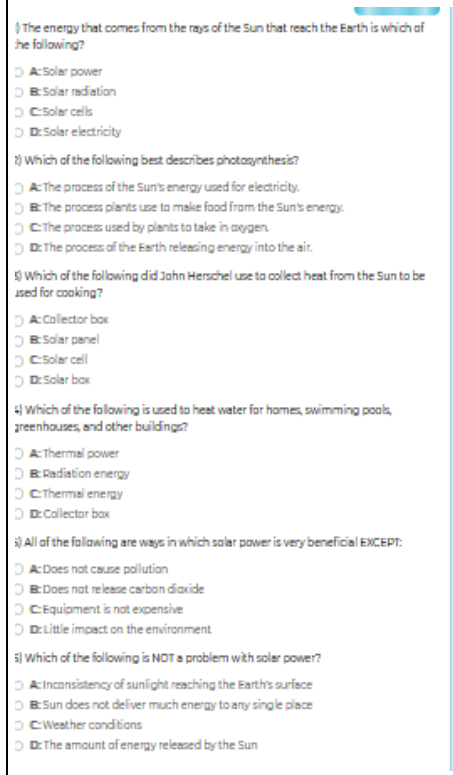
Essential Learning Outcome 4: Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.
[Clarification Statement: Examples of devices could include electric circuits that convert electrical energy into motion energy of a vehicle, light, or sound; and a passive solar heater that converts light into heat. Examples of constraints could include the materials, cost, or time to design the device.] [Assessment Boundary: Devices should be limited to those that convert motion energy to electric energy or use stored energy to cause motion or produce light or sound.]

Grade Level Expectations: Refer to grade level expectations at the beginning of this curriculum document.

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies

Learners are expected to:
 	
Knowledge
• Define the terms:
  ○ Renewable energy
  ○ Fossil fuels
  ○ Solar power/energy
  ○ motion energy
• Compare the advantages and disadvantages of using solar energy as a major energy source of power
• Explain how solar power is used in the community and industry
• Distinguish between renewable and non-renewable energy
• Identify and explain ways in which technology (related to energy use) has enhanced the lives of people past and present. (ST 2 PS EN 7)
• List examples of fuels used in their country in the home, transportation and production of materials. (ST 3 PS EN 4)
	1. **Reading and Comprehension Passage on Solar Energy. Questions After Reading**
	
	Solar Power
	
	Solar power is energy from the Sun. The sun has been producing energy for billions of years, but it is only in the recent past that this energy is being harnessed or collected and changed into heat and electricity across the world.
	
	The energy that comes from the rays of the Sun that reach the Earth is called **solar radiation**. Without humans, animals, or other living organisms needing to do anything, the energy from the Sun has given power to all living things through photosynthesis. **Photosynthesis** takes place when plants use the Sun's energy to make its own food, and then of course, all other living organisms eat the plants or animals receiving that energy indirectly from the Sun.
	
	However, collecting solar power to create electricity and heat is not as easy as plants using the Sun's energy to make its own food. Some people, like an astronomer named John Herschel, used a solar thermal (heat) collector box to cook food during an expedition to Africa. The collector box is a device used to collect the heat from the Sun to cook food. This may not have been the first instance of using the Sun's energy to cook food, but it was a preview of how much energy the Sun has that can be used if collected properly.
	
	Today, the Sun's energy is converted to thermal energy, which can be used to heat water for homes, swimming pools, greenhouses, and other buildings. It can also be used to heat the fluids to high temperatures to power turbines that make electricity. It is not as simple as placing an item in sunlight however.
		
		Retrieved from: https://en.m.wikipedia.org/wiki/File:Fan_in_the_summer.jpg
		
		Look at the picture above. Have you used a handheld fan? (*yes / no*)
		
		How is the fan able to cool you down? (The air is *circulated*).
		
		What powers the fan? (*Battery*)

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
• Describe ways in which solar energy is used in the home. (e.g. heat, electricity & air conditioning) (ST 3 PS EN 6) **Skills** • Observe solar-powered devices at work • Infer that black objects harness the heat from the sun better than a similar object in another colour. • Measure temperature using a thermometer • Construct solar-powered devices using everyday materials • Graph experimental data to identify trends • Infer that the position of the sun changes at different times during the day. (ST 2 ESS SS 3) • Investigate the effects of heat on matter and light on materials. (ST 4 PS EN 2) • Use problem-solving, technological processes, and resources to find solutions to human wants and needs. (ST 5 TE TM 1) • Design and construct objects to satisfy human needs and to make life easier. (ST 5 TE TM 2)	Solar energy is changed into electricity in two ways. Solar cells change sunlight into electricity which are grouped into panels used in a variety of different ways. Sometimes these panels are called solar panels which collect, use and distribute the energy from the Sun. This type of collection is also used to power small cells inside batteries or calculators, but mainly used for power single homes or large power plants. The second way solar power is used to generate electricity is by focusing the Sun's heat to a fluid that produces steam that is then used to turn a generator. Solar power systems are very beneficial. First, they do not cause pollution or carbon dioxide. And they have very little impact on the environment. Overall as well, solar energy costs less once the equipment is in place. The energy and heat from the Sun is basically free but it costs money to build the right equipment to collect the power of the Sun. A couple problems with solar power includes the inconsistency of sunlight reaching the Earth's surface, because the amount of sunlight will vary depending on location, time of day, year, and weather conditions. Also, since the Sun does not deliver much energy to any single place at any one time, a large surface is needed to collect the Sun's energy for it to be useful. Even though the amount of energy reaching the surface of the Earth throughout the world is greater than the total amount of energy used or needed, the current limitations in collecting this energy will need to be overcome. In summary, solar power is a useful source of heat and electricity for the world, but there are some obstacles to overcome before it becomes the only source of energy for the world's needs.	What is the energy transformation in a fan? (***electrical → kinetic energy***) Let us discuss solar power and its uses. **Solar Power and Its Uses** Students will be given a KWL chart where they will fill the K column indicating what they know about solar energy and the W column indicating what they wonder about solar energy and would like to learn. Guiding questions to fill KW columns: • What is solar energy? (*Energy from the sun capable of producing heat and electricity*) • How is solar energy used in everyday living? (*To generate electricity, used in chemical reactions.)*  Retrieved from: https://www.discountschoolsupply.com/stem-curriculum/stem/science/really-good-stuff-jumbo-magnetic-dry-erase--kwl--know-want-learn-chart/p/s812033

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
Attitudes/Values • Appreciate the many ways solar energy is utilized in the home, environment, and industry • Show persistence in creating and testing solar-powered devices • Demonstrate inventiveness in designing and creating solar-powered devices • Work collaboratively to design and test scientific ideas. • Stewardship/Respect for Living Things • Safely handle hot substances and devices that produce heat • When conducting practical and group work, display sensitivity and offer • assistance to peers who may have physical or learning challenges. • Participate actively in classroom discussions. • Natural resources are not likely to last forever so judicious use and looking for renewable sources like solar alternatives is advisable. (ST 2 STSE 3)	 1) The energy that comes from the rays of the Sun that reach the Earth is which of the following? A: Solar power B: Solar radiation C: Solar cells D: Solar electricity 2) Which of the following best describes photosynthesis? A: The process of the Sun's energy used for electricity. B: The process plants use to make food from the Sun's energy. C: The process used by plants to take in oxygen. D: The process of the Earth releasing energy into the air. 3) Which of the following did John Herschel use to collect heat from the Sun to be used for cooking? A: Collector box B: Solar panel C: Solar cell D: Solar box 4) Which of the following is used to heat water for homes, swimming pools, greenhouses, and other buildings? A: Thermal power B: Radiation energy C: Thermal energy D: Collector box 5) All of the following are ways in which solar power is very beneficial EXCEPT: A: Does not cause pollution B: Does not release carbon dioxide C: Equipment is not expensive D: Little impact on the environment 6) Which of the following is NOT a problem with solar power? A: Inconsistency of sunlight reaching the Earth's surface B: Sun does not deliver much energy to any single place C: Weather conditions D: The amount of energy released by the Sun **Answers to questions.** • **1)B** • **2)B** • **3)A** • **4)C** • **5)C** • **6)D** **Passage retrieved from:** https://www.softschools.com/language_arts/reading_comprehension/science/111/solar_power/	Students will be engaged in a brainstorming session where they will share what they know about solar energy. The teacher will play the following video that introduces the concept of solar energy and how it has been harnessed around the world in ancient times and in recent times.  Retrieved from https://youtu.be/cie87hYf1uo?si=LT64gwNC_xI89-Qh (3:28) Students will be asked based on the video: **What is Solar Energy?** (*Energy that comes from the sun*) **Why is solar energy considered to be renewable energy?** (*It cannot be used up. It can be drawn upon over and over again*)  **How did ancient dwellers use the sun's energy to heat their homes** (*They built their homes in such a way so that the position*

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
	2. Reading and Comprehension Passage **What is Energy and Where Does It Come From?** **Passage including answers to questions.** https://www.essa-tlemcen.dz/wp-content/uploads/2018/02/What-is-Energy-and-Where...-Comprehension-Passages%E2%80%9D.pdf **3. Advantages and Disadvantages of Solar Energy.** Students will complete a table showing the advantages and disadvantages of solar energy. Read each statement carefully. Complete the table by placing each statement under the correct heading. **Statements** 1. Solar energy can help reduce your electricity bill. (advantage) 2. Solar equipment is expensive. (disadvantage) 3. Solar panels require lots of space. (disadvantage) 4. The production of solar energy produces no pollution. (advantage) 5. Solar power cannot be harnessed during a storm or at night. (disadvantage)	*of the sun fell directly into an opening of the cave/ house near the top providing heat and light, especially in cold winter months*). The position of the sun changes at different times so the design must take advantage of that so there is heat and light. **What are some of the ways that solar energy is used?** (*Heat or cool homes and buildings, to generate electricity, power small devices*)  **What is used to harness the energy from the sun so that it can be converted to other forms of energy?** (*Panels filled with light-sensitive elements that are positioned to capture sunlight.*) These panels are used to make **photovoltaic cells** that can generate electricity.

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies

Advantages of Solar Power	Disadvantages of Solar Power

4. Make a Better Solar Cooker Project

In small groups students will be challenged to construct the following solar cooker, record the temperatures, and brainstorm and design a better cooker that can achieve greater temperatures. This activity will require more than one lesson.

Let's make a solar cooker
You will need: an old tire, a sheet of glass, a dish of water, a thermometer

Lay the tire on the ground in a sunny spot.
Stand the dish of water inside the tire.
Place the thermometer in the water.
Cover the tire with glass.

Record the temperature of the water every 15 minutes in the table below.
Note: heat energy from the sun passes through the glass and heats the air, water and the ground inside. The glass helps to trap the heat inside.

Solar Energy is used in so many ways right in our home and community. Let us examine some other uses by observing and discussing these pictures:

Here are some other uses of solar energy.

As heat for making hot water, heating buildings, and cooking.
To generate electricity with solar cells or heat engines.
To take the salt away from sea water.
To use sun rays for drying clothes and towels.
It is used by plants for the process of photosynthesis.
To charge batteries

Teacher will have a discussion with students about solar panels and their usefulness in the far north as compared to equatorial locations.

Why are solar panels not as useful to use in the far north for energy compared to equatorial locations?

The tilt of the earth on its axis means the north and south poles get indirect sunlight at some of the year

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies

Time (mins)	Temperature (Celsius)
15	
30	
45	
60	
75	

Now draw a simple line graph of temperature on the Y axis (the dependent variable) and time on the X axis (the independent variable) for the data in the table.

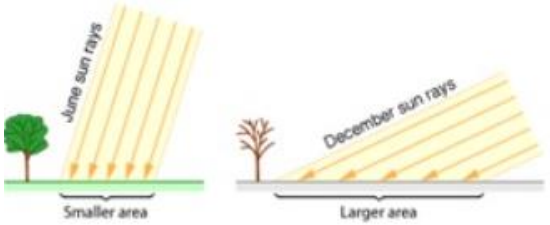
Rubric to Assess Improved Solar Cooker

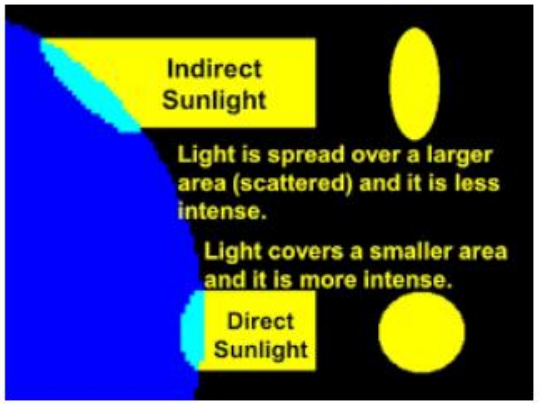
	Max Points	Points Earned	Comments
Design Design of the solar cooker is creative	5		
Quality of Model Solar cooker is constructed neatly and soundly (the parts do not fall apart)	5		
Guidelines Solar cooker fits guidelines	5		
Testing The temperature of the water rises in the allotted time frame.	10		

Adapted from: :https://ccasciencelab.weebly.com/uploads/3/7/8/0/37805103/solar_cooker_rubric_and_web_quest.pdf

while the equatorial regions are exposed to direct sunlight all year round.

The indirect sunlight places the sun's energy over a greater area and therefore individual locations get less sun energy.



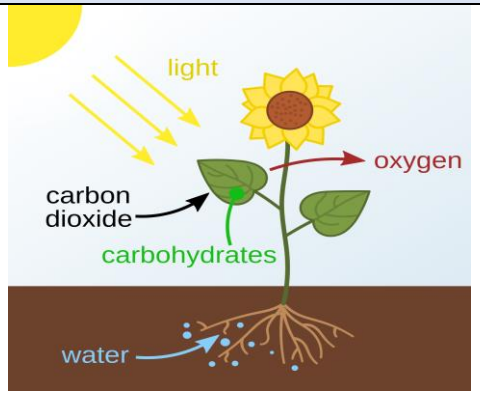


Retrieved from: https://slideplayer.com/slide/4183109/

https://youtu.be/2O0JaROLuUY?si=PMrlM-pII6o7U8O0 (Stop at 2:52 - use in photovoltaic cells and in small devices)

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
	5. **Copy and complete these sentences using the key words.** **electricity heat light solar energy** Energy from the sun is called _____ _____. This energy arrives at the earth as heat and _____. Solar panels trap solar energy as _____ and solar cells convert solar energy into _____. Energy from the sun is called **solar energy.** Thus, energy arrives at the earth as heat and **light**. Solar panels trap solar energy as **heat** and solar cells convert solar energy into **electricity.** **<u>6 Answer in complete sentences.</u>** Describe three (3) ways in which we use solar energy every day. **<u>7. Creative Writing/ Student's Choice</u>** Each student selects one of the following tasks to complete. The completed products can be displayed in a class exhibition. a. Students can create a poster describing at least three benefits of solar energy. b. Students can create a short comic strip explaining the benefits of solar energy. c. Students compost a song or poem on the benefits of solar energy.	 **How does the calculator and wristwatch work?** (*Solar cells power calculators, wrist watches, and other small solar-powered devices.*)  Solar Cells are an important power source for spaceships and man-made satellites. 

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		Retrieved from: https://byjus.com/question-answer/which-of-the-following-scenario-is-the-best-for-drying-our-clothes-the-quickest-given/ Why were the clothes placed outside on the line? (*To dry*) How do they dry? (*The sun's rays are used for drying clothes and towels. The water gains heat energy and evaporates into the atmosphere.*)  Retrieved from https://www.bhg.com/gardening/houseplants/care/watering-houseplants/ **What is that plastic container used for?** *(To water the plants*) Why were the plants placed near the window? (*To get sunlight*) What is sunlight needed by the plants? (*To make their food*) Plants utilize solar energy in the process of **photosynthesis.**

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		 Retrieved from https://en.wikipedia.org/wiki/Photosynthesis Solar energy powers the food chains, providing food for all living things. Plants use sunlight to make food for energy and when animals consume plants, they gain some of that energy.  Retrieved from https://www.walmart.com/ip/Solar-Charger-30000mAh-Portable-Power-Bank-For-Cell-Phone-Camping-External-Backup-Battery-Pack-With-Flashlight-IP65-Outdoor-Activity/

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		What devices is the cell phone connected to? (*Charger*) **What is powering the charger?** (*Solar power*) **How can you tell?** (*I can see the solar panel/cell*) Solar energy can be used to charge batteries in different devices.  Retrieved from https://patricklepetit.jalbum.net/_AGRICULTURE/PHOTOS/SALT%20FARMS/indexb.html This is a sea salt farm. Sea water is first pumped into the fields. Once the water has evaporated, layers of salt remain to be collected by the farmers. **What energy do you think is used for evaporation?** (*Solar energy is used to take the salt away from seawater.*)

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		Advantages and Disadvantages of Solar Energy The students will be given a passage to read on Solar Energy. The passage reviews the uses and also points out some of the advantages and disadvantages of using Solar Energy. Students will read together. Passage: https://www.softschools.com/language_arts/reading_comprehension/science/111/solar_power/ **Solar power** is energy from the Sun. The sun has been producing energy for billions of years, but it is only in the recent past that this energy is being harnessed or collected and changed into heat and electricity across the world. The energy that comes from the rays of the Sun that reach the Earth is called **solar radiation**. Without humans, animals, or other living organisms needing to do anything, the energy from the Sun has given power to all living things through photosynthesis. **Photosynthesis** takes place when plants use the Sun's energy to make its own food, and then of course, all other living organisms eat the plants or animals receiving that energy indirectly from the Sun. However, collecting solar power to create electricity and heat is not as easy as plants using the Sun's energy to make its own food. Some people, like an astronomer named John Herschel, used a solar thermal (heat) collector box to cook food during an expedition to Africa. The collector box is a device used to collect the heat from the Sun to cook food. This may not have been the first instance of using the Sun's energy to cook food, but it was a preview of how much energy the Sun has that can be used if collected properly. Today, the Sun's energy is converted to thermal energy, which can be used to heat water for homes, swimming pools, greenhouses, and other buildings. It can also be used to heat the fluids to high temperatures to power turbines that make electricity. It is not as simple as placing an item in sunlight however.

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		Solar energy is changed into electricity in two ways. Solar cells change sunlight into electricity which are grouped into panels used in a variety of different ways. Sometimes these panels are called solar panels which collect, use and distribute the energy from the Sun. This type of collection is also used to power small cells inside batteries or calculators, but mainly used for power single homes or large power plants. The second way solar power is used to generate electricity is by focusing the Sun's heat to a fluid that produces steam that is then used to turn a generator. Solar power systems are very beneficial. First, they do not cause pollution or carbon dioxide. And they have very little impact on the environment. Overall as well, solar energy costs less once the equipment is in place. The energy and heat from the Sun is basically free but it costs money to build the right equipment to collect the power of the Sun. A couple problems with solar power includes the inconsistency of sunlight reaching the Earth's surface, because the amount of sunlight will vary depending on location, time of day, year, and weather conditions. Also, since the Sun does not deliver much energy to any single place at any one time, a large surface is needed to collect the Sun's energy for it to be useful. Even though the amount of energy reaching the surface of the Earth throughout the world is greater than the total amount of energy used or needed, the current limitations in collecting this energy will need to be overcome. The students will be engaged in a classroom discussion aimed at identifying some of the advantages and disadvantages of Solar Energy, drawing on some ideas from the passage. **What are some of the advantages of using solar power?** (*Good source of light and heat, can generate electricity, environmentally friendly - reduction in carbon emissions)* Solar energy is called a renewable resource because unlike oil it doesn't disappear after we use it. Why would we choose renewable forms of energy? (*The amount of oil and gas we can access is limited and we will become reliant on other countries for this type of fuel. This could get very expensive* Those forms of fuel like coal, gas, and oil are commonly referred to as Fossil Fuels and are non-renewable. Solar energy is readily available and can be used when needed without running out. What fuels do you use at home? (*charcoal, propane gas, etc.*) Why

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		are these non-renewable? (*They have limited supply because they are obtained from fossil fuels*) Solar power costs money to set up but panels last a long time; Do you think over the long-term solar power can be cost-effective? (*Over the long term it saves energy/power costs, so your electricity bill would be much lower*) Let us discuss. Having solar power depends on the amount of sunlight that a country gets. Do you think the Caribbean countries get enough sun to justify solar power?  Retrieved from: https://www.constellation.com/energy-101/energy-innovation/solar-energy-pros-and-cons.html

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		Students will fill the L column of their KWL chart, stating what they learnt about solar energy: its uses, advantages, and disadvantages. **<u>Solar Oven Project</u>** Students will be required to collaborate with their classmates to build an oven. The purpose of this project is for students to understand that the sun is a source of energy. Materials marker/pencil ruler box cutter/scissors tape black construction paper pizza box thermometer foil paper saran wrap oven mitt dish/plate the object that will be used for heating up (marshmallow, chocolate) Steps: 1. Start with a clean pizza box 2. use a maker/pencil and a ruler, draw a square one inch in from the edges on top of the pizza box 3. Using the scissors/box cutter, cut out there of the four lines to make a flap

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		 4. cover the inside of the clap with aluminum foil and tape it down securely  5. Line the inside edges of the bottom of the pizza box with aluminum foil strips 6. Line the bottom of the bottom of the pizza box with the black paper  7. Cover the opening with the saran wrap and securely tape one piece of it to the top of the bole and one-piece underneath. Ensure its an airtight window. 8. Place the aluminum pan/plate covered with foil inside your solar oven then your item on the plate.

<table>
<tr><th>Specific Curriculum Outcomes</th><th>Inclusive Assessment Strategies</th><th>Inclusive Learning Strategies</th></tr>
<tr><td></td><td></td><td>

Students can use their oven to make predictions:
How long will the food item take to melt?
How hot was the sun?
What time of day was the hottest?
retrieved from https://jenniferfindley.com/solar-oven-project/?epik=dj0yJnU9M1RRSmQzMXBhYTJoc242dThOUmI2X0prRGFRX0E2LUEmcD0wJm49QUtFbW9xRzZqdTQ0enRRUFpYUjZvdyZ0PUFBQUFBR1dwTjU4

Students can test their oven by:
1) measuring the temperature of a cup of water every 15 minutes for 2 hours using a timer and a thermometer
<table>
<tr><th>Time (mins)</th><th>Temperature (Celsius)</th></tr>
<tr><td>15</td><td></td></tr>
<tr><td>30</td><td></td></tr>
<tr><td>45</td><td></td></tr>
<tr><td>60</td><td></td></tr>
<tr><td>75</td><td></td></tr>
</table>
Students can draw a simple line graph of temperature on the Y axis (the dependent variable) and time on the X axis (the independent variable) for the data in the table.

2) the length of time it takes to melt a tablespoon of butter/ bar of chocolate/wax. Repeat each substance three times and take the average time.
</td></tr>
</table>

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		

Item	Time taken to melt (Minutes)			Average Melting Time (Minutes)
	Trial 1	Trial 2	Trial 3	

Students can also sketch their completed oven. label the materials used and the purpose for each.

Students can also share the difference observed with their solar oven compared to the oven used at home.

Making a Solar Water Heater

You will need: five metres of rubber hose pipe (black works best) two corks, cold water, and a funnel.

1. Cork one end of the hosepipe using the funnel to fill the pipe with cold water. Then cork the open end.
2. Measure the temperature of the cold water that you added by putting some water in a cup and using a thermometer.
3. Wind the pipe in a spiral on the ground in a sunny place. Leave the pipe for one hour.
4. Uncork the pipe and feel the water with your hands. Is it hot or cold?

Pour some of the water into a cup and measure the temperature. How does it compare to the water you put into the black hose?

Note: Heat energy from the sun warms the hose and the water inside.

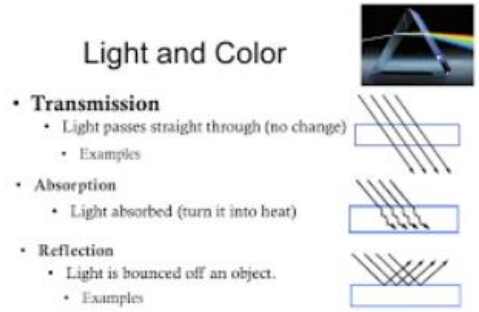
Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		Some people use such black pipes or (black barrels on the roof) to preheat water for use in their homes.  Retrieved from https://housing.com/news/overhead-water-tank-location-and-position-as-per-vastu/ Is black the best color for our hoses for heating water? Students will conduct an experiment. What you need: four clear colourless plastic bottles the same size, white paint, black paint, aluminium foil, water, thermometer, measuring cup ● Plastic bottle 1 - paint white ● Plastic bottle 2 - paint black ● Plastic bottle 3 - cover in foil ● Plastic bottle 4 - keep clear and colourless Measure 4 cups of water and place in a large bowl. After 5 minutes measure the temperature of the water. Using the water from the bowl measure 1/2 cup of water or an appropriate volume and place it in each plastic bottle. Place the bottles outside in the sun for two hours. Measure the

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		temperature of the water in each bottle. Students record their measurements in a table. (*Black should be the hottest.*)

Plastic Bottles	Initial Temperature of Water (Celsius)	Temperature of Water after 2 hours (Celsius)
Bottle painted white		
Bottle painted black		
Bottle covered in foil		
Bottle kept colourless		

Without **light**, there is no color. When people see colors, they are really seeing different types of light bouncing off objects. Light is made up of wavelengths of light, and each wavelength is a particular colour. Objects appear to be different colours because they absorb some colours (wavelengths) and reflect or transmit other colours. The colours we see are the wavelengths that are reflected or transmitted.

White objects appear white because they reflect all colours. Black objects absorb all colours so no light is reflected. Thus all the sun's heat was kept to keep the water the hottest in the plastic bottles.



Additional Resources and Materials
(Additional material and resources that are not included in the Inclusive Learning and/or Inclusive Assessment Strategies that may be useful for lesson planning)
What is Energy and Where Does It Come From?
https://www.essa-tlemcen.dz/wp-content/uploads/2018/02/What-is-Energy-and-Where...-Comprehension-Passages%E2%80%9D.pdf
Lessons on Solar Energy
https://www3.uwsp.edu/cnr-ap/KEEP/Documents/Solar%20Lessons%20One%20Pager.pdf
Solar Oven Project
https://ccasciencelab.weebly.com/uploads/3/7/8/0/37805103/solar_cooker_rubric_and_web_quest.pdf

Additional Useful Content Knowledge for the Teacher: (*any additional knowledge that the writers believe would be helpful for the teacher such as reading material at a lower or higher grade level, links to curriculum documents for other grades)*
Solar Energy
https://education.nationalgeographic.org/resource/solar-energy/

The Advantages and Disadvantages of Solar Energy

https://www.constellation.com/energy-101/energy-innovation/solar-energy-pros-and-cons.html

Video on the design process:
https://www.sciencebuddies.org/science-fair-projects/engineering-design-process/engineering-design-process-steps

Opportunities for Subject Integration: *(Additional ideas about how the inclusive learning strategies might be adapted and/or applied to include other subjects in the curriculum)*
Language Arts - Reading passages and answering questions based on renewable energy and solar energy.
Expository writing - Writing steps involved in constructing a device, for example a solar cooker.
Art and Craft - making a collage with pictures and statements showing the advantages and disadvantages of solar energy
Social Studies - uses of solar energy long ago and present. (research and devise a timeline)
Health and Family Life - Precautionary measures to be taken for example when using thermal energy. (appliances that use heat energy / thermal energy)
Research on modern devices/ gadgets that use solar energy.
Mathematics: plotting graphs of experimental data; calculating energy used in kilowatt per year at home

Students can build a solar oven as a class or in groups.
SVG: flambeau is a local element that converts chemical energy->light and heat energy, however there are safety concerns regarding construction and use, homemade solar water heaters, incubators, wind turbine, windmills, etc.

Elements from Local Culture, Technology, TVET, Environment that are integrated:

Students can build a solar oven as a class or in groups.

Items of Inspiration (teaching tips, inspirational passages, connections to educational research):

1. **Questions for research by students:**

- **Where do plants get their energy? (sun, water and soil)**
- **Where do humans get their energy? (food converted to motion)**
- **Where do cars get their energy? (burning fossil fuel)**
- **Where did grinding mills get their energy many years ago? (water wheels powered by flowing water in rivers)**

2. **Research on the various ways solar energy was used long ago versus now.**

3. **Research on the various devices that use solar energy. (The pros and cons of these devices).**

4. **If a family uses 5000 kilowatt hours of energy per year, how much savings will they have using the comparative rates shown below?**

   Have students fill in the table and find the differences.

e.g. 5000 x 0.05 = 250 and 5000 x 0.029 = 1

45

Retrieved from: https://news.energysage.com/solar-energy-vs-fossil-fuels/

KWH used per 365 day year	Fossil Fuels Cost in USA dollars	Solar Cost in USA dollars
5000	(250)	(145)
10000	(500)	(290)
15000	(750)	(435)
20000	(1000)	(580)

Have students research at home to see what number of kilowatt hours their household uses in a year.

Students can also research and suggest ways they can conserve electrical energy at home.

Essential Learning Outcome 5: Obtain and combine information to describe that energy and fuels are derived from natural resources and that their uses affect the environment [Clarification Statement: Examples of renewable energy resources could include wind energy, water behind dams, and sunlight; non-renewable energy resources are fossil fuels and fissile materials. Examples of environmental effects could include loss of habitat due to dams, loss of habitat due to surface mining, and air pollution from burning of fossil fuels.]
Grade Level Expectations: Refer to grade level expectations at the beginning of this curriculum document.

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
Learners are expected to: **<u>Knowledge</u>** ● Define the terms: ○ natural resources ○ renewable resources ○ non-renewable resources ○ fossil fuels ○ solar power ○ hydropower ○ geothermal power ○ tidal power ○ biomass ○ wind power ○ energy consumption ○ greenhouse effect ○ sustainability ○ global warming ● List examples of both renewable and non-renewable energy resources. ● List 3 benefits of using fuels	1. Define the terms by using them in a complete sentence. a. natural resource b. renewable resources c. non-renewable resources d. fossil fuels e. fissile materials 2. Name four (4) devices in the home that make it easier for us to dry/heat things. Complete the table below with the name of each device, what each device is used for and the type of energy source it uses.	**<u>Introducing Natural Resources</u>** Students, do we use things from nature? (*Yes*) Let us go outside and find some of those things that we use from nature. Ask students to record the resources they identify. **Note to teacher:** For example: Wind, water, trees, soil, plants, animals, rocks, sunlight. When students return to the classroom, generate a list of **ONLY** natural resources. Where needed, explain to students why some of the things they listed are not natural resources. Students, all the things that we have identified are called natural resources. Hold a discussion on the natural resources that they have identified and how these are used. **<u>Activity</u>** Look around the classroom and list as many items as you can that are made from natural resources. Let's watch the short video below to learn some more about natural resources: https://www.youtube.com/watch?v=axCR3uIn3Vs **(0-0:28 mins)**

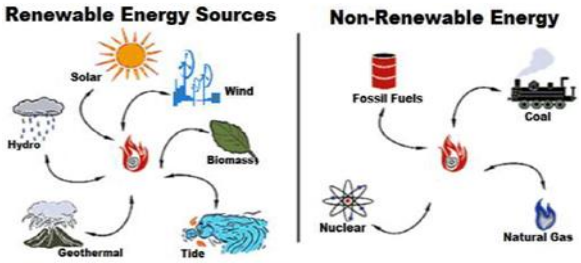
Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
• List 3 consequences to the environment of using fuels. • What the sources of different fuels are. • State the benefits of fossil fuels • Recommend solutions for reducing the use of fossil fuels. • Summarize the environmental impact of obtaining and using fossil fuels. • Explain the difference between renewable and non-renewable sources of energy. • Identify multiple sources of renewable and non-renewable energy. • Explain how each resource is used to generate energy. • Compare renewable and non-renewable energy resources. • Briefly explain the process of obtaining energy from the different renewable sources of energy (wind, hydroelectricity/water from	3. Complete the following table to show one advantage and one disadvantage of each renewable source of energy listed. **Renewable source energy** / **Advantage** / **Disadvantage** Solar energy Hydropower Geothermal energy Wind energy Biomass Wave/tidal energy 4. Complete the following table to show one advantage and one disadvantage of each of the non-renewable source of energy listed **Renewable source energy** / **Advantage** / **Disadvantage** Coal Crude oil Natural gas Nuclear energy	 As you watch the video be prepared to answer questions about the following: 1. What is a natural resource? *(A natural resource is a part of the earth that people use.)* 2. What are some examples of natural resources? (*Ans: sunlight, wind, water, plants and animals and fossil fuels like, coal, crude oil and natural gas)* 3. What are the new natural resources that you didn't know before? (*coal, crude oil and natural gas)* As we would have learnt, natural resources provide us with many different things. Natural resources provide the raw materials necessary for various human activities. including the production of energy. **Renewable resources and non-renewable resources** You would have also learnt from the video that natural resources can be divided into two main groups: renewable resources and non-renewable resources. Let us continue watching the short video to find out the differences between renewable and non-renewable resources. https://www.youtube.com/watch?v=axCR3uIn3Vs (0:28 - 1:16 mins)

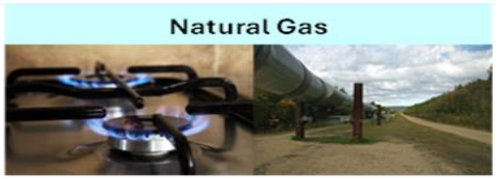
Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
behind dams, geothermal and sunlight). • Describe ways in which solar energy is used in the home (heat, electricity, air conditioning) • Discuss how the use of renewable sources of energy may affect the environment. • List examples of fuels used in their country, in the home, transportation and production of materials. • Describe, in simple terms, how these fossil fuels are extracted and prepared. • Identify and discuss some of the unintended consequences of using fuels for transport and production of materials for commerce (e.g. pollution). • Realise, that with all good intentions, technology may be abused and misused. • Develop an understanding that: • Sustainable use of resources would help to minimize	See overview of response types here: https://www.energysage.com/about-clean-energy/advantages-and-disadvantages-of-renewable-energy/  Retrieved from: https://pixabay.com/photos/fuel-gas-station-refueling-gas-6999637/ 5. The above photo shows a vehicle being filled with fuel at a station. a. List 2 renewable fuels which are currently being used to power vehicles. (*alcohol, electricity*) b. List 2 non-renewable fuels that are currently used to power vehicles. (*diesel, gasoline*) 6. Wind energy is a renewable source of energy that is used in many countries of the Caribbean.	 As you watch the video, listen for the following: 1. Differences between renewable and non-renewable resources. 2. Examples of renewable resources and two examples of non-renewable resources. From the video we see that natural resources can be divided into two main groups: renewable and non-renewable. From the video, let us now write a definition for these terms. **Renewable resources** are replaced or replenished by nature when they are used so they won't run out. They can be used now and by future generations too. Sunlight, wind and water are examples of renewable resources. **Non-renewable resources** on the other hand are not able to be replenished by nature at the rate at which they are being used whenever. Examples of non-renewable resources are crude oil, coal and natural gas. **Natural Energy resources** As mentioned above, natural resources provide us with the energy we need to cook, run vehicles, factories, light, etc. The natural resources that provide us with energy are called natural energy resources.

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
pollution and destruction of the environment. • The impact of Science and Technology may be positive or negative. • Knowledge acquired and products developed in the search for solutions to human problems and challenges affect everyday life, the society and the environment. • Compare devices that burn different fuels and the amount of pollution they cause. • Compare the amount of air pollution in two named areas. • Hypothesize as to the reasons for the differences exhibited. • Explain the importance of "clean: air in their country. • Recognize that resources should be used wisely since many of them are non-renewable. • Recognize that the impact of science and technology	a. Give one reason why wind turbines do not generate electricity all the time. (*weather patterns may not include breezes*)) b. Give one advantage of using wind turbines to generate electricity compared with using fossil fuel power stations. (*wind source is free*) *c.* Give one disadvantage of using wind turbines to generate electricity compared with using fossil fuel power stations. (*requires space and initial investment)* 7. Draw one line from each energy source in List A to the statement about the energy source in List B List A Geothermal energy Hydro power Nuclear energy List B Uses energy from falling water. Uses energy from inside the Earth. Is not available all the time of day Produces dangerous waste. Produces harmful emissions. *Geothermal: energy inside the earth* *Hydropower: energy from falling water* *Nuclear energy: produces dangerous waste* 8. Different energy sources are used to generate electricity.	Note to Teacher: Discuss the importance of energy in everyday life with the students. Include a talk about common sources of energy that may have been observed on the nature walk that children are familiar with, such as sunlight, wind, and water. **Renewable and Non-renewable Energy Resources** The following table shows examples of renewable and non-renewable sources of energy: **Non-renewable resources**: Crude oil, Coal, Natural gas, Nuclear fuel **Renewable resources**: Sunlight, Wind, Hydro, Geothermal, Biomass, Tidal/wave **<u>Activity on Natural Energy Resources</u>** Divide the class into two groups: Renewable and Non-renewable Energy Resources, then divide these groups into subgroups as follows: **<u>Team Renewable Energy Resources</u>:** Subgroups: Wind Energy, Solar Energy, Hydropower. **<u>Team Non-renewable Energy Resources</u>:** Subgroups: Coal, Natural gas, Crude oil.

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
activities may be planned or unplanned. • Summarize the environmental impact of obtaining and using fossil fuels. • Recommend solutions for reducing use of fossil fuels. • Distinguish fossil fuels from nuclear and renewable energy sources. • Discuss uses of various fossil fuels. • Describe the sequence of processes by which coal forms. • Describe the sequence of processes by which oil and natural gas form. • List the advantages and disadvantages of the use of biomass • Develop an awareness of the use of biomass in the Caribbean. • Give examples of biomass and state their uses. • Explain why the supply of fossil fuels is limited	Use words from the box to match the correct energy source to each of the descriptions given in the table. Biofuel Coal Geothermal Nuclear Waves Description / Energy source Energy from the Earth's core is used to heat water. ____ Gases from rotting plant material are burned to heat water. ____ Fission of uranium nuclei is used to heat water. ____ *Energy from earth's core: geothermal* *Rotting plant material: Coal or Biofuel* *Fusion of Uranium: Nuclear* **Game-based Learning** The teacher should make up cue cards with the following questions one per card. The teacher would mark out a game board (or tiles on the floor) for start to finish. The object is to play a cooperative game where the game piece advances if the students (one at a time) are able to answer the questions correctly as they select a card from a box. This could be a summative assessment to review unit understanding. 1. Give two reasons why recycling is important to the environment. (*less*	**Instructions**: Provide each subgroup with the following materials: A sheet of cardstock paper, toothpicks/matchsticks, glue and assorted coloured markers, scissors, a picture of the device/material used to harness the energy (wind turbine, solar panels, hydro plant - dam/river) or the actual material (coal, crude oil, natural gas burning), as shown below.  Solar panels  Drums of crude oil  Hydroelectric dam  Cylinders of LPG gas

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
• Describe the origin of fossil fuels. • Explain the important role of engineering in gathering and finding oil. • Describe how people use oil in their everyday lives • List examples of fuels used in their country in the home, transportation and production of materials (ST 3 PS EN 4) • Identify and discuss some of the unintended consequences of using fuels for transport and production of materials for commerce (e.g. pollution) (ST 3 PS EN 5) • Describe ways in which solar energy is used in the home (heat, electricity, air conditioning) (ST 3 PS EN 6) • Compare devices that burn different fuels from the amount of pollution they cause. (ST 5 ESS ER 8) • Compare the amount of air pollution in two named areas. (ST 5 ESS ER 9)	*pollution, reuse materials protects natural resources*) 2. Explain how reducing electricity is good for the environment. (*energy to make electricity can be expensive and non-renewable*) 3. State three things we can all do to reduce the amount of electricity we use. (*Turn off lights, preheat water in the sun, reduce hot water consumption, dry clothing on a clothesline)* *4.* Explain briefly how coal is obtained from the earth. State two ways that these methods can impact the environment. (*underground mines, strip mining/ pollution & destruction of land habitat)* *5.* Crude oil is normally transported all over the world from one place to another. Oil spills have occurred in several different places. State two ways in which these spills have impacted the areas that the spills have occurred. (*killed animals, destroyed drinking water)* *6.* What are some of the technologies that have been put in place to reduce the impact of fossil fuels on the environment. (*emission scrubbers, cleaner burning fuels)* *7.* Apart from reducing our use of electricity, name two things that we can do to reduce our use of fossil fuels. (*reduce automobile consumption, reduce transportation & delivery of items by truck)*	 Coal pit  Natural gas burning  Coal  Windmills **Links to the sites where photographs were retrieved from:** **Wind Turbine** - https://pixabay.com/photos/windmill-energy-transition-4865181/ **Solar panels** https://pixabay.com/photos/solar-energy-photovoltaic-power-872804/ **Hydro dam** - https://pixabay.com/photos/dam-hydro-power-water-2492809/ **Liquid Petroleum Gas (LPG)- https://live.staticflickr.com/8313/8053592864_09eb9959a3_b.jpg** **Coal** - https://pixabay.com/photos/coal-briquette-black-471903/

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
• Hypothesize as to the reasons for the differences exhibited. (ST 5 ESS ER 10) • Explain the importance of "clean: air in their country. (ST 5 ESS ER 11) **Skills** • Observe the use of renewable and non-renewable energy sources in a given environment. • Observe the impact of energy-related activities on ecosystems. • Infer the consequences of continued reliance on non-renewable energy sources. • Infer the potential benefits of transitioning to renewable energy. • Classify different types of resources as renewable and non-renewable energy resources. • Classify environmental effects based on the type of energy resource and its extraction method. • Measure different materials when making models of devices used in the production of energy.	8. Name two materials that we can burn in order to get energy from biomass. 9. Describe two methods for getting energy from the Sun. 10. List three uses of the Sun's energy in the home. 11. Why are renewable resources considered sustainable? 12. Explain how one of the following renewable sources can be depleted if it is not used carefully. a. Water b. Trees c. Soil Answer the following questions on the Greenhouse effect. 1. What is the major cause of the greenhouse effect? (*gases like carbon dioxide trap the heat of the sun close to the earth*) 2. What are greenhouse gases? (CO_2, CH_4, N_2O) 3. Which form of energy is absorbed by the atmosphere and mainly causes this increased temperature? (*solar energy*) 4. Where do greenhouse gases come from? (*motor vehicles & burning fuels to heat homes & cook*),	**Natural gas burning -** https://www.flickr.com/photos/todbaker/9148692 **Drums of crude oil-** **https://pngimg.com/uploads/oil/oil_PNG13.png** **Coal pit –** Reni King, St. Vincent and the Grenadines On the cardstock sheet provided, have students create a poster/model showing the natural energy resource they have been assigned. (Research/Teacher provides). Their poster/model should also include a few sentences about the device or the energy resource. Example of a poster  **Figure 1.** Renewable and non-renewable energy sources. Have each group present their work to the class, then display the work on the classroom wall. Ensure that all of the students are able to identify the forms of energy, or the devices displayed.

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
• Formulate hypotheses about the long-term impact of specific energy-related practices. • Develop hypotheses regarding the potential advancements in renewable energy technologies. • Communicate the environmental implications of energy choices effectively. • Collaboratively present findings on the benefits of renewable energy. • Construct models to illustrate energy conversion processes in renewable and non-renewable systems. • Construct arguments for sustainable energy practices. • Investigate information regarding emerging technologies in renewable energy. • Investigate the historical and current trends in energy consumption. • Compile/analyse data obtained from experiments and from different sources • Interpret the significance of policy decisions on energy and the environment.	5. What impact are greenhouse gases having on the climate? *(higher mean temperatures & melting of glaciers- rising sea levels)* 6. Why don't we use wood as our main energy resource anymore? (*supply of wood isl ow*) 7. How is the greenhouse effect helpful for life on Earth? *(provides environment for plant growth*) *8.* Name two human activities that contribute to greenhouse gas emissions? (*vehicles which rely on oil production industry)* **Assessment on the Greenhouse Effect** The following resource was retrieved from: https://www.educationnaturepark.org.uk/resource/greenhouse-effect-simulation Link: https://phet.colorado.edu/sims/html/greenhouse-effect/latest/greenhouse-effect_all.html	Let students state: 1. Which ones they had not seen or used before. 2. Which ones are renewable energy resources, and which one were non-renewable energy resources **Renewable energy sources** Let us now have a closer look at the energy sources grouped as renewable energy, to see how they are formed, extracted and prepared for use. **Fossil fuels** Coal, crude oil and natural gas are a group of fuels called fossil fuels. A fuel is any substance/material that when burnt, produces energy. **Fossil fuels** were literally formed from the fossils or the remains of plants and animals that lived millions of years ago. It is important that students have an appreciation for the fact that these fuels were formed a long time ago and they take a very long time to be formed.  **Characteristics of natural gas** Natural gas is comprised of many different compounds. However, the main component is methane gas. In its pure form, it is colourless and odourless. **How is natural gas formed** The process that creates natural gas, is the same as the process that creates crude oil. Natural gas is generally found, in the same areas that crude oil is found.

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies

- Interpret data to assess the effectiveness of renewable energy initiatives.
- Plan and execute appropriate research using technological methodology, to solve environmental challenges. (ST 4 TE TM 1)

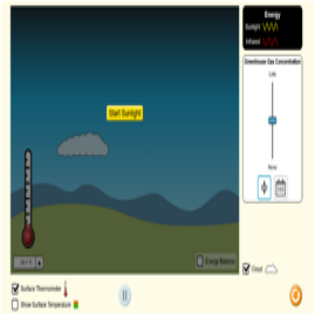
Attitudes/Values

- Develop an appreciation for the interconnectedness of energy choices and environmental impact.
- Appreciate the importance of energy in our everyday lives.
- Develop an awareness of the importance of conserving and using energy efficiently.
- Be persistent in conducting experiments to demonstrate the effects of non-renewable sources of energy.
- Foster a habit of inquiry into the environmental consequences of energy-related decisions.

Greenhouse Effect Name: _____

Open the link https://phet.colorado.edu/sims/html/greenhouse-effect/latest/greenhouse-effect_all.html

Observe the relationship of UV (sunlight) to IR (infrared light). Before starting the simulation make sure that t
Thermometer and Cloud are turned on. Click the button "Start Sunlight". Use the Toggle button "Greenhouse
Gas Concentration" to decrease and increase the amount of CO_2.



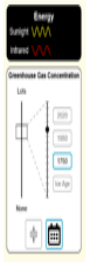
1. How does the temperature change when yo
decrease the CO_2?

_____

2. How does the temperature change when yo
increase the CO_2?

_____

Change the Toggle button "Greenhouse Gas Concentration" to the Calendar View. Complete Table 1



Date	CO2 Concentration	Surface Temperature
Ice Age		
1750		
1950		
2020		

What do you mean by refining petroleum?
Name four products formed by this refining.
Explain the uses of each.

2. Suppose that electricity to your area was cut off for two weeks. Give one suggestion on how you would do the following things.

COAL

What does coal look like?

Black/brown or black sedimentary rock which is composed mainly of carbon and hydrogen. Usually found underground. There are four different types of coal.

How is coal formed

Coal was formed when dead plant matter buried in swampy environments is subjected to heat and pressure over hundreds of millions of years. Over time, the plant matter is transformed to coal.

Crude Oil

Characteristics of crude oil

Crude oil is a smelly, yellow-black liquid, usually found underground. It can also be yellowish, reddish, tan, or even greenish. It consists of many different compounds.

How is crude oil formed

Millions of years ago, the remains (fossils) of marine animals and plants were covered by layers of sand and silt. Over a very long period of time, heat and pressure from these layers, turned the fossils into what we know as crude oil.

<table>
<tr><th>Specific Curriculum Outcomes</th><th>Inclusive Assessment Strategies</th><th>Inclusive Learning Strategies</th></tr>
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<td>

Respect evidence obtained through experimenting and from different sources.
Demonstrate their inventiveness in the models they will develop
Work collaboratively with group members and other members of the class to produce the models, create posters, make presentations, etc.
Develop a sense of stewardship towards the environment and respect for living organisms affected by energy choices.
Participate in a class discussion of their ideas and opinions related to energy conserving efforts that could directly impact their school experiences
When conducting practical and group work, display sensitivity and offer assistance to peers who may have physical or learning challenges.

</td>
<td>
a. How would you light your house? (battery torch)
b. How would you cook? (gas stove or wood fire)
c. How would you keep cool? (wet cloth)
d. How would you play your devices? (battery powered)

3. Below is a table showing the different sectors that use both renewable and non-renewable sources of energy. Complete the table to show the different energy sources used by each sector and what the
<table>
<tr><th>Sector</th><th>Energy source used by the sector</th><th>What the energy source is used for</th></tr>
<tr><td>Residential sector</td><td>(fossil fuel)</td><td>(electricity for lighting and appliances)</td></tr>
<tr><td>Commercial businesses</td><td>(fossil fuel)</td><td>(electricity for lighting and appliances)</td></tr>
<tr><td>Industrial sector</td><td>(fossil fuels)</td><td>(conveyers, boilers, lighting, heating systems)</td></tr>
<tr><td>Transportation sector</td><td>(fossil fuels)</td><td>(power motors)</td></tr>
</table>
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<td>
After students have studied the information on the posters and watched the videos, lead students on a discussion centred around the following concepts:

1. How fossil fuels are formed and the time it takes for them to be formed.
2. Reasons why fossil fuels have been placed in the category of non-renewable energy.
3. If it is possible to use all of the fossil fuel that has been mined/drilled from the Earth or we are aware of.
4. What might be the consequences of No. 3 happening.

<u>Extracting fossil fuels and preparing them for use</u>

Now you know how fossil fuels are formed and where they are found. Let us now look at how they are extracted from the Earth and how they are prepared before they are used to provide energy.

<u>Natural gas:</u>

Let us look at the following video to find out how natural gas is formed, extracted and processed before use.

Natural gas https://www.youtube.com/watch?v=-njmj0diWu8 (3:38 mins)

Once natural gas is found, it is transported to the surface by a well. Natural gas can be pumped out through the same wells used for extracting crude oil. After it is brought to the surface, it then flows into large pipelines. At a gas processing plant, certain gases found along with the methane gas are separated from the methane and cleaned.
</td>
</tr>
</table>

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
• Analyze data from a graph to determine the types of energy currently used in the Caribbean • Participate in a class discussion of key terms related to energy including fossil fuels, renewable and non-renewable resources, greenhouse gasses, and global warming • Participate in a simulation activity and conduct research and create a project that will be used to teach others about alternative/renewable energy sources • Realise, that with all good intentions, technology may be abused and misused. (ST 3 TE UT 2) • Sustainable use of resources would help to minimize pollution and destruction of the environment. (ST 3 STSE 1) • Impact of science and technology may be positive or negative. (ST 3 STSE 2)	A large portion of the natural energy resources man uses goes towards producing electrical energy. Electrical energy may be sourced through a variety of resources both renewable and non-renewable. Look at the picture below and state where each of the electricity sources below gets their energy:  Retrieved from: https://www.123rf.com/photo_68605792_stock-vector-alternative-energy-sources-set-wind-geothermal-power-bio-energy-solar-energy-hydropower-illustration.html?vti=mmgyzlkjwm0ltd9mv4-1-2	Why do you think it is important to remove the unwanted substances from the coal before it is used? **Coal:** Coal buried below the surface of the Earth, can be extracted by underground or surface mining.   **Retrieved from:** https://pixabay.com/photos/industry-dumper-minerals-coal-2023592/ https://pixabay.com/photos/coal-briquette-black-471904/ The mined coal is taken to a plant, where it is cleaned and processed, to remove unwanted substances such as dirt, Sulphur, ash, etc. The coal is then broken into smaller usable lumps for use in domestic settings. Why do you think it is important to remove the unwanted substances from the coal before it is used? **Crude oil: How do we get oil from the ground** https://www.youtube.com/watch?v=vjcfxqMt5D (1:24 mins)

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
• Knowledge acquired and products developed in the search for solutions to human problems and challenges affect everyday life, the society and the environment. (ST 4 STSE 1) • _Recognize that resources should be used wisely since many of them are non-renewable. (ST 5 TE UT 2) • Recognize that the impact of science and technology activities may be planned or unplanned. (ST 5 TE UT 4)	Questions: 1. Which of the above use renewable sources of energy and which use non-renewable sources of energy? 2. How does each electricity source affect the environment? (include discussion on greenhouse gases and air pollution) 3. What do you understand about global warming? 4. What do you think will happen if there are no greenhouse gases? **Research and Writing** A new technology known as "fracking" has become a popular technique for extracting oil or natural gas from the ground. Students should be asked to do internet research and create a one-page response paper that includes a description of the fracking technology and the possible detrimental effects to the environment. They should include a picture in their description. Rubric: Definition of fracking (5 marks) Diagram of technology (5 marks) Impacts of the technology (5 marks) Teacher reference: https://education.nationalgeographic.org/resource/how-hydraulic-fracturing-works/	**Where Do We Get Oil From?** https://www.youtube.com/watch?v=xZ1HIBIIJU0 **(**1:31 mins) Before crude oil can be used it has to be converted into various finished products through a process known as refining., which is a series of processes that transform it into useful products like gasoline, diesel and jet fuel. Crude oil distillation is the first process in the refining journey. Crude oil is also used for the manufacturing of plastics. The following simulation helps to explain the processes that take place at a refinery. **Animation showing the process of refining crude oil through fractional distillation** https://www.youtube.com/watch?v=COm8ute0VJs (0:34 mins) **<u>So, what are the different fossil fuels used for?</u>** **Coal:** Coal is a solid fossil fuel that is used for heating homes, cooking and generating power plants **Natural gas** Natural gas is widely used for cooking and for heating homes. **Crude oil** Many substances are obtained from the refining of crude oil. Refined products obtained from crude oil have several uses. While some are used as fuels, some are used for other purposes. Uses of some of the more well-known fuels are shown in the table below.

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies

SUBSTANCE	USES
Butane and propane	For cooking, heating and transportation
Gasoline	Fuel for cars
Diesel	Fuel for cars and heavier vehicles such as lorries and buses.
Kerosene	To power aircrafts
Fuel oil	Fuel for ships and power stations

Activities

1. As a whole class, generate a list of machines that have an engine to 'burn' fossil fuels to generate power, the fuel each uses and one function of the equipment. Encourage kids to think of things that they use. Examples: lawn mower, quad, dirt bikes, etc.

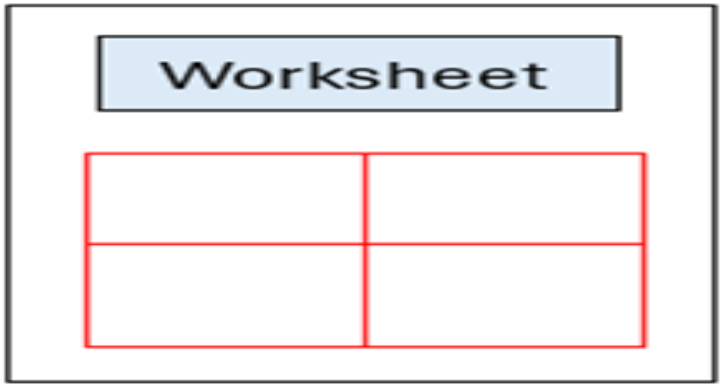
Homework:

Ask students to identify 5 different fuel-burning sources at home.

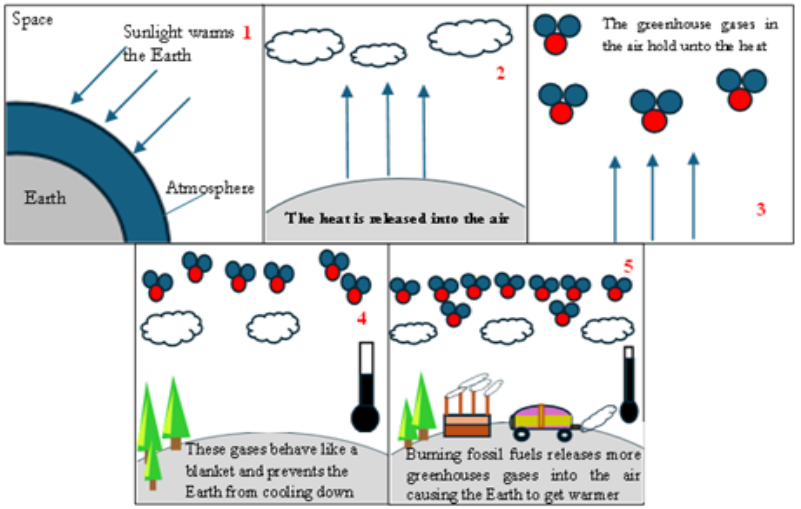
From what we have covered so far, you would have seen that, to extract fossil fuels, we have to bore into the Earth's crust, in some cases hundreds of metres. These fossil fuels then must be processed and transported over very long distances.

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		Impact of fossil fuels on the environment Although fossil fuels have made life easier, finding, extracting, refining, transporting and using fossil fuels, all have negative effects on the environment. Let us continue watching the video to find out how fossil fuels impact the environment: https://www.youtube.com/watch?v=axCR3uIn3Vs (1:45 - 400 min) As you watch the video, pay attention to the different ways that coal, oil and gas impact the environment, keeping the following questions in mind. **Questions:** 1. What are two ways that the mining of coal or the drilling of oil or natural gas may impact the land? (*Landscape changes and habitat loss. Destruction of living things. Chemical use for extraction and effluent pollutes the air and land.)* 2. What impact does fossil fuels have on our water bodies? (*Pollution of waterways from oil spills. Rising water levels due to global warming*.) 3. Air pollution is one of the ways that fossil fuels impact the environment and organisms. State two ways how this can happen. (*Burning of fuels gives off gases that pollute the air. The emissions from power plants can combine with water in the air to make acid rain which kills plants and potentially destroys farmlands.*) Discuss with the students the differences between surface and underground mining of coal. Also discuss the effects that mining and drilling may have on the environment.

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		1. List two ways we use coal today. 2. Why do you think coal is still being used today, even though it causes many environmental problems? **<u>Cookie mining activity</u>** Below is an investigation using chocolate chip cookies (similar models using plasticine or clay, can be used instead) as a model for what happens to the environment when fossil fuels are extracted. Today, you will get an opportunity to play the role of a miner in a simulation exercise, but you will not be mining coal, you will be mining chocolate chips from a chocolate chip cookie, using a toothpick.  **Chocolate chip cookie** - Retrieved from: https://pixabay.com/photos/cookie-chocolate-chip-cookie-snack-1264231/ Before you start the activity, there are a few rules you must follow. ● You must wash your hands before you receive your cookie. ● The chocolate chips are not to be eaten before the end of the activity. 1. After you receive your cookie, draw your cookie in the top left-hand box of the table on the worksheet provided. 2. After you have drawn your cookie, you must now draw an imaginary habitat in the top right-hand box of the table. Your habitat must contain animals, plants, a water body, etc.

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		 3. Now mine the chocolate chips from your cookie using the toothpick supplied. 4. After you get to a point where it is not possible to mine anymore cookies, draw your cookie or the pieces of cookie remaining, in the bottom left-hand box in your table. 5. Look at the damage done to your cookie, and imagine similar damage being done to your habitat. How would your habitat be impacted? What would it look like? What parts of your habitat would be affected? Now draw a picture in the bottom right-hand box of your table, to show what your habitat may look like, after it was damaged from the mining. After you have finished your drawing, answer the following questions. 1. Was it difficult to mine chocolate chips from the surface or from deep in the cookie? 2. What could you have done to make mining the chocolate chips easier? (Wetting the cookies). 3. State two damages that could result from mining coal or extracting oil.

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		Highlight that the cookie represents the environment, the chocolate chips represent fossil fuels. **<u>Air pollution caused by fossil fuels</u>** **Activity: Investigating the Amount of Air Pollution caused by Different Fuels** When fossil fuels are burnt to produce heat or electricity, they release certain gases into the air that can cause air pollution. The following activity, comparing the amount of air pollution caused by two different fuels, should be done by the teacher, as a demonstration: **Materials**: Spirit lamp with kerosene oil, gas stove, two metal lids or wires, potholder, matches/lighter. white tissue/cloth **Method:** 1. Hold the metal lid or wire above the flame spirit lamp flame for 30s to capture the soot that forms. *Caution: The lid will become very hot please handle with care.* 2. Once the lid/wire has cooled, label it A. 3. Have students observe the lid/wire once it has cooled. Wipe the lid or wire with a white tissue or cloth and make observations. 4. Repeat the experiment by holding the other lid/wire over the flame of a stove for 30s. Label the cooled lid/wire B. Wipe the lid or wire with a white tissue or cloth and make observations. 5. Compare the amount of soot on each tissue/cloth. **Questions for discussion:** 1. How did each tissue appear after being wiped? *(There was a black solid on one of the tissues)*

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		2. Which lid/wire made the tissue made the tissue dirtier *(The lid heated with the kerosene oil flame became black(er) than the lid heated over the stove)* 3. What is the black substance? *(Soot)* **<u>Emission of Greenhouse gases</u>** The emission of greenhouse gases, causing the Earth to heat up, to temperatures, above which is sustainable, is another impact of the use of fossil fuels. This is known as the greenhouse effect. Discuss with students the greenhouse effect, global warming and climate change. With additional materials on these topics, ask students to create a poster, similar to the one shown below. 

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		Students can also be taken to the following sites where they would be able to manipulate several variables to see the greenhouse effect. https://phet.colorado.edu/sims/html/greenhouse-effect/latest/greenhouse-effect_all.html An accompanying worksheet can be found in the assessment section. **The transportation of crude oil and natural gases** Another problem with fossil fuels is their transportation, often over hundreds of kilometres. Most oil spills are the result of accidents at oil wells or on the pipelines, ships, trains and trucks that move oil from wells to refineries. Oil spills contaminate soil and water and may cause devastating explosions and fires. Oil spills can also damage or kill wildlife and destroy habitats of many organisms.  **Retrieved from:** https://www.flickr.com/photos/19378856@N04/2037098785 One of the most devastating oil spills occurred in 1989 in Prince William Sound, Alaska. The video below gives more information on this oil spill.

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		Another oil spill, which occurred in Trinidad and Tobago, happened, off the coast of Tobago, in February 2024. As you watch these videos, pay attention to the effects of the spills on the environment and organisms living in the areas. Also look to see what was done to clean up the spills in each case. **Exxon Valdez oil spill harmed wildlife** https://www.youtube.com/watch?v=CVm1pB3iJOw (2:25 mins) **Oil spill in Trinidad & Tobago** https://www.youtube.com/watch?v=FRApkdzKheM (1:36 mins) **Cleaning up oil spills** When an oil spill occurs, it is very important that as much of the oil as possible is removed from the area where the spill occurred. Attention must also be given to the animals in the area that are affected and to remove those not affected to safer areas if possible. There are several methods currently available to clean up oil spills. These include skimming the oil off the water, using chemicals to help to break up the oil and burning the oil. **Clean-up simulation exercise** **Activity** Imagine that you have an oil spill in a dish of water. Design an experiment, to clean-up this oil spill using three different methods. From the videos and from the different activities you have done, you would have gathered that fossil fuels as energy sources, can have very devastating effects on the environment.

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		Problems with fossil fuels • Fossil fuels are non-renewable They are dangerous to produce. • Can cause land/water pollution from oil spills or chemicals used to extract the fuels. • Destruction of habitats • Air pollution and smog formation. • Emissions of greenhouse gases. Do you know of any other problems associated with fossil fuels? **Class activity** • Lead a class discussion about the environmental impact made by each type of fuel and energy-producing device from the video. Discuss how these impacts can affect the environment, human beings, plants and other organisms. • Generate a class list of the types of impacts that the problems listed could have on the environment, person, animals and plants. Write students' responses on the board. • As a whole class, generate a list of machines that have an engine to 'burn' fossil fuels to generate power. Encourage kids to think of things that they use. Examples: lawn mower, quad, dirt bikes, etc. • Can you think of three types of transport that do not burn fuel to make them work? For each one given, state where you think the energy comes from to make it go.

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		Advantages of fossil fuels Despite the many problems associated with fossil fuels, they have remained the major sources of energy used the world over. This is due to the fact that they have several advantages. A few of them are listed below. ● The energy produced by fossil fuels is greater than that produced by other energy resources. ● Many products sold nowadays were developed thanks to fossil fuels, for example computers. ● Fossil fuels are both cheap and reliable. ● Transport of fossil fuels is very easy as it is usually done through pipes. ● Fossil fuels are easier to extract and process than the renewable forms of energy. Do you know of any other advantages of fossil fuels? Working in their groups, students could be asked to state how each advantage is important. **Activity** After students have gone through the advantages and disadvantages in their groups, listed above and have done and have done the exercises, organize a class debate on the following topic **"Do the advantages of fossil fuels outweigh the problems associated with their extraction, processing, transport and use?"**

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		<u>Nuclear energy another form of non-renewable energy</u> Nuclear energy comes from radioactive elements, mainly uranium, which is extracted from mined ore and then refined into fuel.  **Nuclear Energy** https://www.youtube.com/watch?v=uvhi4vju1TY (2:45 mins) As you watch the video, pay close attention to how nuclear energy is formed and its effect on the environment. ● Found in the centre of atoms – tiny particles that make up every object in the universe. ● Energy is released from these atoms by a process called nuclear fission. ● During 'nuclear fission', atoms are broken apart and the energy stored in their centre is released. ● This energy is used to produce steam. The steam turns huge turbines, which drive generators that make electricity. ● Nuclear-generated energy releases no carbon dioxide into the atmosphere.

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		• The waste that is produced must be stored carefully so that it does not come into contact with the outside environment, where it can cause serious damage to all organisms. Why do you think nuclear energy is not produced in all countries of the world? **<u>Renewable energy and Sustainable energy</u>** Fossil fuels are not only harmful to the planet but one day the world will run out of fossil fuels, as we are using them faster than they can be replenished. So, what can we do to save the planet, reduce our dependence on fossil fuels and combat global warming? One key solution is sustainable energy use. **Sustainability** refers to the concept that all people can meet their basic needs infinitely, without compromising future generations. Sustainable energy meets our demand for energy without any risk of going bad or running out. Examples of sustainable energy sources include wind, solar and water (hydropower). To help us gather more information on sustainable energy use, let us watch the following video. In a previous lesson, you learnt that renewable resources are natural resources that can be replenished at a higher rate than they are consumed. Therefore, using renewable energy resources forms a significant part of sustainable energy use. In this section, you will look closer at these renewable energy resources and the advantages and disadvantages of producing and using these energy resources. You will also get a chance to demonstrate your creativity and innovation, as you create models of different energy resources.

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		Sustainable Energy for All https://www.youtube.com/watch?v=7PrMaAY39sY (0:50 mins) Teacher, introduce each of the renewable energy resources by showing photographs or videos of each type. A series of questions related to each type can then be asked. Sample questions on solar energy are given below. These can be used as a guide for the other renewable energy resources. **Solar Energy:** ● What types of energy do we get from the sun? (light, heat) ● How do we use it in our homes? (dry clothes, light rooms, dry plant materials). ● Is solar energy used in your country? ● What can we use the transformed energy for? ● What kind of work can the device do for us? Teacher, show a photo of a solar plant/solar panels. Have you seen these before? If so, where?  **Retrieved from:** https://pixabay.com/photos/solar-cells-photovoltaic-electricity-491701/

<table>
<tr><th>Specific Curriculum Outcomes</th><th>Inclusive Assessment Strategies</th><th>Inclusive Learning Strategies</th></tr>
<tr><td></td><td></td><td>Discussion should highlight why solar panels are seen in bright sunny spots. Let students share their thoughts.

Teacher, explain how sunlight can be captured using solar panels to generate electricity or heat water.

Suggested resources and suggested technological activity for each renewable energy source are shown below.

<table>
<tr><th>Energy resource</th><th>Suggested video</th></tr>
<tr><td>Solar energy</td><td>Solar Energy - Science for Kids (https://www.youtube.com/watch?v=2O0JaROLuUY) (5:19 mins)</td></tr>
<tr><td>Wind energy</td><td>What is Wind Energy - Science for Kids Duration: (https://www.youtube.com/watch?v=_8DtGAp1fyI) (3:34 mins)</td></tr>
<tr><td>Hydropower</td><td>What is Hydropower - Science for Kids Duration: (https://www.youtube.com/watch?v=-Zwe_2f_PyY (4:25 mins)</td></tr>
<tr><td>Geothermal</td><td>What is Geothermal Energy
https://www.youtube.com/watch?v=ldfRWjUpO8M (4:18 mins)</td></tr>
<tr><td>Biomass</td><td>What is Biomass
https://www.youtube.com/watch?v=LsvrsXhxO2I (3:59 mins)</td></tr>
<tr><td>Tidal/wave energy</td><td>What is Tidal Energy?
https://www.youtube.com/watch?v=Nai-dcyogb8 (1:31mins)</td></tr>
</table>
</td></tr>
</table>

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		Suggested projects **Solar energy -** A solar oven or solar cooker **Wind energy** - A wind turbine **Hydropower** - A model water wheel **Biomass energy** - Observing the fermentation of yeast **Tidal/wave energy** - Wave turbine model **Geothermal energy** - Model geothermal power plant. Students can also be taken to a place where solar panels have been installed. Have someone point out the main components of the devices and explain how they work. Solar energy can also be demonstrated using a small solar panel to power a toy car. **Note to teacher**: You are encouraged to take the students on a field trip to observe the power plants available in your country. A panel of local energy experts can also be invited to visit the classroom to discuss with students' examples of alternative energy sources being used in their country. **Advantages and disadvantages of renewable sources** While we know that renewable sources of energy can be replaced over a short period of time and that they are good for the environment, some environmental issues have been associated with their production and use. We would now take a closer look at some of these issues.

<table>
<tr><th>Specific Curriculum Outcomes</th><th>Inclusive Assessment Strategies</th><th>Inclusive Learning Strategies</th></tr>
<tr><td></td><td></td><td>
Advantages and disadvantages of renewable sources.
<table>
<tr><th></th><th>Advantages</th><th>Disadvantages</th></tr>
<tr><td>Solar energy</td><td>Produces no toxic pollution or global warming emissions</td><td>• Habitat loss
• Solar energy is expensive</td></tr>
<tr><td>Wind energy</td><td>Produces no toxic pollution or global warming emissions</td><td>• Habitat loss
• Affect wildlife such as birds</td></tr>
<tr><td>Hydropower</td><td>Produces no toxic pollution or global warming emissions</td><td>• Can flood land upstream.
• Dams can alter the natural flow of water in an area.</td></tr>
<tr><td>Geothermal energy</td><td>Produces no toxic pollution or global warming emissions</td><td>• Geothermal system can be very costly to install.
• Limited to areas with volcanoes and geysers, etc.</td></tr>
<tr><td>Biomass energy</td><td>When burnt, biomass may produce less pollution than fossil fuels.</td><td>Use is limited as there are only a few sites to produce enough power</td></tr>
<tr><td>Tidal/wave energy</td><td>Is able to provide a more predictable source of energy.</td><td>• Large areas of land are needed to plant the plants needed.
• In some areas, forest are being destroyed to plant these crops</td></tr>
</table>
Have students discuss these impacts.

Now that you know the advantages and disadvantages of using alternative energy sources, we will now organise a class debate on the following topic.
</td></tr>
</table>

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		Would you consider using an alternative energy source to power your car or cool your home? Why or why not? Ask students to design a poster to depict the following. What will happen if renewable alternative energy sources are not developed and used widely by the general public. **<u>Activities</u>** Divide the class into five groups and assign one of the following to each group. Working in your group, prepare an advertisement to sell one of the following. When you are done, you will present your advertisement to the class. 1. A house heated by geothermal energy. 2. A property which has solar panels. 3. A machine that captures and stores solar energy. 4. A house that is powered by wind energy. 5. A house where everything is powered by the Sun. **<u>The impact of energy technologies</u>** Over the last set of lessons, we looked at both renewable and non-renewable sources of energy – how they are formed, extracted, processed and transported. We have also looked at the environmental impact of these fuels. You would therefore have seen that several technologies are involved in the energy industry. These technologies are crucial to our daily lives. Without them, we would not have the ability to power our vehicles, air

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		conditioners or heaters or have warm water. However, these technologies have both positive and negative effects on the environment. **<u>Technology can also be misused and abused</u>** **Abusing technology** ● Buying equipment/devices that are not needed. ● Energy exploration by oil and gas companies that are not warranted. ● Wasting energy simply because it can be afforded. **<u>Misusing technology</u>** This is where a technology is used for a purpose it was not intended for. One of the best examples of the misuse of energy technology is the use of nuclear energy for the development of nuclear weapons. What are some other examples of the misuse of technology you can think of? **<u>Conservation</u>** We all must play our part in reducing the amount of energy we use, which will help to reduce the negative impact on the environment. **Conservation** means to use less of something. If nothing else, we need to use the resources we have more efficiently. Every action counts! What can individuals do to reduce the amount of energy they use? What do you do to save energy? What else could you do?

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		Working in groups, students can be asked to make a list of the things that they think persons can do to reduce the amount of energy they use. Each group can then present their ideas to the class. Examples could include: 1. Uses buses and trains instead of individual vehicles, as these hold more persons. 2. Use cars less, walk where possible. Use a bike instead of using a vehicle. 3. Recycle, reuse and reduce garbage generated. 4. Turn off lights and other appliances and devices, when not in use. 5. Use sources of clean energy instead of fossil fuels, such as solar energy. 6. Use energy saving bulbs. 7. Energy smart landscaping. 8. Switching to more efficient appliances. Add to the list that students generate where necessary. Go through the list with students to find out how they think each suggestion would help to reduce the use of energy. Ask students to look at the list and state some of the things that they are currently doing to reduce their energy use. Also ask students to list other things that they may be able to do to reduce their energy use. Invite someone from a well-known business to tell students what they are doing to reduce their energy use.

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		Activity – School energy audit Divide the class into groups of three or four students. Have students in each group, conduct an energy audit in the school, during which time, they will identify areas where energy is being wasted. After conducting the energy audit, they will discuss their findings and then come up with measures that the school could put in place to save energy. Each group will then write an energy management action plan for the school. Each group will present their plan and the class will discuss the proposal put forward by each group. **Homework assignment** With the help of an adult, conduct an energy audit in your home. Look out for the following: 1. Areas where energy is being wasted. 2. Activities designed to save energy. 3. Any energy saving devices/equipment found in the home. 4. After conducting the energy audit, discuss your findings with members of your family and suggest different measures that can be put in place to save energy in the home. List some of the things you are doing or could do, to save energy.

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		Ask the pupils to each share one thing they are going to do at home to reduce their energy consumption. Students can research and propose renewable energy options for their school, such as solar heating or photovoltaic cells, or a wind turbine. **<u>Culminating activity</u>** The OECS territories use a lot of energy however they are not producers of the fossil fuels needed for generating that energy. For example, the electricity needed to power our homes, factories and industries come from the burning of fossil fuels. This fuel has to be imported from oil producing countries at very high costs. As a result, the energy consumption bills in the region are very high. **Activity:** Have learners conduct research to demonstrate that they can obtain and combine information on the following ● the energy and fuels used in their territory. ● the main sources of the energy and fuels in their territory ● how the energy and fuels are used in their territory ● Students may complete a table such as the one below, some possible answers have been included for teachers to be guided:

<table>
<tr><th>Specific Curriculum Outcomes</th><th>Inclusive Assessment Strategies</th><th>Inclusive Learning Strategies</th></tr>
<tr><td></td><td></td><td>
The uses of energy can be placed in 4 main categories as shown in the table below.
<table>
<tr><th>Sector</th><th>Energy source</th><th>Uses</th></tr>
<tr><td>Home</td><td>Wood, coal</td><td>Cooking, cooling and heating homes</td></tr>
<tr><td>Transportation sector</td><td>Gasoline, diesel,</td><td>Transport people, goods and animals by buses, cars, trucks and planes</td></tr>
<tr><td>Industrial</td><td>Coal, wood and diesel</td><td>For operating industrial motors and machinery.
Producing electricity</td></tr>
<tr><td>Commercial sector</td><td>Light, heating, cooking, security</td><td>Coal, charcoal, LPG, natural gas, nuclear energy</td></tr>
</table>
From the list of energy resources used in your country, choose one then prepare a presentation on that energy resource. Your presentation must include the following:

What is the natural source it is derived from?
What is this energy resource used for?
How it addresses energy needs in your country.
The positive and negative effects that this energy resource has on the environment.
The role of technology in improving or mediating the environmental effects of using the given energy resource.

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</table>

Additional Resources and Materials

Renewable Energy 101: How Does Hydroelectricity Work? (https://www.youtube.com/watch?v=pEUzot8Zufo 1:15 mins)

How Do Wind Turbines Work? | Sources Of Electric Energy | The Dr Binocs Show | Peekaboo Kidz (https://www.youtube.com/watch?v=ia1LJE9sOxQ 5:30 mins)

What If The Whole World Runs On 100% Solar Energy? | The Dr. Binocs Show | Peekaboo Kidz (https://www.youtube.com/watch?v=6djnJxdSQWQ 6:00 mins)

The journey of natural gas (https://www.youtube.com/watch?v=V8EHHW-3N5Y 7:11 mins)

CRUDE OIL DISTILLATION SIMPLIFIED
https://www.youtube.com/watch?v=-0CwOvo3aKs (3:33 mins)

Working in groups, students can create various models for renewable and non-renewable energy sources. Here are some ideas.

Solar Oven:
Materials: Cardboard box, aluminium foil, plastic wrap, black construction paper, glue, scissors.
Instructions: Students can construct a simple solar oven using a cardboard box lined with aluminium foil to reflect sunlight onto a black construction paper-covered surface inside. They can experiment with different designs and angles to optimize heat absorption and cooking efficiency.

Wind Turbine:
Materials: Cardboard, wooden dowels or sticks, paper cups, hot glue gun, scissors, string, small DC motor (optional).
Instructions: Students can build a small-scale wind turbine model using cardboard blades attached to a central shaft made of wooden dowels. They can mount the turbine on a base and experiment with different blade designs and wind speeds to generate rotational motion.

Hydroelectric Generator:
Materials: Plastic bottle, small water pump or motor, plastic tubing, wooden dowels, cardboard, glue, scissors.
Instructions: Students can create a hydroelectric generator model by constructing a miniature dam using a plastic bottle filled with water. They can attach a small water pump or motor to the bottle's opening and connect it to a turbine made of cardboard blades. As water flows from the bottle through the turbine, it can generate electricity.

Geothermal Heating System:
Materials: Clear plastic container, soil, small water pump, plastic tubing, thermometer, heat lamp (optional).
Instructions: Students can simulate a geothermal heating system by filling a clear plastic container with soil and burying a small water pump connected to plastic tubing inside. They can monitor the temperature of the soil and observe how it varies with depth.

Oil Refinery Model:
Materials: Plastic bottles, straws, clay or playdough, food colouring (optional), scissors, glue.
Instructions: Students can construct a simplified model of an oil refinery using plastic bottles to represent different processing units. They can use straws to simulate pipelines connecting the units and moulding clay or playdough to depict storage tanks and other structures.

Coal Power Plant:
Materials: Cardboard tubes, small LED lights, black construction paper, cotton balls, glue, scissors.
Instructions: Students can create a model of a coal power plant by using cardboard tubes as smokestacks and attaching small LED lights inside to represent burning coal. They can cover the base with black construction paper to simulate coal storage and use cotton balls for smoke emissions

Additional Useful Content Knowledge for the Teacher: (*any additional knowledge that the writers believe would be helpful for the teacher such as reading material at a lower or higher grade level, links to curriculum documents for other grades)*

The teacher should have:

A Basic Understanding of Energy Concepts

Knowledge of Renewable Energy Technologies

An understanding of Environmental Science Principles

Knowledge about current events and trends in renewable energy research, industry developments, and policy changes enables teachers to provide students with up-to-date and relevant information.

Opportunities for Subject Integration: *(Additional ideas about how the inclusive learning strategies might be adapted and/or applied to include other subjects in the curriculum)*

Social Studies- Resources

Mathematics:

Measurement and Data Analysis: Collect and analyse data related to energy usage, such as electricity consumption in their homes or school. Calculate energy savings achieved through renewable energy initiatives and graph their findings.

Geometry: Explore the geometric shapes and dimensions of renewable energy structures, such as the blades of a wind turbine or the surface area of a solar panel.

Language Arts:

Writing: Write persuasive essays advocating for the adoption of renewable energy policies or expressing their opinions on environmental conservation.

Public Speaking/Debates: The writing pieces can be used to participate in debates about energy policy and environmental issues.

Reading: Students can read informational texts and literature related to renewable energy, sustainability, and environmental activism. Analyse and discuss the themes, characters, and messages conveyed in these texts.

Social Studies:

Civic Engagement: Explore the role of government, NGOs, and communities in promoting renewable energy adoption and combating climate change. Research local and global energy policies.

Art:

Visual Arts: Create artwork inspired by renewable energy themes, such as paintings of wind farms or sculptures made from recycled materials. Design posters or infographics to raise awareness about renewable energy and environmental conservation.

Elements from Local Culture, Technology, TVET, Environment that are integrated:

Some factories in the OECS e.g. arrowroot and sugar cane factories, used dammed water, turbines and water wheels to generate energy for milling.
The local "coal pit" is made by cutting trees and burning them in the absence of air to make charcoal.
Baking in a stone or drum oven using charcoals which are commonly referred to as "coals". This coal is to be distinguished from coal which is the formed by heat and pressure applied to plant materials over millions of years.

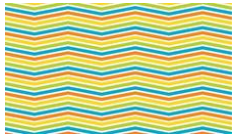
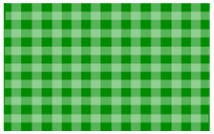
Forest fires which threaten the environment
Burning bamboo joint
Dominica has hot sulfur pools and champagne beach which is a strong indication that geothermal energy is very a viable technology and renewable energy source.
St. Lucia has hot water pools and mud baths that are heated very hot due to geothermal energy.

Underwater signals can affect the migration patterns of animals such as whales.

Waves

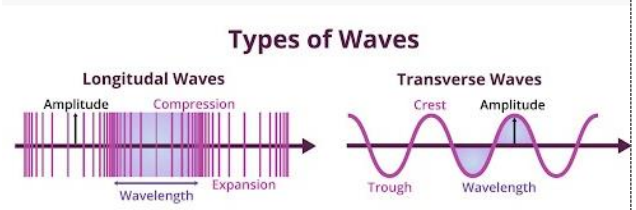
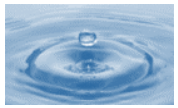
Introduction to the Subject: The study of science encompasses knowledge, processes and values. Scientifically literate persons will foster an attitude of caring not only for themselves, but as responsible citizens, for the world around them. Their decision making will be enhanced by a systematic study of the structure and behavior of the physical and natural world through observation and experiment. In learning science, students benefit from leveraging and evaluating available technological tools to study and therefore understand the world and their relationship to it
Strand (Topic): Waves An understanding of the properties of waves helps students to account for natural phenomena including the behaviour of light and further establishes the foundation for explaining interactions of matter based on an atomic theory**.**
Essential Learning Outcomes 1: Develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move [Clarification Statement: Examples of models could include diagrams, analogies, and physical models using wire to illustrate wavelength and amplitude of waves.] [Assessment Boundary: Assessment does not include interference effects, electromagnetic waves, non-periodic waves, or quantitative models of amplitude and wavelength.]
Grade Level Expectations: Refer to grade level expectations at the beginning of this curriculum document.

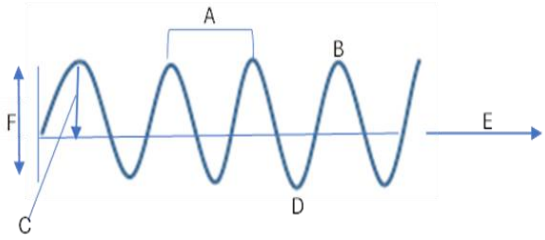
Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
Learners are expected to: ● **Define the terms:** ➢ Wave ➢ Amplitude ➢ Wavelength ➢ Crest ➢ Trough ➢ Pattern ➢ Longitudinal waves ➢ Transverse waves ➢ Pitch ➢ Vibration	**General questions on waves motion and wave characteristics** 1. Draw a picture of a wave and label it with the following terms. a. Wavelength b. Amplitude c. Crest d. Trough	**Wave Motion Characteristics** As part of introduction, students may be asked to describe the sea/ocean when the winds are high, or a storm is approaching. The waves are in a regular pattern. Students may also describe the effect on the surface of the water when they skip rocks across the surface or drop a stone into a pool of water. **Repeating patterns** Introduce the concept of "repeating patterns" by presenting to the students' examples of repeating patterns. Ask them to state the things that they notice about each of the examples. After some

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
➢ Volume ➢ Loudness ➢ Mechanical waves ➢ Electromagnetic waves ➢ Reflection ➢ Refraction ➢ Diffraction ➢ Sound intensity and decibels. • Demonstrate an understanding that waves carry energy from place to place. • Describe the characteristics of a wave. • Identify the amplitude, wavelength, crest and trough of a wave on a wave diagram. • Explain how amplitude and wavelength change when energy is added or taken away from a disturbance. • Demonstrate an understanding that waves can cause an object to move. • Demonstrate an understanding that the motion of objects varies with the amplitude and wavelength of the wave carrying it. • Compare waves produced from the same source.	2. You encounter many different waves in your daily life. a. Give two examples of waves that you encounter in everyday life. (*ocean, skipping rope)* b. Give two characteristics that you expect the waves you listed in 2a. to have. (*have an amplitude, have a direction)* c. Explain how you know that waves have repeating patterns. (*same crest and trough repeated)* d. Give two reasons why studying waves is important. (*waves are used for communication and medical devices*) 3. A wave can be considered as a disturbance, moving energy from place to place. For each of the following examples given, state the source of energy for the wave.	discussion, identify what you have presented as examples of "repeating patterns" and define the term for the students.   Patterns retrieved from: https://pixabay.com/illustrations/zigzag-lines-colorful-pattern-7957807/ https://pixabay.com/vectors/gingham-background-fabric-texture-48107/ Divide the class into groups of three to four students. Students, working in your group, create an example of a repeating pattern. Use numbers, shapes, etc. When you are finished creating your pattern, present it to the class. The other members of the class will determine if it is a repeating pattern and make suggestions, if necessary, as to how it can be corrected. Class, what are some other examples of repeating patterns that you have seen before? (*Stripes on a bee's body, spots on a leopard and scales on a fish).* Students, I want you to keep the term repeating pattern in mind as we begin to look at this unit's topic – waves. **<u>Introduction to waves</u>** Students, what do you think of when I say the word waves?

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
• Account for differences observed between waves produced from the same source. • Demonstrate how certain waves are produced. • Explain how different types of waves are produced. • Explain how different waves travel from place to place. • Explain how the repeating patterns produced as a wave are propagated. • Explain what a longitudinal wave is. • Explain what a transverse wave is. • Give examples of longitudinal waves. • Give examples of transverse waves. • Distinguish between different types of waves. • Describe the basic characteristics of waves. • Describe how different types of waves transfer energy. • Describe what happens when waves move across the surface of deep water. • Identify models or diagrams of different types of waves. • List the different mediums that a specific wave can go through.	**Wave example** / **Source of energy** a. Waves moving along a rope. b. Water waves formed in a pool. c. Sound waves formed from the beating of a drum. *Rope: moving hand provides energy* *Waves in a pool: a dropped object provides energy* *Drum: hand motion beating drum provides energy* 4. Below is a picture of a swimming pool. If a stone is thrown into the pool, water waves would form.  https://pixabay.com/photos/pool-swimming-pool-swimming-system-375466/ a. Describe how the water waves would move in relation to the point where the stone was thrown. (*in a circle moving from the centre)*	Write students' responses on the board. To help us answer that question, let us look at the following video. As you watch the video, keep in mind the following: • A definition for the word wave. • Examples of waves. **Video - Waves** https://www.youtube.com/watch?v=73FLjzJNt_I (1:50 mins) From the video we learnt that there are many waves that we encounter on a daily basis. Can you name some of them? *(Sound waves, light waves, radio waves, microwaves and water waves).* We will now begin our exploration of waves, by taking a closer look at the ocean waves., shown in the following video. **Video – Waves** https://www.youtube.com/watch?v=h0W5GBobAZE (2:00 mins) As you watch the video, pay attention to how the waves are moving, how they sound, etc. Also think about possible answers to the following questions. 1. Do the waves make the same sound? 2. Do the waves look similar? 3. Do the waves move in a similar manner? Suppose I tell you that a wave is a repeated pattern of motion. What evidence from the video supports this? (*The ocean waves repeated themselves over and over space and time*)

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
• Label parts of a wave diagram or model. • Explain what a wave is in terms of energy. • State the similarities and differences among different types of waves. • Differentiate between volume and pitch. • Describe the properties of sound waves. • Explain how frequency and pitch are related. **Skills** • Draw a model of a wave based on the information given. • Demonstrate sound travelling through different media. • Develop and use models to describe patterns of waves in terms of amplitude and wavelength. • Illustrate the relationship between vibration and pitch. • Demonstrate the transfer of energy through the creation of a mechanical wave. • Observe the vibrations made by various objects that produce sound. • Observe how waves are produced.	b. Where does the energy to form the wave come from? (*the impact of the stone falling – potential & kinetic energy*) c. Suppose a beach ball was on the surface of the when the stone was thrown into the pool. How would you expect the ball to move after the stone was thrown into the pool? (the ball would ride the crests of the waves and move across the pool) d. What would you expect to see if a larger stone was thrown into the pool of water? *(a larger wave would be formed because the falling stone would have more energy due to higher mass)* **Questions on types of waves** **NOTE: Teacher should limit the assessment to simple examples of transverse (rope) longitudinal (slinky) and electromagnetic (light) waves. Some questions that follow can be differentiated to be age and ability appropriate.** 1. Transverse waves and Longitudinal waves are two different types of waves. Answer the following questions about these two types of waves.	As the ocean waves move from place to place, they carry energy with them. One of the ways that ocean waves get their energy is from the wind, as it blows over the surface of the water. **The formation of water waves and how they affect the movement of objects** **Teacher demonstration** Demonstrate for students how water waves can be created, by a fan blowing across the surface of water in a container. Turn the knob on the fan to the lowest setting, then to its highest setting Ask students to record their observations. • Students, what did you notice? (*When the fan was turned on, waves formed in the water. When the fan was turned to the highest setting, a larger disturbance was produced, and hence larger waves were produced*). • How is this similar to the formation of ocean waves? (*Energy from the wind caused by the fan, caused water waves to form.*) Students, now that you know what a wave is and you know what it does, you will now continue your exploration of waves by creating some of your own and studying their characteristics. **ACTIVITY** **Creating and studying water waves further** **Materials needed:** Water in a container, 1 plastic cup, A plastic toy that floats on water and Rule Students, have you ever thrown a pebble or rock into a body of water such as a pool, puddle or stream? (*yes/no*)

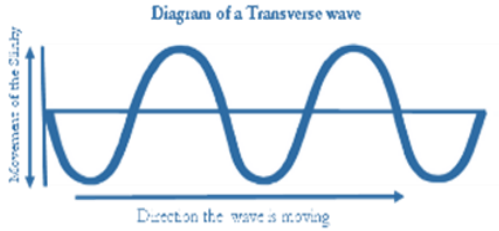
Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
• Infer how a wave will behave under certain circumstances. • Classify waves based on their characteristics. • Conduct measurements when making models of waves. • Hypothesize how a wave will behave under certain circumstances. • Communicate data collected from investigating waves in different formats. • Construct models of different waves. • Calculate the time taken for a wave to move from one point to another. • Conduct experiments to determine how the properties of sound waves are related to wavelength and frequency. • Conduct experiments explaining the characteristics of waves. • Compile data on the characteristics of different types of waves. • Interpret different wave diagrams in terms of the different characteristics of a wave. • Illustrate wave motion in different media. • Investigate to compare how vibrations travel differently	 Retrieved from: http://t1.gstatic.com/licensed-image?q=tbn:ANd9GcTyWR0SIbrrIsegvTOVsgDIe7Dgm8TcYjA6D40FYqe9mNn4AemmrVPcVKD0azUC6F3rohl2sG6NScnKB31en2qIKA *a.* Define Transverse waves and give two examples of a transverse wave. (*skipping rope, ocean wave)* b. State one way in which a transverse wave is different from a longitudinal wave. (*longitudinal wave moves because of compression like a slinky*) 2. Waves can also be classified as mechanical waves and electromagnetic waves. a. What are mechanical waves? (*waves created by a physical movement)* b. Give one example of a mechanical wave. (*stone in a pool*) c. What are electromagnetic waves? (*waves that are created as a result of vibrations between an electric field and a magnetic field)*	 In this experiment, you will get a chance to do so. Students, working in your group, drop the small stone into the container of water provided, from about 15 cm above the level of the water. Pay close attention to what happens to the water and the direction the waves are moving. Record your observations. Retrieve the stone from the container and drop it again. Class, it is sometimes difficult to see water waves, so we will now look at two short videos that show, in slow motion, what happens when a rock is thrown into a pool of water. As you watch the videos again, pay close attention to what happens to the water and the direction the waves are moving **Video - Stone makes waves** https://www.pbslearningmedia.org/resource/buac20-35-sci-ps-waveenergy/wave-energy/ (0:29 mins) **Video - Another large rock thrown off a bridge -** https://www.youtube.com/watch?v=iQW-BE8abZs (Timestamp 0:46 to 1:03 mins) Now that you have done the experiment and have seen the videos, answer the following questions. 1. What happened around the pebble when it went into the water? (*Ripples, or waves, formed.*) 2. Which direction do the waves move? (*The waves move in circles, away from the rock.*)

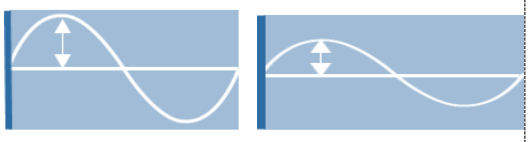
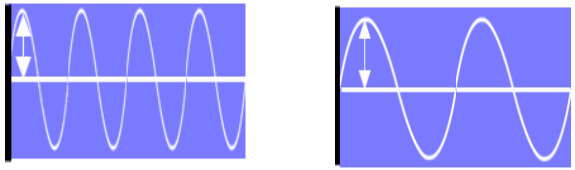
Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
through solids, liquids, and gases. • Demonstrate how the pitch and loudness of sounds waves are related. • Explore and describe different sounds (e.g., high, low, soft and loud). • Investigate the effect on changing the pitch of a sound. • Classify sound by pitch and by loudness • Compare the transmission of sound through air, water, and some solids. • Use a model to demonstrate how waves cause objects to move. • Develop a model (e.g., diagram, analogy, or physical model) of waves to describe patterns in terms of amplitude and wavelength. **Attitudes/Values** • Show an appreciation of the importance of waves in our daily lives. • Demonstrate persistence in the investigation of waves and the production of models of waves. • Show interest in finding out about different waves.	d. Give one example of an electromagnetic wave. (*different types of light*) 3. Slinkys are very useful for modelling longitudinal and transverse waves. a. Explain how you would move a Slinky to produce transverse waves. (*compress and release a slinky)* b. Explain how a longitudinal wave moves along a Slinky. (*the compressed wire pushes each adjacent wire as the compression is released*) c. What happens to a transverse wave when it gets to the end of a Slinky? (*the energy gets absorbed by hand holding it or it pushes air*) 4. Below is a diagram of a transverse wave. Write the name of the different parts of the wave in the spaces provided.  	3. Do you think if you dive into a pool you will cause similar waves to form? Give each group an object that will float on water. Students, place your object on the surface of the water. While you are waiting for the water to settle, predict what would happen to the object if you made waves with the cup provided. Now make waves by moving the plastic cup (rim up), up and down in the water. Students record what happened to the object and state whether or not it matched your prediction(s). **<u>Let us summarize what was observed</u>** • When the stone was thrown into water, waves formed. • These waves moved outwards away from the point of disturbance, in a circular manner. • The objects on the surface of the water moved up and down. but did not move with the water. This point will be explored further in the next activity. **ACTIVITY - ROPE WAVES** Students, many of you might have played with a jump rope/skipping rope. In this exercise, you will be creating waves using a rope. To do so, you will be working in groups of three – One student to hold the rope firmly, one student to create the waves and the third student to record observations. Your roles will be rotated as you repeat the tasks. **Note**: It is easier to create waves if the rope is held almost parallel to the floor and not held too tightly.

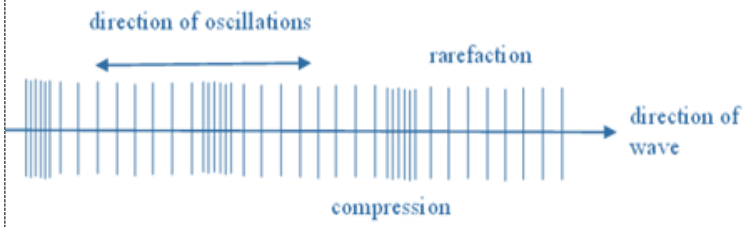
Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
• Use the inquiry approach to investigate wave characteristics and wave motion. • Demonstrate respect for the evidence produced through the investigations of different waves. • Demonstrate their inventiveness in the construction of models of different types of waves. • Work collaboratively in the investigation of waves and the production of models of waves. • Ensure when investigating waves in the environment e.g. throwing stones into water bodies, or making sounds, that animals are not affected. • When investigating waves, ensure that safety rules are followed, especially when using items such as ropes and slinky to produce waves. • When conducting experiments on the characteristics of waves, display sensitivity with respect to persons who may not be able to for example, hold a rope, move a slinky, etc. • Participate actively in classroom discussions, investigations, presentations about waves, at	A_____ B_____ C_____ D_____ E_____ F_____ a. What type of wave is shown in the diagram? b. Why do you think waves might be important? 5. Below is a wave diagram.  a. What type of wave is this? (*longitudinal*) b. Describe how this wave would move along a Slinky. c. Describe how the slinky would move. d. What are the areas labelled A and B called?	Students, to begin the exercise, the Wave maker will flick the rope quickly up and down. However, before the rope is flicked, predict how the rope will move when it is flicked. Begin flicking the rope now. Practice flicking it a few times, before you begin to take observations. After the Observer records the observation, switch roles. Now, repeat the above step. However, before you do so, tie a ribbon at any point along the rope. Before you flick the rope, predict how the ribbon will move when the rope is flicked. Record your observations. **Answer the following questions:** 1. How did you generate waves in a rope? (*The waves were generated as the rope was moved up and down.*) 2. How did the rope move? (*Up and down*) 3. What was transferred by the waves along the rope? (*Energy was being transferred from the hand going to the end of the rope.*) 4. How did the ribbon move with respect to the movement of the wave? (*The ribbon moved up and down in the same spot, while the wave moved along the rope.)* 5. How is the movement of the ribbon similar to the movement of the objects in the bucket of water? (*Both moved up and down in the same spot*) **Explanation** The up and down movement of your hand at the end of the rope, created a wave, which moved energy from your hand along the rope. You should have also observed that while the ribbon tied to the rope moved up and down, it did not move along the rope with the wave.

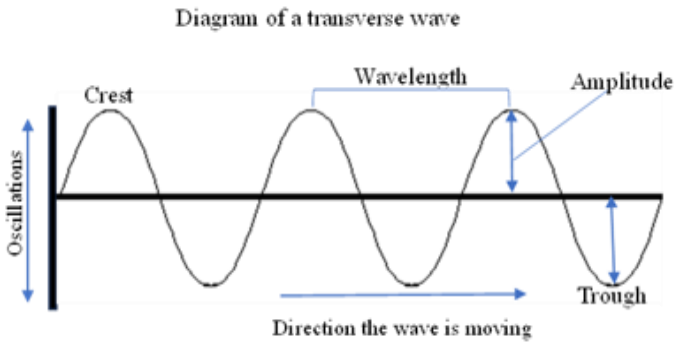
Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
individual, group or class levels where necessary.	A__(*rarefaction*)_____ B___(*compression*)_____ **Questions on sound waves** 1. Sounds are all around us. We hear sound because it travels from one place to the other in the form of a wave. a. What type of waves are sound waves? (*longitudinal*) b. What are sounds made by? (*vibrations*) c. How do sound waves travel from one place to the other? (*through a medium like air or water*) *d.* If you screamed in outer space no one would hear you. What is the reason for this? (*Space consists of a vacuum (no air) therefore without a medium the vibrations can't travel)* 2. Pitch and loudness are two terms which can be used to describe sound. a. What is the pitch of a sound? b. What is a high pitch sound? c. What is a low pitch sound? d. What is the amplitude of a sound wave equal to? e. Give an example of a high pitch sound f. Give an example of a low-pitch sound	This shows that the energy produced moves along with the wave, not the source of the energy, your hand. **Different Types of waves and wave characteristics** On a whiteboard/chalkboard write down the words: longitudinal wave, transverse wave, wavelength, amplitude, trough and crest. In this activity, you will be using the Slinky you have been given to model two different types of waves.  Note: The following video gives some insight as to how this activity can be conducted. Slinky Waves - https://www.youtube.com/watch?v=OXlMWa3kxL (5:47 mins) Slinkies can be used to demonstrate two important groups of waves: transverse and longitudinal waves. From these activities, you will also learn about some important wave features. **Creating transverse waves using a Slinky** Like in the last activity, you will again work in groups of three, with each student having the same role as before. As before, your roles will be rotated as you repeat the tasks. Spend a few minutes practicing moving the Slinky from side to side.

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
	3. Draw a wave diagram to represent each of the following sound waves. a. Sound with a low volume and a low pitch. b. Sound with a low volume and a high pitch. c. Sound with a high volume and a low pitch. 4. Circle the correct option. Which sound is the	Now that you are comfortable moving the Slinky, begin the experiment by moving the Slinky from side to side and recording your observations. Pay close attention to the movement of the Slinky and the movement of the wave. The type of wave you just made is called **a transverse wave**. It is the same type of wave that you made with the rope. Let us look at the following video to see this wave in slow-motion. As you watch the video, pay attention to how the wave is travelling and also the direction the hand is moving. **Video - Transverse wave using slinky coil** https://www.youtube.com/watch?v=g8GcMn7K0u4 (0.56 mins) Now, repeat the above step. However, before you do so, tie a ribbon at any point along the Slinky. Before you move the Slinky, predict how the ribbon will move when the Slinky is moved. Record your observations. **Questions** 1. What direction did you move the slinky to create the disturbance? (*Side to side*) 2. In what direction was the wave moving? (*Along the Slinky*) 3. Were both the Slinky and the wave moving in the same direction? (*No*) 4. What happened to the wave when the wave got to the end of the Slinky? (*It bounced back/was reflected*) 5. Did the ribbon move down the Slinky or did it stay in the same place? (*It stays in the same place*)

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
	loudest?    a. A whisper b. A Fire alarm c. An airplane https://pixabay.com/photos/alarm-fire-alarm-red-danger-safety-3410065/ https://pixabay.com/photos/whisper-children-indonesia-funny-2792979/ https://pixabay.com/photos/plane-aircraft-flight-sky-take-off-50893/ 5. Circle the correct option. Which sound is the softest? a. Footsteps b. Beating of a drum c. A kettle whistling 8. Circle the picture that best matches each question a. Which sound wave is louder?	Draw a picture of your wave. It should look similar to the drawing below. Let us look at the diagram closely to see what it is telling us  From the activity and from looking at the video, what can you conclude about transverse waves? (*In a transverse wave, the material of the slinky moves in one direction (up and down) while the wave travels along the slinky in another direction.)* This means that while the hand is moving the Slinky from side to side, the wave is moving along the Slinky in a direction that is said to be perpendicular/at right angles to the direction the Slinky is moving. **<u>Creating longitudinal waves using a Slinky</u>** You are now going to model another type of wave using the Slinky. Keeping the slinky straight, Wavemaker, quickly push your end of the slinky just a few centimetres toward the person holding the other end of the slinky and then bring it back to the original length. Before you push the Slinky, predict what will happen to the Slinky as the wave reaches the other end of the Slinky

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
	 b. Which sound wave has a higher pitch?  c. What makes some sounds louder than others? **Question on light waves** 1. Light is all around us, without light we would not be able to see the things around us. Answer the following questions. a. Light travels in _____ _____ b. Light is an example of a _____wave.	Repeat the action you just performed. This time, pay attention to the direction you had to move the slinky to make the wave and the direction the wave is moving. The type of wave you just modelled is called a **longitudinal wave**. Sound is an example of a longitudinal wave Just as we did with the transverse wave, we will now look at a video showing the movement of this wave in slow motion. **Video - Longitudinal waves using a slinky coil** https://www.youtube.com/watch?v=fMJrtheQfZw (0.56 mins) **Questions** 1. What direction did you move the slinky to create the disturbance? (*Forwards and backwards*) 2. In what direction was the Slinky wave moving? (*Along the Slinky*) 3. Were both the Slinky and the wave moving in the same direction? (*Yes*) 4. What happened to the wave when the wave got to the end of the Slinky? (*It bounced back/was reflected*) From the activity and looking at the video, what can you conclude about longitudinal waves? (*In a longitudinal wave, the slinky moves forwards and backwards and the wave moves in the same direction as the slinky is moving.) Therefore,* in this type of wave, we say that the slinky is moving in a direction parallel to the direction in which the wave is travelling. Below is a diagram of a longitudinal wave. Let us look at the diagram closely to see what it is telling us.

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
	2. Like other waves, light can be reflected, refracted and diffracted. Define these three processes in the space provided. a. Reflection _____ _____ _____ b. Refraction _____ _____ _____ c. Diffraction _____ _____ _____ 3. State two ways that light waves are different from sound waves. 4. Light waves get their energy from the light source. Give two sources of light. **Health and Wellness** Some large cities in the world have sound level measures (decibels) on street corners.	There are some areas where the coils of the Slinky appear to be very close together, while in other areas, they appear to be further apart. The areas where the coils of the Slinky appear to be very close together are called **compressions**, while the areas where the coils appear to further apart are called **rarefactions**. Did you see **compressions** and **rarefactions**?  Now, I want you to tie a piece of coloured fabric around one of the coils. Predict what will happen to the ribbon as the wave travels along the Slinky. 1. What happened to the ribbon as the wave moved through the Slinky? (*It moved up and down*) 2. Did your prediction match what happened? (*Yes/No*) 3. How is this similar to the ribbon on the rope? (*Both moved up and down but did not move along with the wave*) **Summary:** • The Slinky is the medium that the waves travel through. • The student holding the slinky provided the energy to make the waves. • There are two main types of waves: transverse waves and longitudinal waves.

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
	 Retrieved from: https://www.cbc.ca/news/canada/edmonton/noise-monitoring-edmonton-led-1.4824209 1) What is the purpose of those? (*to measure and then reduce loud sounds in the neighborhood*) *2)* Why are loud sounds dangerous? (*the wave vibrations can enter our ears and do damage to our ear drums)* 3) In what occupations do we see people hearing protection? (*construction, roadwork, fabrication, automotive tools, airport runway staff*) The waves that carry sound energy to our ears can be very dangerous and cause long term hearing damage because our ear drum vibrates as the wave enters our ear.	• When the wave reached the opposite end of the Slinky, it bounced back or was reflected. **<u>Naming parts of a transverse wave</u>** It is now time to put names to the various parts of a wave. Here, I have a blank diagram of a transverse wave. Pay attention as I label the diagram to show certain characteristics of waves.  • The amplitude of a wave is the height of the wave • The wavelength of a wave is the distance • The trough is the lowest point on the wave. • The crest is the highest point on the wave. **<u>Changing the wave patterns made by a Slinky</u>** Students, now that you have created transverse waves using the slinky, you will now manipulate the slinky further, to identify patterns in waves, to see if there is a relationship between frequency, wavelength and amplitude, by exploring the changes in frequency, amplitude and wavelength by:

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
	Teacher Demonstration Arrange for two identical empty bottles. Fill one bottle A two-thirds filled with water and the other bottle B one third filled with water.  Create a sound above bottle A by striking a tuning fork above the bottle. Ask students to listen very carefully to the tone that leaves bottle A. Now strike the same tuning form above bottle B. Students should note that the tone they hear is not the same. 	• Shaking the slinky at different rates without removing it from the surface. • Shaking the Slinky with different force without removing it from the surface. **By changing the size of the Slinky** Students, try stretching the slinky out a little more. Make some waves. Try pulling the slinky closer together and make more waves. Before you make the waves, predict if the wave would be smaller or larger. Record your observations in the table below. **Tasks** | **Prediction** | **Larger/smaller waves formed** Create waves with the Slinky stretched out. | | Create waves with the Slinky pulled closer. | | 1. Did the waves move faster when the Slinky was stretched out or when it was pulled closer? 2. Were bigger waves (waves with more amplitude) produced when the Slinky was stretched or when it was pulled closer? **Changing the amount of energy used to make the waves** Students, let us now see if the amount of energy used to make the waves affects the amplitude and wavelength of the waves produced.

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
	Questions About the Demonstration 1) Ask the students what that means? *(The tone they hear is not from the tuning fork but instead from the bottle.)* 2) Ask students why the tone would be different from the second bottle B? (*there is a different amount of water and the air space above the water level is different in bottle B*) 3) Ask students …is the tone from the bottle coming from the water or the air above the water? (*the air column above the water gives a certain space for the wave energy to move)* *4)* Would you expect there to be a different tone created for different levels of water in the bottle? (*yes*) *Let try some different levels and see if you are correct!* Our ear drum receives wave energy just like the bottles when the tuning fork vibrates. Depending on the energy in the sound wave our ear drums can be damaged.  We usually hear a sound by vibration of air.	Before you shake the Slinky, predict what will happen. | Tasks	Prediction	Larger/smaller waves formed | |---|---|---| | Create waves by shaking the Slinky harder. | | | | Create waves by shaking the Slinky softer. | | | 1. What does shaking the slinky harder do? (*Shaking the slinky harder causes greater amplitude*) 2. What does shaking the slinky softer do? (*Shaking the slinky softer causes less amplitude*) Now students draw pictures of the waves for the different actions performed on the Slinky in the table below.

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
	Retrieved from: https://www.goldendance.co.jp/English/boneconduct/01.html The sound pressure or sound intensity is measured in **decibels**. Have students do internet research to find out decibel levels of different sound wave sources in our environment including the dangerous levels for human ears. Teacher resource: https://soundear.com/decibel-scale/ Have a discussion about ways to protect our hearing from loud sounds.	<table><tr><th>Different ways the Slinky was manipulated</th><th>Drawing of the waves produced</th></tr><tr><td>Shake the Slinky slowly</td><td></td></tr><tr><td>Shake the Slinky faster</td><td></td></tr><tr><td>Shake the Slinky with a lot of force</td><td></td></tr><tr><td>Shake the Slinky with less force</td><td></td></tr></table> Students now make conclusions based on the patterns that you see in your drawings. Did both the force and the speed at which the Slinky was shaken change the pattern of the waves produced by the slinky? (*Yes, the shape of the wave produced was determined by the amount of energy that was used to cause the disturbance and how fast the vibrations were made.)* **Students, you should have observed the following:** • When the Slinky was shaken slowly, they got more waves on the Slinky (a higher

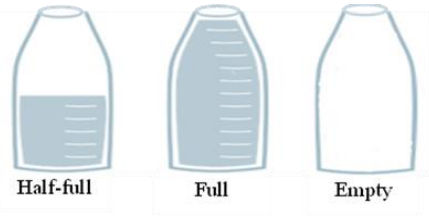
Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		• frequency of waves) and the waves were longer in length • When the Slinky was shaken faster, they got more waves on the Slinky (a higher frequency of waves) and the waves were shorter in length. • Shaking the slinky harder produces waves with greater amplitude. • Shaking the slinky softer produces waves with less amplitude. **<u>Activity</u>** **Using a Mexican wave to demonstrate different types of waves** Students you may have seen spectators participating in "the wave" at a sporting event, such as football or cricket. Now that you have made longitudinal waves and transverse waves, as a class, have fun modelling each type of wave using your body. **Note:** During the Class demonstrations, ensure that students do not push each other hard, as a student could fall. 1. Students form a line standing shoulder to shoulder with everyone facing me (the teacher). 2. To create the wave, we will start with the student at the end of the line to my (the teacher's) left, by him/her raising his/her arms, then immediately putting them down. 3. As soon as his/her hands are lowered, the second student should raise his or her arms. This continues down the line with each student raising his or her arms as soon as the student before him/her in line, puts his/her arms down

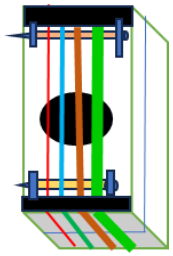
Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		4. Let us see how quickly you can do the wave! Good, you have just modelled a transverse wave. 5. Now to model a longitudinal wave, this time, line up with your hands on the shoulders of the student in front of you. Each student will *carefully* lean into the student in front of him/her and then stand up straight. Each student must, however, wait until they have been "leaned into" before they can continue the wave. **Note:** A video of the students making the "wave" can be recorded, so that the students can see the result. **<u>Sound Waves</u>** Sound can only be made when something is vibrating. To vibrate means to move back and forth very fast. Sound waves are a type of **mechanical wave** that require a medium to travel through. They are longitudinal waves, meaning the particles of the medium vibrate in the same direction as the wave is travelling. Remind students that sound is produced by vibrations and vibrations produce sounds, by doing the following demonstrations. 1. Strike a drum on which a few grains of rice have been placed. a. Could the drum make a sound by itself? b. How did the drum make the sound? c. What happened to the rice grains when you hit the drum? Why? 2. Tap a tuning fork on the desk then bring it close to a ball on a stick, without touching the ball. The ball should begin to

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		vibrate. Repeat the action, this time put the tuning fork near the surface of some water in a bowl, without touching the water. What did you observe? (*The vibrating tuning fork caused both the ball and the water to vibrate*). **<u>Sound travels from one place to the other</u>** Teacher, ask students to close their eyes, then stand behind the class and clap your hands. Students, what did I just do? How did you know what I just did since you couldn't see me? You knew what I just did because you heard the sound I made. How did you hear me? You heard me because the sound I made travelled through the air in the form of waves called sound waves.  https://pixabay.com/vectors/audio-signal-wifi-wireless-304331/ **<u>Is sound affected by the matter it travels through</u>** 1. Distribute a pair of bottles the same size to each student. 2. First, have students listen to a sound travelling through the air, then have them hold the empty water bottle to one ear

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		while they cover the other. Ask their partner to tap the bottle with a pencil. Have students described the sound they heard? 3. Then ask them to listen to the same sound travelling through water, by holding the full water bottle against one ear while their partner taps it with the pencil. 4. Have pairs of students then repeat, using the block of wood as a solid. Have students switch roles, repeat the experiment, then answer the following questions. **Questions** 1. How did the sound change between what you heard with air and what you heard with water? (*The tapping sound is louder through the bottle filled with water than the bottle with air.*) 2. How did the sound change between what you heard with water and the solid? (*The sound is louder through the solid than through the bottle of water.*) 3. How did the sound change between what you heard with air and the solid? (*The sound through the solid is louder than the sound through the bottle of air.*) **Pitch and volume - Two properties of sound** The larger the ***amplitude*** of the waves, the **louder** the sound. **Pitch** (frequency) is determined by the ***spacing of the waves***. The closer together the waves are, the higher the pitch of the sound. Pitch and loudness are two characteristics that help us to decide whether a sound is pleasant or not.

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		Pitch Pitch distinguishes shrill sounds from grave sounds. A shrill sound, such as the blowing of a whistle, is called a high pitch sound, whereas a less shrill sound, such as a whisper, is called a low pitch sound. Let us compare the sound of a **whistle** with that of a **drum**.   https://pixabay.com/photos/drum-musical-instrument-hand-drum-96179/ https://pixabay.com/photos/whistle-toy-1115360/ Which sound would you say is a high sound? You will notice that blowing a whistle produces a high sound, while a drum produces a low sound. The whistle is an example of a high pitch sound, while the drum is an example of a low pitch sound. Provide more sounds for students to listen to and categorize as high pitch sounds and low pitch sounds **Homework assignment** Listen to sounds in your home and see if you can identify five examples of high pitch sounds and five examples of high pitch sounds of low pitch sounds. How do these sounds make you feel? **Investigating pitch - Teacher demonstration** Students, today I will be using these materials to conduct two simple experiments. Before I conduct each experiment, I want you to write down a hypothesis about what you think will happen.

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		Experiment one: In front of me are 3 glass bottles of the same size - one full of water, one half-full of water and the third one empty. I am going to strike each one with a spoon and I want you to observe what happens. You must be quiet as I strike each bottle.  Bottle tapped / Prediction / Observation Full bottle Half-empty bottle Empty bottle 1. What happened to each bottle when it was hit with the spoon? (*It made the glass vibrate*) 2. Which bottle produced the highest sound? (*The empty bottle*) 3. Which bottle produced the lowest sound? (*The full bottle*) 4. Why do you think you got the results you got? (*Fast vibrations make a high sound and slow vibrations make a low sound*) Explanation: A full bottle will produce a slow vibration and a low sound because water slows down the vibrations. An empty bottle produces a faster vibration and a higher sound. This is because of the air space for the sound to vibrate within the bottle. That is the same principle of a

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		pipe organ in a church where the pipes are different lengths forte air to vibrate in. **<u>Activity No. 2</u>** I am now going to blow across the top of each bottle, instead of tapping it with the metal spoon. Before I blow across the bottle, write a prediction about whether or not blowing across the bottles will produce the same sound, as when I tapped the bottle with the metal spoon. Record your observations. 1. Was your hypothesis correct? Why or why not? 2. Did the pitch change? <u>Explanation</u>: Clinking the bottle and blowing into it do not produce the same sounds. Blowing into the bottle makes the air in the bottle vibrate while hitting the glass makes the glass vibrate. **<u>Using a Shoebox Guitar to produce sounds of different pitch</u>** **Materials needed**: Shoebox or similar box (with a hole cut out from the top), tape, rubber bands (of different thickness), pencils  Students, you will now build a shoebox guitar from the materials provided. Follow the following steps to make your guitar. After

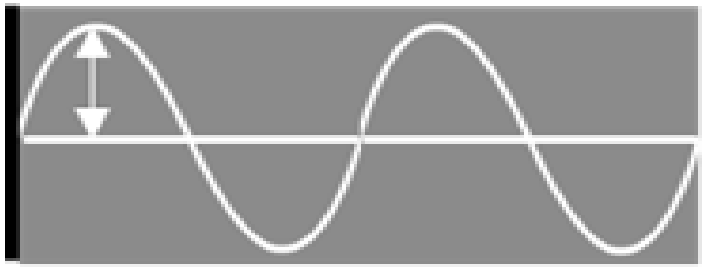
Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		making your guitar, you will use it to further investigate pitch and sound. ● Decorate your shoe box (which already has a hole cut in the top of it). ● After you are finished decorating your boxes, pull the elastic bands (of different widths) around the length of your box, be sure there is space between the rubber bands. ● Place two pencils underneath the rubber bands, to lift the rubber band and allow them to vibrate freely. Tape the pencils down to ensure that they stay in place. ● Once you are finished making your shoebox guitar, pluck the rubber bands one by one to make a sound. Repeat this step, listening carefully. Record your observations. See if you could arrange the sound from the rubber bands from highest pitch to lowest pitch. ● Pluck the bands again but before you do, hold down part of the elastic bands with your fingers to shorten them. ● Record your observations **<u>Questions</u>** 1. Which rubber bands made the highest sound? 2. Which rubber band made the lowest sound? 3. How do you think both shoebox guitars and real guitars make sound? Explain your answer. **What you should have found:** ● The thickest rubber band made the lowest sound while the thinnest rubber band made the highest sound. ● The shortest rubber band vibrates the fastest. It makes the highest note. ● The longest rubber band vibrates the slowest. It makes the lowest note.

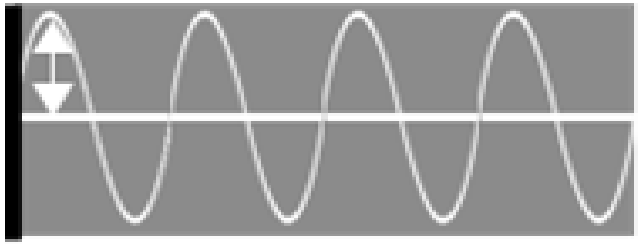
Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		Loudness A loud or soft sound is identified by its volume, another property of sound. A loud sound has a high volume while a soft sound has a low volume. Loudness is related to the amplitude of a sound. The larger the amplitude, the louder the sound. Loudness depends on the energy of the sound. The greater the energy, the louder the sound. **Homework activity** Identify 10 loud sounds in the neighbourhood. Why is it important that these sounds are loud? **USING THE COMPUTER TO GENERATE AND VISUALIZE WAVES** 

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		There are several sites that could be used to provide students with the opportunity to manipulate certain wave characteristics. For example, students may be able to change the amplitude and frequency, to see how these changes affect wavelength and hence see how the wave diagram changes as the different wave characteristics change. Three of them are shown below. As students explore these sites, they should begin to recognize how a wave's amplitude (height) and wavelength (length of a wave) can change. Students should be able to describe **patterns** of waves in terms of amplitude and wavelength and draw diagrams to represent waves with different features. https://www.physicsclassroom.com/Physics-Interactives/Waves-and-Sound/Simple-Wave-Simulator/Simple-Wave-Simulator-Interactive https://phet.colorado.edu/sims/html/waves-intro/latest/waves-intro_all.html https://academo.org/demos/virtual-oscilloscope/ **Note to teacher:** Using the computer can be very challenging for some students. Students who are better at manipulating computer sites, should be placed with those who may have difficulty doing so.

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		As students explore the sites and become familiar with them, they can be asked to produce waves with specific features. Some examples are given below 1. a wavelength with high amplitude. 2. a wave with many wavelengths (high frequency). 3. a wave with many wavelengths and high amplitude. 4. a wave with few wavelengths and low amplitude Working in groups, students can be asked to draw the waves they create. **Exploring sound waves** There are also other programmes that allow students to explore sound waves to see how the wave diagrams change as the amplitude (loudness) and frequency (pitch) of a sound are changed. They also get to hear how the sounds change. The links to two of these sites are given below. https://serpmedia.org/scigen/oscillo-board/ https://academo.org/demos/virtual-oscilloscope/ Some sites may also allow students to upload their own sounds, to see how the wave pattern changes as the sound changes. Before students begin their exploration, remind them of the following. Sound waves are Longitudinal waves and longitudinal waves are difficult to draw, as a result, sound waves are represented using the same wave diagrams as those of transverse waves.

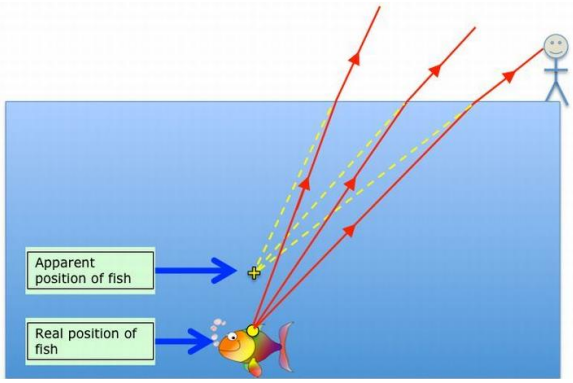
Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		Loudness is given by the amplitude of the sound wave, while pitch is given by the frequency of the sound wave. Amplitude changes when more or less energy is added to the wave. With sound, the more volume, the higher the amplitude. Also, the higher the tone or pitch, the more wavelengths can be seen. High amplitude sounds are made by objects that vibrate with a lot of energy, like the sound of a rocket blasting off. Low amplitude waves are like a whisper, where your vocal cords vibrate lightly to make sound waves. Upon visiting a site, allow students free exploration for about 2 minutes to familiarise themselves with the different options available for them to manipulate. After some time, students can be asked to produce waves with specific characteristics. Some examples of waves that they may produce are given below. a. High amplitude with few wavelengths (high volume with a low note) b. High amplitude with many wavelengths (high volume with a high note) c. Low amplitude with few wavelengths (low volume with a low note) d. Low amplitude with many wavelengths (low volume with a high note Discuss the differences between the waves created with: 1. A high pitch and a low pitch sound. 2. A loud and soft sound

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		For those sites that allow students to upload their own sounds or have sound files that students could use, students should find that the objects that create loud sounds should have large wavelengths and amplitudes, while the objects that create little noise would have the opposite. 1. How does the size of amplitude and wavelength impact the sound that is made? 2. How did the long wavelengths look and sound? 3. How did the short wavelengths look and sound? (*The length of wavelengths will change with the sound and frequency)* 4. How did the high amplitude waves look and sound? 5. How did the short amplitude waves look and sound? (*Amplitude changes with volume of the sound*) **Drawing wave diagrams** Students can then draw the waves that different sounds make. 1. Draw a wavelength with high amplitude. 

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		2. Draw a wave with many wavelengths (high frequency).  3. Draw a wave with low amplitude  4. If you are given two wave diagrams and asked which one has the higher frequency, how would you decide? 5. If you are given two wave diagrams and asked which sound is louder, how would you decide?

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		A CLOSER LOOK AT LIGHT WAVES Like other waves, light waves exhibit the following characteristics. • Light waves also transfer energy from place to place. A light source such as a candle flame, is the energy for the light waves. • Light waves can also be described by their frequency, amplitude and wavelength. • Light waves do not need a medium to travel through, therefore waves can travel through a vacuum. • Light waves are just one type of electromagnetic wave. Other electromagnetic waves include the microwaves in your oven, radio waves, and X-rays. Light travels much faster than sound. • The amplitude of a light wave is its brightness. • Like other waves, light waves undergo reflection, refraction, and diffraction. • An important property of light is that it travels in a straight line. We get shadows when light is blocked by an object. • Light can pass through some but not all materials. Using the materials provided (pieces of cardboard with a hole in each piece, tape and a light source), set up a simple experiment to demonstrate the fact that light travels in a straight line. Teacher: The following video gives some ideas as to how this may be done. **Video - Light Travels in a Straight Line** https://www.youtube.com/watch?v=iXy9Z4J17xY (3:33 mins)

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		Reflection of light All waves are known to undergo **reflection** or the bouncing off of an obstacle. In previous lessons, you would have learnt that you see objects because the light reflected from them reaches your eyes. Two other properties of light is that it can be refracted and diffracted like other waves. **Refraction of light** As with sound waves or other waves, light waves bend or are refracted as they move from one medium to another. Place a pencil into a half-full glass of water. What do you observe?  Hold the pencil straight up and observe what happens. What would you expect to observe at the water level, if you were to look at someone standing in a pool of water? Give one reason why refraction is important.

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		Spearfishing and Refraction  Light coming from the fish refracts (changes direction) when it hits the surface. A person above the water sees the apparent position of the fish closer to the surface than the real position of the fish. Retrieved verbatim from: https://www.sciencelearn.org.nz/images/59-refraction-and-spearfishing **<u>Diffraction</u>** When light waves encounter a small obstacle or a small opening, like other waves, the light wave can bend around the obstacle or pass through the opening and then spread out. This bending or spreading out of light waves is called diffraction. A very simple demonstration of diffraction of light waves can be conducted by holding your hand in front of a light source and slowly closing two fingers while observing the light transmitted between them.

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		1. What do you observe? (*As the fingers approach each other and come very close together, a series of dark lines parallel to the fingers are observed*). 2. What are two examples of diffraction in everyday life? The following video will also help to explain the concept a little better. **Video - Demonstrating diffraction using laser light** https://www.youtube.com/watch?v=MZktgCWvHlE **(Timestamp: 0:00 to 2:40 mins)** **CREATING MODELS OF WAVES USING DIFFERENT MATERIALS** ● Now that you have a better understanding of waves and you are familiar with the different types of waves and properties of waves, working in your groups, you will now create physical models of transverse waves. ● You are provided with different materials (Play-Doh, pipe cleaners, string, wire, fabric, glue and masking tape, etc.). ● Use these materials to make a model of a transverse wave. Your model should have more than one wavelength. Your wave should be labeled with definitions of crest, trough, wavelength, and amplitude at the correct points on the model. ● After you are finished making your physical model, you will make a presentation to explain how transverse waves move. You should use the model you created to demonstrate and define the parts of a wave.

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		The following video demonstrates one example of a wave machine that can be used to make waves. https://www.youtube.com/watch?v=LvFOPWChyA0 (0.22 mins)

Additional Resources and Materials

- Straw waves - https://www.youtube.com/watch?v=IlF8sdHTqaU (2:12 mins)
- A simple wave machine: https://www.youtube.com/watch?v=2eMT3skCTDg (4:10 mins)
- Waves - Light Waves and Sound Waves: https://www.youtube.com/watch?v=IIrjYh9GrGM (9:52 mins)
- How are Longitudinal Waves Related to Transverse Waves? - https://www.youtube.com/watch?app=desktop&v=fNqFciMgIbI (3:13 mins)
- Water droplets make waves - https://www.pbs learningmedia.org/resource/buac20-35-sci-ps-waveenergy/wave-energy/ (0:29 mins)
- Water bottles with a different Pitch: https://www.youtube.com/watch?v=YdAZQhIABAM (1:58 mins)

Additional Useful Content Knowledge for the Teacher:

Opportunities for Subject Integration:

English Language

- Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest.
- Describe characteristics of waves.
- Provide definitions of different concepts of waves
- Take notes and categorize information collected.

Mathematics

- Counting the number of peaks of a wave.
- Taking measurements of amplitude and wavelength.
- Measuring materials to make models of waves.

Social studies

- The use of waves in sporting events such as cricket and football and social events.
- The effects that waves can have on coastal areas and on persons.

Health

- Loud sound waves can damage hearing. Examples: music, jackhammers, vehicle horns, airplanes etc.
- Large waves in the ocean have energy that can knock you down and the undertow can pull you in the water.

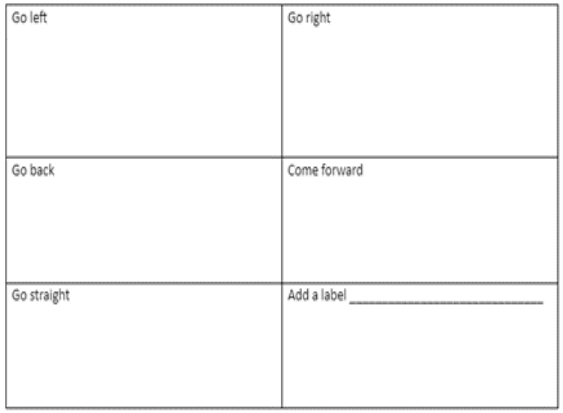
Essential Learning Outcome 2: Generate and compare multiple solutions that use patterns to transfer information [Clarification Statement: Examples of solutions could include drums sending coded information through sound waves, using a grid of 1's and 0's representing black and white to send information about a picture, and using Morse code to send text.]
Grade Level Expectations: Refer to grade level expectations at the beginning of this curriculum document.

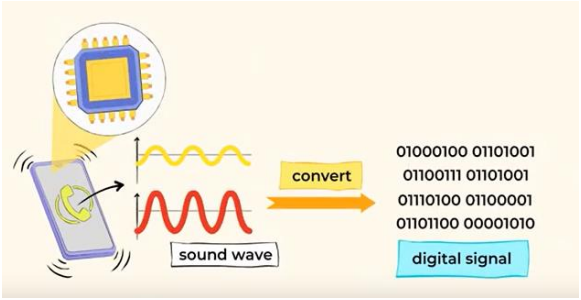
Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
Learners are expected to: **Knowledge** • Define the terms: o Decoding o Encoding o Cell towers o Digital o Patterns o Signals o Symbol o Gestures o Binary o Code o Constraint o Criteria o Radio wave o Controlled experiment o Causal relationships • Demonstrate an understanding of the importance of waves.	1. Write the meaning of each symbol shown below. A  https://pixabay.com/vectors/red-circle-backslash-no-symbol-24018/ _____ B  https://pixabay.com/vectors/sign-caution-warning-danger-safety-304093/ _____ C  https://pixabay.com/vectors/recycling-symbol-logo-green-eco-304974/ _____ D  https://pixabay.com/vectors/confirmation-symbol-icon-green-1152155/ _____ E  https://pixabay.com/vectors/no-smoking-sign-prohibited-1298904/ _____ F  https://pixabay.com/vectors/baby-diaper-diaper-change-icon-1295614/ _____ 2. A long time ago, messages were sent using methods such as the beating of drums and puffs of smoke.	**People Use Waves to transfer information – Introduction** For as long as humans have been on Earth, they have enjoyed communicating with each other. Some of the earlier methods of communicating to persons was the use of speech, gestures, symbols and drawings, reflected rays of the Sun, fire and smoke signals and the beating of drums. From this we can see that waves have been used in communications for a very long time. **Communicating using Sound Waves** Who's ready to feel the beat? Turn on your listening ears and listen closely as I clap out a pattern. Teacher introduces the lesson by clapping/drumming to a rhythm. Students, can you match my rhythm? (Students try to match the rhythm) Students when you hear this beat I want you to run on spot/dance/move around. Teacher beats another rhythm and says when you hear this sound I want you to freeze. Teacher repeats the exercise for students to follow the codes. Teacher makes another pattern and declares that it means, turn around and play it again and continue the game.

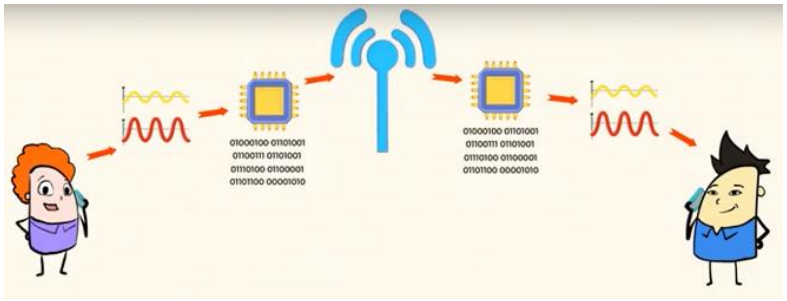
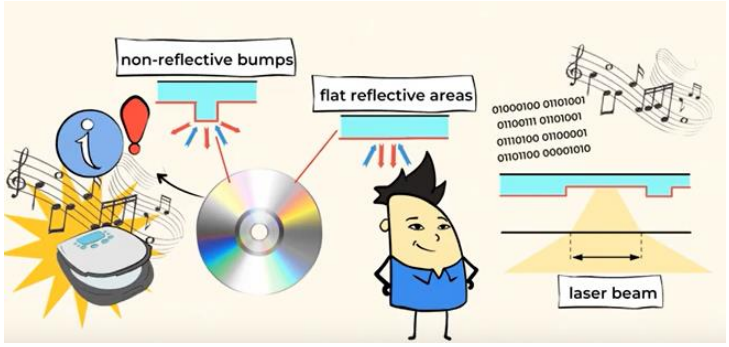
Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
• Demonstrate how high-tech devices use waves to send and receive information. • Compare two different ways of encoding and decoding information. • Give advantages and disadvantages of the different coding methods. • Compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution. • Show how light and sound waves can be used to transfer information. • Account for differences observed in the transmission of information. • Explain how a telephone works using a basic model. • Explain the importance of encoding and decoding messages using different methods • Explain how a string phone works.	a. State one reason why each method was not useful for sending messages over long distances. b. Before Morse code and the telephone were used to send messages long distances, how were messages sent over long distances? 3. Complete the following table by writing sound waves, light waves or radio waves to tell how each signal is sent. **Signaling device** / **How each signal is sent** Morse code Lighthouse Traffic lights Two-way radio Television Cell phone	Students, in today's lesson we are going to learn how patterns can be used to transfer information. In your own words tell me, what is a pattern? **So, what makes waves suitable for communication?** From our last series of lessons, you found out that waves occur in repeating patterns and energy is transferred by waves without matter being transferred. Waves also travel unchanged over long distances. All of these properties make them very suitable for transferring information through the use of coded signals. This makes waves useful for sending and receiving messages. Some examples include: • Patterns of sound waves can transfer information (for example, Morse code and drum signals). • Patterns of light waves can transfer information (for example, smoke signals and ship-to-ship signals of light). **Gestures, symbols and codes all communicate messages across distances.** **Symbols** A symbol is something that represents or stands for something else. **Activity symbols** • Present to students a series of symbols such as a stop sign shape or street sign, common emoji, the peace sign, etc. Ask students to state what each symbol represents.

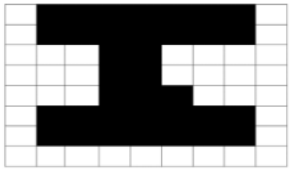
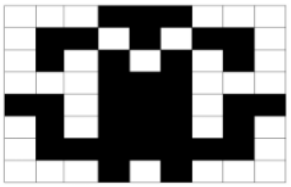
Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
• Explain how the use of waves to transfer information has changed the way information is transferred • Give an advantage and one disadvantage for each model of encoding information • Give examples of devices which use different types of waves to transfer information • Decode and write messages in Morse code. • Identify different types of symbols encountered in everyday life • Distinguish between symbols, signals and gestures. • Examine past inventions in their historical context, with a view to understanding the various positives and negatives of research. (ST 3 TE NT 1) **Skills**	**Develop models of signals**Engineers use waves and signals to communicate images, words and ideas. Draw a model of each of the following. In your model show how waves or signals are used to help the technology work. Cell phone GPS Fiber optics	• Decode each of the symbols together. • Then make a list of other common symbols. • Discuss the advantages of using symbols and codes for communication **Signals** A signal transfers a pattern. Often, this pattern is made up of light waves or sound waves Introduce the idea of a signal by testing the smoke alarm so that it makes a sound. If it is not possible to test the smoke alarm, play the sound of a smoke alarm to the class. Discuss how a smoke alarm uses a code and a pattern.   **Examples of light and sound used to send signals** **A lighthouse** A lighthouse projects a bright, flashing light out to sea. The lighthouse's lamp is the source of the light waves. Sailors detect the light waves and observe any patterns they see. Every lighthouse uses a

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
• Observe the use of different codes in the transfer of information • Infer how a change of different parts of a string telephone will affects its ability to transmit sound waves • Describe characteristics of waves that make them suitable for the transfer of information. • Classify devices based on the type of signals they use to transfer or receive information • Measure the length of materials to conduct experiments • Hypothesize how changes to a string phone will affects its ability to transmit sound waves • Construct a message for others to decode using codes • Construct a model telephone	Answer the following questions a. Give three examples of how you can communicate with someone living in another country. (*phone, email, letter*) b. How might you communicate with a friend to invite him or her to your birthday party? (*send an invitation, telephone call or message by someone*) Answer the following questions on how light and sound are used to communicate information. a. What type of waves do ambulances and police cars use to communicate with people? *b.* Give three examples of how we can use different sounds to communicate information. (*alarms, sirens, clapping, whistle)* c. What is the message that ambulances and police cars want to communicate to people d. as they move on the roads? *(emergency situation)*	unique pattern of flashes. Sailors look at a chart to help them decode or interpret each signal. Every lighthouse also has a foghorn. A foghorn makes a loud sound that can be heard far from land. Each foghorn makes its own unique pattern of sounds. Play a sound bite of a foghorn and ask students to identify the sound and what is its purpose. • Under what condition would it be necessary to use the foghorn? (foggy night) • How do the lighthouse and a foghorn communicate information? **<u>Traffic lights</u>** A traffic light is another kind of signal. Light waves are employed in communicating an idea. It flashes red, green, or yellow. These colors let drivers know whether they should stop, go, or begin to slow down. Traffic lights help drivers move safely in different directions. They also help keep traffic flowing. **Activity:** • Make a class list of different signals that students have encountered and what they communicate, for example, railroad crossing, fire alarm, alarm clock, low battery alert. • Review the different types of signals that students have discussed. Categorize them by energy type. sound signals light signals, motion signals. • With students, identify the pattern that each signal uses to communicate.

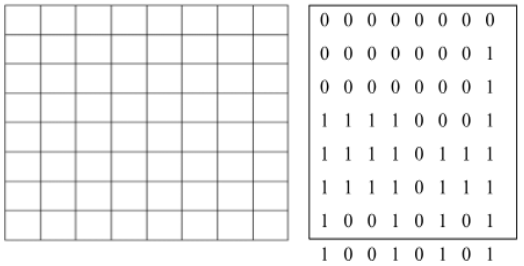
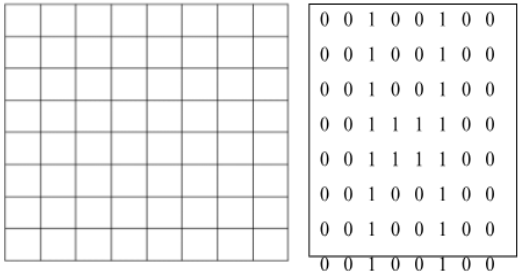
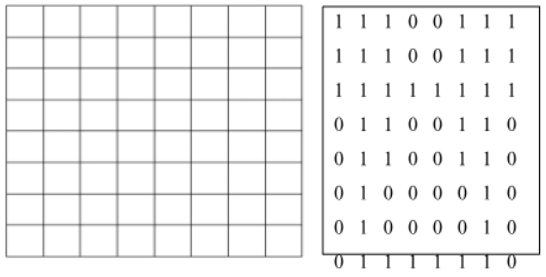
Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
• Construct diagrams to show how a cell phone transfers and receive information. • Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution • Draw diagrams to show how cell phones transfer and receive information • Design at least two different code designs for transferring information • Plan and conduct investigations on different devices that communicate information • Compile data from carrying out different investigations. • Analyse data obtained from testing codes or devices developed by classmates. • Analyze data to explain how communication devices transmit data.	e. List three ways that persons use light to communicate information over a distance. (*headlights on a vehicle, flashlight, boat messages*) f. List three ways that persons use sound to communicate information over a distance (*horn, siren, speaker system*) Draw a light signal for the directions given in each box  	• With students, identify the type of energy and wave that each signal employs to communicate. • Identify how each signal transforms a pattern of one form of energy to another to communicate. **Note:** Be sure students understand that signals act over a distance. Some signals can act over longer distances than others, depending on the type of wave and the medium (wires, air, or other) being used. **Gestures** Have each student think of one gesture they can used to communicate a positive message, such as a smile, a thumbs-up, a head nod, or a high five. (Remind students that some gestures are negative and therefore, should be avoided.) Discuss how students can communicate with babies who can't yet talk or with people who speak a different language. **Activity** • Whisper to one student an animal name (giraffe, wolf, cat, or whale, for example). • Have student use gestures, signals, or symbols to communicate the name of the animal • Discuss the difference between gestures, symbols, patterns, codes, and signals. **Different ways that information is transferred from one device to another**

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
• Create and Interpret data obtained from testing devices • Interpret messages using Morse code or other codes. • Evaluate each code and design solution based on speed, accuracy, and ease of use. • Design and draw a timeline to show how technology for particular purposes has changed over time (ST 4 PS EN 3) **<u>Attitudes/Values</u>** • Appreciate the role that the different types of waves play in the communication of information • Show persistence when developing codes for the transfer of information and in the development and testing of devices to transfer information • Demonstrate interest in developing codes for the	The Morse Code was a very important invention that allowed persons to send messages over long distances. Answer the following questions. a. Why was the invention of the telegraph so important? (*long distance communication*) b. How does Morse Code allow us to send messages? (*Using a code of dots and dashes for words)* c. Write your name in Morse Code d. What is an advantage of Morse code? (*simple language using simple equipment*) e. What is a disadvantage of Morse code (*long words take time to spell*) f. Why do you think Morse code is not used much today? (*other communication faster*)	**Transferring information using patterns** <u>https://www.youtube.com/watch?v=oWOq2cv0U6k</u> (3:57 mins) Video includes: • Discussion of morse code and use of flashing light source to communicate. • Discussion of binary code (communication with zeros & ones) and how a computer uses 0 for "off" signals and 1 for "on" signals. **How information is transferred using patterns** <u>https://www.youtube.com/watch?v=wBBi3FuZsls&t=306s</u> (5:15 mins) Video includes: • Discussion of how computers and phones use binary codes. 

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
transfer of information and in decoding messages received from others • Use the inquiry approach in conducting various investigations on the transfer of information via different types of waves • Show respect for evidence obtained from investigation on the transfer of information • Work collaboratively with their group members to develop different codes for the transfer of information and in the development and testing of devices to transfer information. • Stewardship/Respect for Living Things o When conducting experiments outside be careful not to disturb animals nearby with loud sound, shouting, etc.	Complete the table below by choosing a word to represent the categories of nouns listed. NOUNS / YOUR CHOSEN EXAMPLE / MORSE CODE Animal Place Utensil Plant Food Look at the following scenarios and respond to each by answering the questions. a. Imagine you are lost in the woods and need help. Would you rather use a telephone or Morse Code to send out a message? b. What are two advantages of using this form of communication? c. Imagine you are in your backyard and want to send a message to your best friend, who lives next door. Would you rather use a telephone or Morse Code to send out a message? Answer the following questions about string telephones.	 • Discussion of binary code (communication with zeros & ones) and how a compact disc is read by a laser to convert music into binary and send it to a listener.  However, while some of the methods of communication we mentioned earlier were suitable for sending messages over short distances, using them to send information over long distances was a challenge. To send information across long distances (e.g. from my country to England or to another OECS state) people wrote letters, which in some cases, took weeks or more to get to their destination, after traveling by boat, horseback and by foot. As a result, sending messages over long distances

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
• When conducting practical and group work, display sensitivity to those students who may have hearing difficulty or who may be visually impaired or colour blind. • Participate actively in whole-class and group discussions on the transfer of information. • Humankind values, beliefs and overall attitudes can influence technological activities and use. (ST 3 STSE 3)	a. What materials do you need to make a string telephone? b. How does a string telephone work? c. State three factors that may affect how a person hears what the other person is saying, when they are using a string telephone. Write the binary code for the following images.  	was slow, unreliable and inefficient. Which is why new technologies were developed to help to overcome these problems. These also allowed persons to send information from one device to another. With the discovery of electricity, people began experimenting with electrical communication. One device that came out of this period of experimenting was the electric telegraph. Subsequently, the Morse code was developed for use with the telegraph. A telegraph is a device that moves electrical signals from one place to another through wires.  Retrieved from: https://commons.wikimedia.org/wiki/File:Automatic_telegraph_reciever-CNAM_14704-IMG_5206-white.jpg **So, what is Morse Code?** To help us answer that question, let us look at the following videos. **Invention of Morse Code** https://www.youtube.com/watch?v=ORIDAmGf_yQ (4:24 mins) **What Is Morse Code** https://www.youtube.com/watch?v=N-KcLgXQVa4 (7.06 mins)

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
	 	From the videos we learnt that the **Morse Code** was developed a very long time ago, by a gentleman called **Samuel Morse.** The Morse Code is a very unique method of communicating information over long distances. Using this method of communication, messages can be sent using a special code. A message is sent by tapping out a code via the telegraph. The telegraph converted the taps to electric signals which were sent along telegraph lines. The person receiving the message then decodes the message. From the video we also learn that the Morse code communication system uses dots and dashes to relay messages. Each letter in the English language and every number corresponds to a unique combination of dashes (—) and dots (•).

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
	Look at the binary codes given below, shade the bitmaps for each set of codes to show the image each set represents.    	In the Morse Code system, a dot is called a "dit" and a dash is called a "dah". Different combinations of dits and dahs represent each letter in the English language as shown in the chart below. A•– J•––– S••• B–••• K–•– T– C–•–• L•–•• U••– D–•• M–– V•••– E• N–• W•–– F••–• O––– X–••– G––• P•––• Y–•–– H•••• Q––•– Z––•• I•• R•–• The Morse Code is special because it can be sent electronically using sound or lights. Using the chart above, letters can be put together to create words and sentences. You will get a chance to use the code to write messages and to decode messages sent to you. To use this system, the following rules on timing are employed: The length of each symbol is related to the length of one dit: • A dit is one unit of sound. • When switching between dits and or dahs in the same letter, you leave one unit of silence. • A dah is the length of three units (three dits).

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
	Worksheet for each student to complete after they present. 1. Write the key that can be used for your code below. _____ 2. Describe how your code works. _____ 3. What is the method of transmission for your code? _____ 4. Does your code meet all of the criteria? _____ 5. What message was used to test your code? _____ 6. Was the receiver able to decode your message? _____ 7. What signalling method did you use? _____ 8. Did it use light waves or sound waves? _____ 9. What worked well about this signalling method? _____ 10. What would you do to improve the signalling method _____	• To move to the next letter, you insert a pause of three units. To move to the next word, you insert a pause of seven units. To hear what the Morse Code alphabet sounds like, let us view the following video. Listen carefully for the differences between the dits and the dahs. Morse Code Numbers Receiving Practice https://www.youtube.com/watch?v=6PRYLczCB4&list=PLb3UNFkJ4XkzPPmsxQLmQ7hs7gvqFbtrY (1:56 mins) Practice Morse Code Words with Sound https://www.youtube.com/watch?v=uEfTbKDGo-g (7:21 mins) Write a few words on the board using the Morse Code or project onto a screen to help students to see how the code is used. Sound the Morse code script for each word to the students and then have students take turns sounding out these words using the rules given.

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
	Use the chart to write the following words in Morse code: 1. School 2. Bag 3. Book 4. Glue **Timeline of Technology** The teacher should create a Bristol board poster and have students do research to place a timeline of communication devices that use codes. **Secret Codes** During World War II, it was common to send secret messages about troop moves, warfare equipment and attack locations. Letters and numbers on a page could look unintelligible as words yet using a deciphering code book could actually communicate an important message. They even developed special code machines that made messaging and coding easier. You can imagine that the enemy was looking for ways to steal one of these coding/deciphering machines so they code understand the secret message and be better prepared for battle. The enigma machine was arguably the most famous of these coding devices and even though it was very complicated and seemed foolproof, some very clever cryptologists from Poland were	Divide the class into groups of two. Give each student a copy of the Morse Code Chart. Give students a few minutes to look at the codes for the letters of the alphabet. A•– J•––– S••• B–••• K–•– T– C–•–• L•–•• U••– D–•• M–– V•••– E• N–• W•–– F••–• O––– X–••– G––• P•––• Y–•–– H•••• Q––•– Z––•• I•• R•–• When you think the students understand the code, ask each group to write a word together in Morse Code and to share this word with the class. This will allow you to see if they understand how to use the code. Once students understand how to create words, each student will create a message secretly, then swap the message for his/her partner to decode. Check to see if the work is done correctly. Students can then tape their messages around the classroom for others to see. **Note:** It might be helpful to set up parameters for what is an appropriate message.

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
	able to decipher how it worked. You can read the story on Wikipedia (see link below)! But the machine was changed regularly making it very challenging to decode. **Have students do internet research to discover who finally decoded the enigma machine.** *Teacher note:* Finally, a British mathematician named Alan Turing was instrumental in solving the decoding problem (see: https://www.iwm.org.uk/history/how-alan-turing-cracked-the-enigma-code)  Retrieved from: https://en.wikipedia.org/wiki/Enigma_machine **Coding is Very Important in Today's World** Coding continues to be important for operating computers in many contexts. Codes can give instructions for computer games but also to	Now try decoding these words on your own: 1. •••/——/••• 2. ••–•/——/——/–•• 3. –••/——/—•/••• 4. •——/••–/••/–•–•/• 5. ••/ /•–••/——/•••–/•/ /•••/–•–•/••/•/–•/ –•–•/•/ Write a message to a friend thanking him/her for inviting you to his/her birthday party. The message must have at least 10 words. **Other ways to communicate with dots and dashes** There are many ways to communicate with dots and dashes besides writing them. Examples of these are as follows: 1. If you use your feet, a quick stomp will represent a dot, while sliding your foot on the floor from right to left will represent a dash. 2. If you use an instrument, a quick, 1-second beep or note will be used for a dot and a 3-second-long beep or note will be used for a dash. 3. Tapping a pencil on a hard surface will work well, too. A quick tap of the pencil will be the dot, while setting the whole pencil on a surface will be the dash. Let us try some of them! **Using Sound to "Tap" out the Morse code for a message.** The first phonograph, a device used to record and play sounds (like music), operated much like a pencil tapping on a table. The only difference is that a needle tapping a metal cone made the sound.

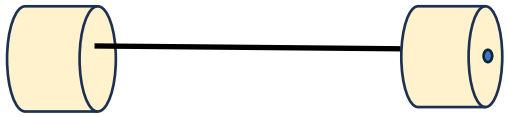
Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
	operate machinery in industry. In our technology-rich world coding is a viable career. There are many user-friendly free programs that allow students to write code to do simple tasks as well as operate robots! The teacher may refer to the following resource for examples (https://stackoverflow.blog/2021/01/12/want-to-teach-your-kids-to-code-here-are-three-apps-that-can-help/) but is suggested the teacher team up with other teachers and consider doing some simple coding activities with children using "Scratch" (https://www.scratchjr.org/)	Recall that sound waves can travel through solid mediums, such as a desk. Tell students they will be passing a Morse code message through the desk to the other students in their group. Have students take turns tapping a five-letter word on their desk. The student tapping the message should tap slowly to ensure that their group members receive the message. Group members should record each letter and as soon as they figure it out, they should signal to allow the student tapping the message to continue onto the next letter. This can be repeated with a student listening with his/her head on the desk. ● How quietly can the first student tap and still have the message be heard by the second student? ● Now repeat the message **at the same volume** with the second student listening normally, away from the table. Can the message be heard as well as before? **Morse Code in Lights** The pattern of turning lights on and off can work in the same way as dits and dahs. Every "dot" in the Morse Code is represented by a quick flash of the light. Every "dash" of the Morse Code is represented by a longer flash of light.

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		 https://pixabay.com/illustrations/flashlight-desk-spotlight-wood-3519697/ Try this activity with a flashlight. Have students take their flashlight and try shining it on the dark surface. cover the front of their flashlight with their palm and move it away to simulate the dits and dahs. Let us look at the following video to see how this is done. **Morse Code with Flashlight** https://www.youtube.com/watch?v=i3HOGdQkTvM (6:27 mins) Sending messages in Morse Code using light can also be done using the bulb and switch in an electrical circuit. 1. If time permits, provide students with materials and help them to build a working circuit with a battery, wires, and a bulb. 2. Next, ask students to add a switch in such a way that the switch turns the bulb on and off. Students, practice by expressing the letter "a" in light by turning your flashlight on for 1 unit, off for 1 unit, on for 3 units, then off (dit-dah).

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		Safety tip: Remind students not to shine the light in anyone's eyes. They should aim the light on the wall or on the dark paper provided. 3. Have each group devise a "secret" message. 4. Have the group practice the lighted code message a few times so that it is clear and readable. 5. Have the groups present their message in Morse Code in light to the class and have one of the other groups decode the message. **Questions:** ● What did the other team's message say? ● Did you have any challenges understanding the other team's message? If so, what? ● What did your team's message say? ● Did the other team understand your message? If not, what went wrong? Where would Morse code using light be useful? (*on the ocean large lights can flash codes between ships!)* 

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		Retrieved from: https://en.wikipedia.org/wiki/Signal_lamp **<u>The use of Walkie-talkies, phones, and cell phones etc. to communicate information</u>**    https://pixabay.com/photos/honor-honor-9-huawei-fingerprint-2631271/ https://pixabay.com/photos/phone-communication-retro-vintage-7473539/ https://pixabay.com/photos/auto-navigation-gps-vehicle-5414514/ Morse Code allowed us to send and receive messages over long distances. Since the development of the telegraph and the Morse Code, many other communication technologies have been developed. Today, the two main devices that are used to send messages from one person to another across long distances are the cellular phone and the computer. Almost all communication technology that we use today, including cell phones, TV, and the Internet, all send signals using either electricity or radio waves. Radio waves are waves similar to light waves. • What are three different methods of communication that you use? • How do these methods differ? • Are you able to communicate the same ideas or feelings in each method

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		The telephone The telephone is a very common device for communicating over a distance. With a telephone, a person can talk almost instantly with someone on the other side of the world. Most telephones are linked to each other by wires. When you speak into the phone, your voice makes sounds. In the telephone, sound is converted into an electrical energy that can travel through wires. When the electrical energy reaches the receiver in the phone on the other end, it is changed back to sound. Come up with a list (as a class) of modern devices that are used to communicate sound. The most important items on such a list are the radio and the telephone. The Science of the String Phone https://www.youtube.com/watch?v=3yqB2KFwJCo (4:37 mins) In this lesson, students will investigate the relationship between sound waves, encoding, and decoding a message. They will be conducting a **controlled experiment** which is defined as an experiment where everything is kept constant except one variable. By carrying out the experiment out in this fashion, they can establish what are called **causal relationships**. Scientists can then say that changing a variable caused the overall result. The experiment will involve investigating the variables involved in making string phones. Ultimately, they want to solve the problem of producing a string phone that can send the clearest and loudest message without leaking the sound to others.

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		Note: Explain that if you change more than one variable at a time, you won't know exactly which change had what effect. So, you should only change one variable at a time, and keep the others constant.   **Experiment One** Students, you are provided with the following materials. • 4 cups (each with a small hole at the bottom), • 2 pieces of string the same length but different thickness • paperclips.

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		Follow the following steps on how to make and use a string telephone 1. Thread one end of the string through the bottom of one of the cups, from the outside in. 2. Pull the string through the hole and tie the end of the string to a paperclip to hold it in place it so that the string cannot pass back through the hole. **Note:** you can also tie a knot if you do not have a paper clip. 3. Repeat steps 1-2 with the other end of the string and cup. 4. Hold one cup and have your partner hold the other. Walk away from each other until the string is fully stretched and tight between the two cups. 5. Hold the cup up to your ear and have your partner speak into his/her cup. The speaker does not need to talk loudly but must be clear because the cup muffles the sound a bit. 6. Talk back and forth with your partner. 7. Make a new string telephone using smaller cups and the first piece of string, repeat steps 4-6. Record your observations **Experiment Two** ● To find out the type of string that sends out the loudest and clearest message through a string phone. ● Replace the string of your cup telephone with the thicker pieces of string provided. Retest your phone by talking with your partner and recording your observations. **Experiment Three** ● To find out which size cup sends out the loudest and clearest message through a string phone.

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		• Replace the cups with the other sized cups. Retest your phone by talking with your partner and recording your observations **Note:** At some point during the lesson have students place a hand on the cup and the string to feel the vibrations traveling through the phone. Have the students make a diagram showing how sound travels through their model of a telephone. Label each part of the diagram (air, cup, string, etc.) with a note about how the material carries the sound and in which direction the sound is moving. • Was it easy or hard to hear? • What is one limitation that a string phone has compared to a real phone? • Which string material worked the best for your telephone design? Give one reason for your observations. • Describe a change that you think would make your telephone better. **How do string telephones transmit sound?** A string telephone works very much like a landline phone. When you talk into the cup, the sound from your voice vibrates the cup, which in turn vibrates the string. The vibrations are transferred to the string, across the string and into the bottom of the other cup, which vibrates the air inside the cup, causing the original sound to be heard. The original message was encoded from vibrations in the air to vibrations in the cup and string. On the other end, that message is decoded back into vibrations in the air.

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		Mobile phones Mobile phones use radio waves to transmit and receive signals. These waves are a type of waves similar to light waves. When a text message is written, the cell phone turns your message into a digital pattern of 0s and 1s. Digital communication turns information into number patterns. Digital signals exist in discrete bits and often only include the numbers 0 and 1. Information is thus broken into a pattern and is a code. With a digital signal, information can be sent anywhere. Tablets, computers, and cell phones use digital signals to send and receive information. When you make a phone call or send a text message your phone sends radio waves traveling through the air to a nearby cell tower. Cell towers are tall structures that are designed to receive and transmit radio signals. The cell tower then sends the signal to another tower or directly to the receiving cell phone. The cell phone receiving the signal changes the pattern back to a text message that your friend can see. **How Do Cell Phones Work?** https://www.youtube.com/watch?v=Qxze1Tzp66U (3:55 mins) **How do phones work?** https://www.youtube.com/watch?v=44hR8ZD5NjI (7:04 mins)

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		Thanks to this binary representation, we can store and process information efficiently on computers. To store an image on a computer, the image is broken down into tiny elements called pixels. A pixel (short for picture element) represents one colour. In order for the computer to store the image, each pixel is represented by a binary value. In a monochrome (two colour) image, like the example below, just 1 bit is needed to represent each pixel e.g. 0 for white and 1 for black. in order for the computer to store the image, each pixel is represented by a binary value (One or Zero). **Binary Representation of Images** Organise students into small groups of three or four. Provide groups with a range of black and white squares: Black and white cards and a 5 x 5 design mat for them to lay tiles on the Design mat .Invite groups to fill up their board with the black and white squares to make a pattern. Ask students how they would get another group of students to create exactly the same pattern without allowing them to see the image? Note ideas on a whiteboard. **Note:** You may want to introduce some constraints such as: ● Students are not allowed to say black or white.

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		• Students are not allowed to use any words or letters This would leave them with either symbols or numbers to work with. Once they have come up with a solution to this, it should be relatively simple to explain that they have essentially created a binary solution. Binary is commonly represented in 1s and 0s. Explain to students that they have just created an image pattern using 'pixels'. **Activity** • Break students into small groups and have them brainstorm how they think a text message moves from one phone to another phone. Students can then diagram a text message moving from one phone to another phone. • Ask students to name things in their homes that show video or provide audio. video and audio that enter their homes as radio waves are then transformed to electrical signals that move through wires before they can be seen or heard. Specific examples of this may be televisions and radios. You will now use patterns of 0s and 1s to transfer information. 1. Ask students to individually create an 8 x 8 square table in a document. Ask them to use the fill bucket to create a picture. They will fill some squares with black and leave others white.

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		2. If an internet connection is available, students could create images using software available on different sites. Two examples are given below. **Make your own binary image** https://tools.withcode.uk/binaryimage/ **Black and White Image Representation in Binary** https://learnlearn.uk/binary/black-white-image-representation-binary/ 1. Alternatively, students could be provided with an 8 x 8 template and asked to shade some of the squares black to create an image. 2. Ask students to get into groups of three and to swap their work so that they have someone else's image. Explain that they are now acting as binary code writers. They need to develop a code for each line of the picture. Each line of code should have 8 numbers (consisting of 0s and 1s). 3. Ask students to swap their work for the final time so they will have someone else's code. Explain that they are now acting as decoders, trying to put the picture back together using each line of code. **Lesson closure** 1. Place a pixelated image on the board for the whole class to see. Challenge students to write the binary code for this image in their books. 2. Place up on the board the following binary code and have students colour it to see the image. Students can then check each other's work. 3. In their notebook, ask students to explain how text, audio and images were transferred from one cell phone to the other

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		Fibre optics Fiber optics is a process of transferring information via light waves using a special cable. Fiber Fiber optic cables can be used to transmit signals very long distances Light travels in waves along bundles of thin, flexible glass fibres. The fibres are bundled inside the cable. How are light waves used to send signals in a fibre optic cable? First, the information, such as a TV show, is changed to a digital code. The code is then transformed from numbers to flashes of light. The light waves enter one end of the cable. It allows the light to move freely through it. The other end of the cable is attached to a receiver. The receiver receives the light waves and translates them back to an electronic digital signal. Finally, the electronic signal is translated back to information the device can understand. https://pixabay.com/photos/technology-fiber-optic-light-cable-2749586/ A visible light ray travelling through a fibre optic cable via internal reflection, adapted from image by Chris Woodford CC BY 3.0 https://www.youtube.com/watch?v=M9AT3hrb35o Waves Transfer Information Duration: 1:53

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		Design solutions for a given problem Students in the last set of lessons, you would have learnt about a number of ways to communicate over distance. Some examples include the use of smoke signals, drums, light signals and Morse code, etc. Divide the class into small groups of about three to four members. Ask each group to conduct research on the different ways to communicate you have done thus far, plus other possible ways of communicating using patterns over distances. In your group, work collaboratively to design and build a device or a communication system for communicating information over a distance. Some examples could include: ● Using drums to send coded information through sound waves. ● Using a flashlight to convey information using a pattern of on and off. ● Using Morse code to send information. ● Building an instrument that can be made to produce sounds of different pitch in a pattern to communicate information. ● Use musical patterns on a xylophone or tuning forks, etc. to convey information. **An example of how light can be used to Communicating** To give you an example of how your task can be done, observe how a group of children use light to communicate over a distance in this live-action video produced by WGBH.

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		Use the video to observe strategies for using light to communicate across a distance as well as to design a light signal code to help to communicate to solve a problem. https://www.pbslearningmedia.org/resource/buac18-k2-sci-ps-communicatelight/communicating-with-light/universe/ As you watch the video keep the following questions in mind. ● Why did the children in the video use different shapes as light signals to represent the different activities? ● How many different ways did the students send a signal using light? ● Did the video make you think differently about using light to communicate? How? Use the video to observe strategies for using light to communicate across a distance as well as to design a light signal code to help them to communicate to solve a problem. **<u>Problem:</u>** Imagine that you are stranded on an island without electricity. Your boat has become untied and has drifted out to sea. How would you signal for help? Create a communication system from your island to the persons who might rescue you. **Possible criteria that could be included:** ● Groups must communicate information using patterns.

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		• Design solution must communicate over a predetermined distance and • Groups must be able to describe how patterns were used in the design to communicate over a distance. **Possible constraints that might be included** • Materials available to build/create a device. • The amount of time available to design and build the device. • Different safety issues. • Working with your partner, develop the code that you will be using, decide if you will be using light or sound waves in patterns to transfer your codes. • Make instructions and a key for transferring the signals and decoding the messages. • After you are finished designing and building your device, or communication system, put together a presentation that includes an explanation of how patterns are used to communicate information. • You would need to include your communication system in your presentation and how the messages will be sent. • After observing each design solution, • Students will investigate how well the solutions perform under a range of likely conditions. • All tests that are planned and carried out should be fair tests in which variables are controlled. • Students then compare the solutions, determining which can be used to successfully communicate information over a distance using patterns.

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		Lead a discussion about the different ways that students used to send their signals. ● What do you think makes a coded system "good"? (It should be complete enough to solve a problem or to make something usable.) ● State two things that you can use to tell whether or not a signal works or doesn't work? (If a code works, the receiver will be able to decode the message). ● Why is it important to follow the criteria and constraints? (The criteria and constraints help make sure that the code can be used for the use that is intended). ● How are these signaling methods similar? (They communicate a message.) ● How are these signaling methods different? (Possible answer: Some methods use light, some use color, and some use sound.) ● Which signaling method do you think is best? Why? (Students should explain their rationales for stated preferences.) ● How do you think the other signaling methods could be improved? (Students may point out ways to make the messages or instructions clearer.) ● How well could your classmates decode your message? ● How far could your message travel? ● Which method of communication did you find easiest? ● Which method of communication did you find hardest?

Additional Resources and Materials

Patterns Transfer Information - 3 Easy Science Activities (enjoy-teaching.com)

Coding in Scratch :
https://www.youtube.com/watch?v=Rxoppbm-y8k&list=PLNIdDxctsZe9gVqjHHj_TxzHfElHszdst **(6:08 mins)**
https://www.youtube.com/watch?v=D-nW4jvzRr8 **(15:37 mins)**

Additional Useful Content Knowledge for the Teacher:

Morse code

Before the advent of Morse code, the only way to communicate with people in far-off places was via horseback, carrier pigeon, or mail.

The invention of Morse code changed all that. It enabled people to communicate quickly, even if they were thousands of miles apart. Rather than using words and sentences, Morse code uses dots and dashes, usually in the form of electrical pulses, to communicate messages

An operator would send the message, using the telegraph machine, to an operator at the receiving end who would decode the dots and dashes.

The dots make up the short sounds, and the dashes are the long sounds. In order to see this on paper, the dot sounds are written as a period (.), and the dash sounds are written with a dash (–).

SOS is an internationally recognized distress single established using Morse code.

Morse code is not as widely used as it once was, the U.S. Navy and coast guard continue to use signal lamps to send messages via Morse code today. Amateur radio operators and aviators also still use it to communicate with one another.

Information transfer

Information transfer is the way information is turned into a code and transferred from one place to another. Patterns are used to send and receive information.

Information is transferred from devices through signals. These signals are analog signals and digital signals. Analog signals are made of waves with a continuous pattern. Sound waves and radio waves are examples of analog signals that transfer information from one device to another.

Digital signals carry binary data i.e. 0 or 1 in the form of bits. Examples of devices that use digital signals include digital watches, digital video signals, CDs, DVDs and computers. Information sent by digital signals is not continuous—it is broken down into digits, or millions of individual bits of information.

How electronic devices transfer information

All electronic devices, from computers to mobile phones to smart home appliances, use binary code as their communication language. Computers and other electronic devices transfer information in the form of patterns containing 1's and 0's That is, all information stored and processed by a computer is represented internally in binary form Each letter, number, or symbol is converted into a sequence of bits. Each bit represents an on or off state, which translates to a 0 or 1 respectively.

Digital pictures also use electronic patterns. The patterns are used to turn pixels on or off. Pixels are simply tiny lights.

By sending a pattern of information telling a device which pixels to turn on and off, an image can be made. Images with more pixels have more detail.

Although music is not text or image it can also be stored and transferred as patterns of 1's and 0's.

How mobile phones work

Cell phones send signals in the form of radio waves. These are received by nearby cell towers. These transmit these signals to another cell tower or to the phone directly.

Cell towers

Cell towers are structures that are designed to receive and transmit radio signals. Cell towers are connected to mobile networks, which are a series of interconnected towers and switches that allow mobile phones to communicate with each other.

A traditional telephone depends on wires to send sound

When the caller speaks into a telephone, the microphone changes the sound of the person's voice into an electric signal. The base sends out the signal through its wire. The signal can travel as an electric current, travel through thin glass fibres in the form of light or the signals can be changed into radio waves and sent through the air by antennas and satellites. When the signal reaches the telephone at the other end, its loudspeaker changes it back into the sound of the caller's voice.

How GPS works

GPS satellites circle the Earth twice a day in a precise orbit. Each satellite transmits a unique signal and orbital parameters that allow GPS devices to decode and compute the precise location of the satellite. GPS receivers use this information and trilateration to calculate a user's exact location.

How radio and television work

Both a car radio and a TV receive a signal that has been broadcast. To broadcast means to transmit, or transfer, a signal in some form of a wave. Broadcast stations such as radio and television stations send signals in the form of waves to receivers in TVs and radios. The signals transmit information such as symbols, pictures, and sounds, and often they do so in the form of waves.

TV remotes send information as patterns of light pulses. The pulses tell the TV when to change the channel, increase or decrease volume, or when to turn the power on and off.

Opportunities for Subject Integration: *(Additional ideas about how the inclusive learning strategies might be adapted and/or applied to include other subjects in the curriculum)*

English Language

- Use both print and digital sources, to build their understanding of the use of waves to communicate over a distance
- Present information to their partner and class using different methods.
- Record observations using their smartphones.
- Provide definitions of different concepts related to the transfer of information.
- Discuss information at the group or class level.

Mathematics

- Taking measurements of distances that sound can be transferred using string phones.
- Measuring materials to make devices that transfer information.
- Writing binary codes for different images given

Agriculture

- Different types of digital resources are used to transmit information in agriculture: Examples include: The use of drones to monitor crop diseases, to track animals, in marketing of agricultural produce.
- Sensors on farms can be used to help to reduce predial larceny.

TVET

- Different digital resources are used in the teaching of TVET
-

Social studies

- We communicate with each other using several methods such as symbols, signals and gestures.
- Signals are used in communicating information in our everyday life such as traffic lights.
- Morse Code is used by persons with certain challenges to communicate information.

Elements from Local Culture, Technology, TVET, Environment that are integrated:

Elements from Local Culture

1. Examples of information being transferred
   - Conch shell used to make sound
   - The beating of drums
2. Lights are used to guide airplanes and boats
3. The use of symbols in certain religions

Technology

- Waves are used to transfer information in almost all of the devices we use today.
- Certain inventions use waves to enhance our senses, like our hearing and sight.
- Waves are used to study volcanoes and other natural disasters
- The use of digital solutions in TVET
- The use of smart technology in TVET training

TVET

Many tools used in TVET utilize waves in their operation.

Environment that are integrated

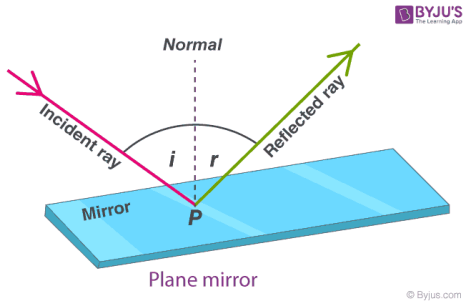
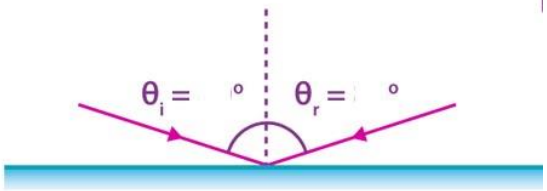
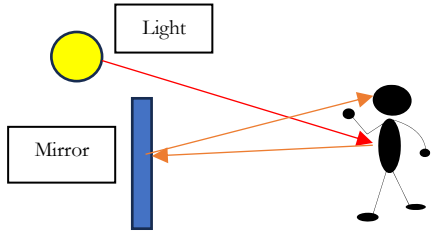
- Loud sounds can be dangerous to animals.
- Underwater signals can affect the migration patterns of animals such as whales.
- Cell towers can cause potential harm to birds and other organisms.

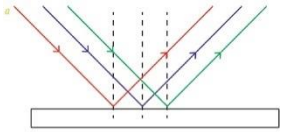
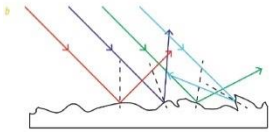
Structure and Function

Strand (Topic): Structure and Function All living things have features that allow them to interact and survive in their environment. Understanding the function linked to such structures allows us to better care for living things and also adapt as humans.
Essential Learning Outcome 1: Develop a model to describe that light reflecting from objects and entering the eye allows objects to be seen. [Assessment Boundary: Assessment does not include knowledge of specific colours reflected and seen, the cellular mechanisms of vision, or how the retina works.]
Grade Level Expectations: Refer to grade level expectations at the beginning of this curriculum document.

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
Learners are expected to: **<u>Knowledge</u>** • Define the terms: ○ reflect ○ specular reflection ○ glare ○ diffuse reflection ○ translucent ○ lens ○ retina ○ absorb ○ white light ○ luminescent ○ bioluminescent ○ law of reflection ○ protractor ○ telescope ○ laser ○ periscope	**Terminology and Comprehension** (specular, absorbs, smooth, reflected, rough, glare diffuse, retina) ***Fill in the blanks*** with the correct term chosen from the list above. The only reason we see objects is because light is _____ off the object back through a lens in our eye with an image formed on the back of the eye called the _____. Light reflected off of smooth objects like the surface of water can generate a _____ because of the intensity and singular direction of the light. This is called _____reflection. Surfaces that are _____, tend to reflect light in many directions. This is called _____reflection. Dark colored clothing tends to be hotter in direct sunlight because it _____all the colors of white light the energy being converted to heat.	**The Sun and Moon: An Example of Reflection** **Students Already Know** Students, you know that the sun is very bright. It gives off a lot of light and heat energy. After the sun goes down in the sky and it becomes dark, the moon appears. Does the moon give off heat? (*no*) Does the moon have its own light? (*no*) Where does the moon get its bright light? (*from the sun*) Yes, the light of the sun bounces off of the moon and comes to our eyes. The science word we use for bounce is **reflect.** We would say the moon **reflects** the light of the sun. What does the moon look like? (*at different times of the month it can have different shapes*)

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
• Demonstrate they understand the difference between specular and diffuse reflection. • Compare the reflectivity of objects in the real world. • Account for the glare we experience off of water or shiny smooth objects. • Explain why black objects heat up when subjected for prolonged periods to direct sunlight. • Distinguish reflection and absorption of light. • Identify two parts of the eye that help us to gather light and make an image for our brain to process. • Identify phases of the moon (ST 2 ESS SS 4) • Outline the relationship between the earth, moon and sun. (ST 3 ESS SS 1)	**What Happens in Ecosystems When there is no Light to Reflect?**? Why, in the deepest parts of the ocean might some animals need bodily structures that glow? (*Very little light gets to the bottom of the ocean. If there is no light to reflect off objects, we couldn't see the animals*) Fact: As many as 90% of all deep-sea animals are **luminescent** (create their own light in the absence of sunlight using biochemical processes in their bodies. Some of the most common functions of bioluminescence in the ocean are for defense against predators or to find or attract prey. Students should do research to discover at least three animals that use **bioluminescence** in the absence of reflected daylight/sunlight. Teacher resource: https://latzlab.ucsd.edu/bioluminescence/bioluminescence-questions-and-answers/ **Law of Reflection** This law states that the angle that the light hits a plane mirror (called the **angle of incidence (i))** equals the **angle of reflection (r)**	Depending on the position of the moon, the earth and the sun, we see different portions of the moon reflecting the suns light. We call these the phases of the moon. **Investigating Reflection** "Today, we will explore how we see objects around us. Have you ever wondered why you can see things like your favourite toy, your textbooks, or the beautiful sky? It's all because of light! Let's dive into the world of light and discover how it helps us see." ***Activity 1***: Let's Play with Light Gather students in a well-lit room. Get them to notice an object like a chair or a desk in the room. Turn off the lights. Students, do you see the chair. (*no teacher it is dark in this room)* So the chair doesn't have its own light? (*no teacher*) What if I shine a flashlight on the chair. Can you see it now? (*yes teacher*) So the only reason you see the chair is because the light from the flashlight reflects off the chair and comes to your eyes. We say that the chair becomes visible, we can now see it. ***Activity 2***: Exploring Reflection Just as we talked about the sun and moon, when light hits an object, it can bounce off, just like when you throw a ball against a wall, it bounces back. Can you draw a picture of how the light might bounce so that you see yourself in a mirror? (*the light leaves the source reflects off your body, reflects off the mirror and returns to your eyes*.)

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
Skills • Observe how objects reflect light to different extents. • Infer why white clothing is preferred in hot climates. • Measure angle of incidence & reflection. • Measure temperatures. • Classify glass as plain clear or translucent. • Design a periscope. • Construct a periscope. • Investigate and communicate your research findings on the use of mirrors. • Draw a diagram of a light beam that allows you to see yourself in a mirror. • Classify through research at least three animals with bioluminescent ability.	 Students should use a **protractor** to measure the angle of incidence and angle of reflection in the following diagram.  Diagrams retrieved from: https://byjus.com/physics/angle-of-incidence/ **Technology Research** Students can choose one of the three technology advances below to research and report in a one-page description including a picture.	 **Different Surfaces** A mirror is a very smooth surface, so it reflects light very well. We can move a mirror around and direct the light from a flashlight quite easily. (*Teacher: Shine the flashlight onto the mirror and observe how the light reflects off the mirror and onto the surrounding walls*) Reflection of light off of smooth surface has the property that the angle of impact on the surface is the same as the angle of reflection. The reflected light tends to be focused as a result. This is called **specular reflection.** If you look at a puddle in the road or the surface of still water like a pond, it also is very smooth and reflects light well. When we look at those water surfaces or smooth glass, we sometimes refer to the **glare** of the light off the surface because it is so direct and intense. Humans have invented sunglasses to battle that glare - something we will learn about elsewhere in our science class. Some types of glass are not so smooth; they have a rough surface When the light hits that surface it reflects in many directions at many angles. This is called **diffuse reflection.** You may have seen **translucent** glass used for shower doors and bathroom windows.

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
• Interpret results from a light reflection/absorption experiment. • Use a thermometer to measure temperature (ST 3 ESS EW 9) • Examine past inventions in their historical context. (ST 3 TE NT 1) • Formulate problems and do research in development of technological devices. (ST 3 TE TM 1) • Demonstrate giving examples that some materials reflect, transmit, or absorb light. (ST 4 PS MM 3) • Describe with examples, materials that are translucent. (ST 4 PS MM 5) • Design and construct objects to satisfy human needs and to make life easier. (ST 5 TE TM 2)	1) The use of mirrors and reflection in **telescopes** 2) The use of mirrors and reflection in **laser** research 3) The use of mirrors and reflection in the **periscope** for submarines **Rubric:** • Clear description of the value of mirrors for reflection in the technology (5 marks) • Grammar and punctuation (5 marks) • Clear picture depicting the utility of mirrors for the invention (5 marks) **Applications of Mirrors: Build a Periscope.** As a technology design activity, have students design and build a rudimentary periscope. Teacher see materials/process here: https://www.youtube.com/watch?v=GsuJZufaGcU (1:36 mins) https://www.youtube.com/watch?v=B5NCqIBM34o (5:57 mins) **Protect Your Eyes From Reflected Sunlight (Sources of UV exposure)** Direct light from the sun is extremely damaging to eyes, but **indirect reflected UV rays from the ground can be even more dangerous.** The table below shows the UV radiation reflection levels for several common indirect sources. The higher the percent, the more risk of eye damage.	 Retrieved from: https://www.flickr.com/photos/drew_makepeace/3705825219 Because the reflection of light is diffuse or spread in many directions, it is difficult to see images through the glass. Humans invented that glass for the specific purpose of giving privacy in bathrooms! Specular Reflection  Diffuse Reflection  Retrieved from: https://www.americanlaboratory.com

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<tr><th>Specific Curriculum Outcomes</th><th>Inclusive Assessment Strategies</th><th>Inclusive Learning Strategies</th></tr>
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Attitudes/Values

- When conducting practical and group work, display sensitivity and offer assistance to peers who may have physical or learning challenges.
- Participate actively in classroom discussions.
- Appreciate that science informs how we design everyday objects that make our lives easier.
- Collaborate with peers productively in design challenges.
- Identify and appreciate that the gadgets, tools and structures used in their homes and community are made by humans. (ST 3 TE UT 1)

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Surface Type	UV Reflection
Grass, Open water	2-8%
Asphalt	4-9%
Light -colored concrete	8-12%
Dry beach or sand	15-18%
Sea surf/foam	25-30%
Snow	Up to 80%

Data Retrieved from:
https://www.yourtracktohealth.com/WellnessPageContent.aspx?MenuId=181

Consumer Research Project: Choosing the Best Product
Teacher note:
The information below would allow students to visit a local store and assess the availability of best eye wear for screening out reflected UV rays and reporting back to the class on relative availability.

Information Supplied by:
https://www.yourtracktohealth.com/WellnessPageContent.aspx?MenuId=181

"While sunglasses are definitely a good idea when it comes to eye protection, **not all sunglasses are created equal.** It's highly recommended that you choose sunglasses that limit transmission to no more than 1 percent of UV rays. When purchasing sunglasses:

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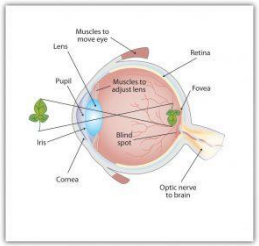
I want you to think about throwing a rubber ball at a solid wooden wall. How would it bounce back?
Now think about throwing a rubber ball at a wire fence…how would that be different?
(*The wire fence would make the ball bounce in many different directions like diffuse reflection. I could throw the ball at the smooth wooden wall in such a way that it always bounces back to me where I want; that would be more like specular reflection- it has specific and consistent direction*)

Activity 3: The Eye Accepts Light and the Brain Processes

(*Teacher note: the specific anatomy and process of image formation in the eye is not necessary at this grade level)*

Our eyes are like cameras. They have a **lens** that takes in light. The light travels through the eye and forms an image at the back of the eye called the retina.
The **retina** sends signals to the brain, allowing us to see the object.



Retrieved from:
https://ecampusontario.pressbooks.pub/testbookje/chapter/seeing/

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Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
	• Look for a label on the lenses that indicates 99 percent of the UV rays are blocked. • Consider wrap around sunglasses or lenses large enough to completely cover the eye and to help prevent as much light as possible from entering through the edges of the glasses. • Consider darker lenses, particularly if you are more light-sensitive. Gray lenses provide the least color distortion but do not offer any better protection than other colored lenses. • There are also UV-blocking contact lenses for added protection. Talk to your eye care professional for more information about UV-blocking contact lenses. "	**Closure of Activities** "Today, we learned that light helps us see objects around us by reflecting off them and entering our eyes. We also discovered how mirrors reflect light and explored how our eyes work like cameras. Keep observing the world around you; remember, light makes everything visible!" **<u>Extension Activity</u>- Reflect or Absorb?** Did you ever notice how cars in warm climates are more often white in color? Why do you think white cars may be more popular? A white car tends to be cooler than a black car, but why? **Fact**: The sun gives off **white light** that is a combination of all the colors of the rainbow! We can see those colors if we shine the white light through a prism, slow down and bend the light into its components. A white object reflects all colors of white light equally. A black object takes in (absorbs) all colors of light. When a black object absorbs all of that light energy it causes the object to get very warm. If an object absorbs all colors but one, we see the color it does not absorb. i.e. a red object is an object that absorbs very other color but reflects only red light. ***Experiment or teacher demonstration.*** 1. Obtain three 2 L plastic soft drink bottles 2. Cover one bottle with aluminum foil, one bottle with black paint and one bottle with white paint.

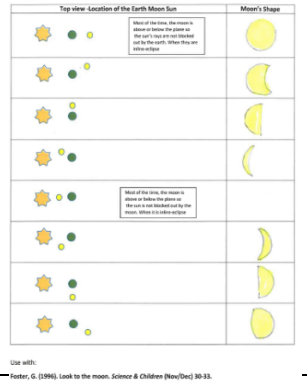
Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		3. Remove the cap from each bottle and use a thermometer to measure the internal temperature of the bottles. 4. Shine a high-powered flood lamp on each bottle sequentially for 10 minutes at the same distance. 5. Measure the temperature once again. You should find that the black bottle temperature increases the most because of light absorption. The foil covered bottle should reflect most of the energy and remain near initial temperature value. The white bottle will also be cooler than black bottle because it reflects the light rather than absorbing.

Additional Resources and Materials
Translucent: https://www.youtube.com/watch?v=wL_yVzBH40Q (6:16 mins)
Reflection and absorption: https://www.youtube.com/watch?v=LAbAk5Ab674 (3:15 mins)
Anatomy of the eye: https://www.youtube.com/watch?v=axpCN6Vj9p0 (4:16 mins)
Bioluminescence: https://www.youtube.com/watch?v=fYsAK24le6U (3:29 mins)

Additional Useful Content Knowledge for the Teacher:

Moon phase simulation: https://sepup.lawrencehallofscience.org/space-unit-moon-phases/

Light reflection simulation: https://simpop.org/reflection/reflection.htm



Opportunities for Subject Integration:
Mathematics: measuring angles of incidence and reflection/measuring temperatures

Language Arts: Researching information and communicating the research in the written and visual forms (project work) **HFLE**: protecting our eyes from reflected light
Elements of the Essential Education Competencies that are addressed: **Elements from Local Culture, Technology, TVET, Environment that are integrated:** • Technologies that use reflection are part of the research n the assessment column. • Building a periscope is part of design and problem solving.

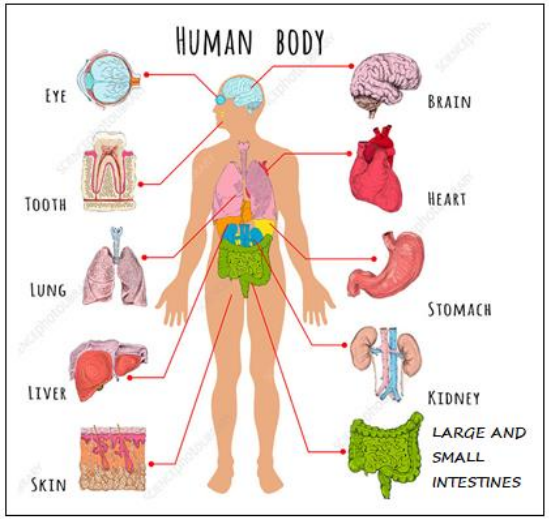
Essential Learning Outcome 2: Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.

[Clarification Statement: Examples of structures could include thorns, stems, roots, colored petals, heart, stomach, lung, brain, and skin.] [Assessment Boundary: Assessment is limited to macroscopic structures within plant and animal systems.]

Grade Level Expectations: Refer to grade level expectations at the beginning of this curriculum document.

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies

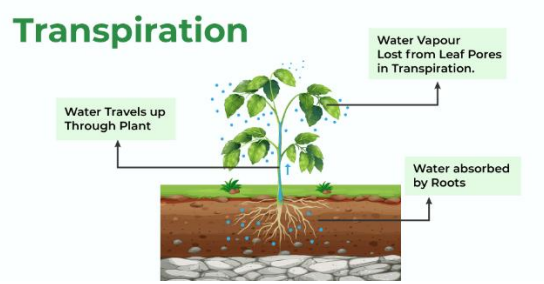
Learners are expected to:
 	
<u>Knowledge</u>
• Define the terms:
  ○ survive
  ○ seed dispersal
  ○ ejected
  ○ evaporation
  ○ transpiration
 	
• Demonstrate with examples, they understand that animals and plants have special features that allow them to survive.
 	
• Recall the names of organs in the human body and state their inherent function for survival.
 	
• Explain how some features of organisms enable their survival in their habitats. (ST 2 LS ECS 5)
	Animal Parts and Functions to Survive
	Students will research each of the following animals and their particular feature that allows them to survive. They should enter their research results in the table below.
	
	Description / Survival Function
	Teeth on a Hutia Rodent
	Changing colors on a chameleon lizard
	Heavy hair on a Highland cow
	Rockfish spines
	Thick fat on an Artic seal
	Changing colors on a chameleon lizard
	Quills on a porcupine
	Venom of jelly fish
	Grit in a bird gizzard
	Shell on a tortoise
	Spots on Owl Butterfly wings
		Looking for Prior Knowledge on Survival Features in Humans
		Students, I want you to think about the way our bodies are designed to help us survive, especially in the early days when humans didn't have all the machines to help us with our work or stores to buy our food!
		
		What do our teeth help us do? (*cut food, chew food, grind food for eating*)
		
		What do our long strong arms help us do? (*reach for food like apples in high branches, swim across waterways and lift materials to build shelter)*
		
		What do our strong legs and upright stature help us to do? (*chase/ hunt animals for food, escape from predators)*
		
		What does our nose help us do? (*smell food to see if it is spoiled/ safe to eat, smell animals that may be warning us)*
		
		What do our ears help us do? (*hear danger in our vicinity like predatory animals, impending storms,)*
		
		What does our sense of taste help us do? *(taste food to see if it is spoiled/ safe to eat, avoid bitter or foods that upset our digestion)*

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
• Explain with examples what are endangered species. (ST 2 LS ECS 12) • Draw and label the main eternal parts of a plant. (ST 2 LS SF 1) • Define the term dispersal and list the agents of seed dispersal. (ST 6 LS DC 10) • Describe the physical features of the parts of a plant, relating these features to their functions. (ST 3 LS SF 1) • Describe the eternal features of animals relating these structures to their functions in the animals. (ST 3 LS SF 2) • Identify that the transport system is a major system in plants and describe the function of its parts. (ST 5 LS SF 3) **Skills** • Observe pictures & videos that allow you to make inferences about the link between features and function,	**Courting Features and Behaviors** For animals to produce their own offspring, a male and female of the species will often form a parenting couple. This often means the male will try to attract the female with colorful displays and sometimes even dances! The following "bird of paradise" puts on a colorful display to attract a female parenting partner.  Retrieved from: https://youtu.be/nPhVOZiPokA (2:05 mins) Have students research a Caribbean animal that uses a courting display (using external body features) in order to attract a female thereby ensuring reproduction of offspring and survival of the species. Students should create a poster with pictures of the display and a description of the animal species. ***Rubric:*** Poster pictures (5 marks) Description of species habitat (3 marks) Description of survival function (2 marks) Grammar and punctuation (2 marks)	What do our special hands help us do? (*with opposing thumbs our hands allow us to grasp things so we can build shelters and use tools and do many daily requirements for surviving)* **What about Internal Structures of Humans**? Review with students the function of internal organs. How do they work together to help us survive as a living thing?  Retrieved from: https://binged.it/2RJrJXI For internal organ explanation see: https://www.youtube.com/watch?v=Yv0YKjgNKaA (2:43 mins) Heart (*pumps blood throughout the* ***body*** *via the circulatory system, supplying oxygen and nutrients to the tissues and removing carbon dioxide and other wastes*)

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
• Infer what advantage these internal or external structures have in promoting survival. • Tabulate and classify the animal features and their impact. • Research instances of body parts having specific functions for survival. • Communicate understanding by creating a poster. **<u>Attitudes/Values</u>** • When conducting practical and group work, display sensitivity and offer assistance to peers who may have physical or learning challenges. • Participate actively in classroom discussions. • Investigate the physical, emotional and social adjustments that occur with organ donation.	**Plant Survival** How do you think the plant structure in this picture helps this tree produce offspring and survive? See: https://mynaturenook.com/helicopter-seeds/ (*wind carries the seeds like a helicopter)*  **Importance of Water to Plants** Have students sketch a picture of a plant, label the parts and use the picture to explain the process of transpiration. **Internal Organs Help Us Survive: Donation**? Teacher should introduce topic of organ donation and elicit opinions from students on the ethics and viability of the practice. (see information below) • Many countries have programs that allow families of perished accident victims to donate organs to those that have diseased organs but are otherwise healthy. • Also, because we have two kidneys it is very common for a family member to donate a kidney to another family member whose kidneys no longer function.	Kidneys (*maintaining overall fluid balance. regulating and filtering minerals from blood. filtering waste materials from food, medications, and toxic substances)* Liver (*filters blood from intestines and removes harmful chemicals)* Lungs (oxygenates blood to feed muscles; In *respiration, oxygen from incoming air enters the blood, and carbon dioxide, a waste gas from the metabolism, leaves the blood).* Stomach (intestines) have 3 functions: • temporary storage for food, which passes from the esophagus to the stomach where it is held for 2 hours or longer. • mixing and breakdown of food by contraction and relaxation of the muscle layers in the stomach. • digestion of food So you see students, we have many bodily features that help us to stay healthy and continue living. Read Aloud Books to Support Function of Animal Parts **Sandra Markle Authored Books** What if You Had Animal Teeth? https://www.youtube.com/watch?v=_vLAx4veHhc (9:15 mins) What if You Had Animal Eyes? https://www.youtube.com/watch?v=_vLAx4veHhc (13:16 mins) What if You Had Animal Ears? https://www.youtube.com/watch?v=tWV0SEnI7gc (9:33 mins)

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
	• This can allow the person with kidney problems to live a normal lifestyle. In all organ transplants the donator and recipients must have very similar blood characteristics in order for the new organ to work properly in the recipient body. Have learners recount a story of friend or family member who may have had an organ transplant. Ask them to identify the lifestyle change before and after the transplant. **Endangered Species** Some animal parts like the tusks of elephants have important functions Digging holes, moving branches, accessing food) (d. They are however valued by humans for other reasons like making jewellery or house decorations etc.) Write a one-page essay about an endangered species in eth Caribbean whose body partis highly valued for reasons other than what was intended for the plant or animal. Rubric: Description of the Problem (5 marks) Grammar & punctuation (5 marks) Pictures if included (3 marks) How to solve the issue (2 marks)	**Plant Features for Survival** Did you know that plants also have parts and that have a function to help them grow and protect them so they can survive? Let us look at some examples: How do the thorns on a rose bush function to help it survive? (*animals that get too close to the plant that might destroy its flowers will get prickled and decide to stay away*) Some plants (poison oak, poison ivy, stinging nettle) have oils in their leaves that are very irritating to animals. How would that help the plant survive? (*animals would not want to brush up against the plant to hurts its leaves or eat it for food as it would cause the animal great discomfort*) Some plants have small hairlike structures that sense an animal like a housefly on them and react. The Venus flytrap actually captures the fly and digests the fly for food- a form of survival. 

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
	Other Examples of Bodily Function **Students may do research on the uniqueness of certain species in their respective countries.** • Students may research the St Lucia whiptail lizard (Cnemidophorus vanzoi) or other local species of the lizard found in their island. • The armoured body of crabs and the use of their claws for digging. • Snakes make use of the fangs • Scorpions make use of their stinger and claws. • Turtles use their back flippers to dig a nest in the sand.	Venus flytrap picture retrieved from: https://www.nature.org/en-us/about-us/where-we-work/united-states/north-carolina/stories-in-north-carolina/pitcher-venus-flytrap-carnivorous-plants/ See the flytrap in action here: https://www.youtube.com/watch?v=O7eQKSf0LmY (2.50 mins) Other plants will close or move if they are touched. (e.g. mimosa pudica) to protect against being eaten or to avoid losing water through their leaves (dehydration)   See the mimosa pudica moving here: https://www.youtube.com/watch?v=xEQJ0byHMXw (6:14 mins) Plants can also ensure their survival by making sure their seeds get to fertile ground. This is called **seed dispersal** and it happens by many processes. Sometimes their seeds are ejected from a pod, carried by the wind or by water or by animals (on coats or in stomach) to other locations where they flourish. They have special features likes wings, waterproof seed coverings or sticky burrs that allow them to move to better locations for surviving.

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		Examples: *Tetraberlinia moreliana* (Leguminosae — Caesalpinioideae) Pea Family (Leguminosae) **Transpiration: Plants Need Water**! Sun shines of the leaves of plants and warms them up. The liquid water in those leaves gest additional energy and begins to jump into the air as a gas in a process we have already studies called **evaporation**. The departure of the water from the leaves has the impact of drawing more water up from the soil through the stem. This process is called **transpiration** and plants could not survive without it. The process works properly because of the specialized parts in the plant.  Retrieved from: https://www.geeksforgeeks.org/transpiration/

Additional Resources and Materials
Ejection of seeds
https://www.youtube.com/watch?v=OB0P3mx_lxY

Water transpiration:
https://www.youtube.com/watch?v=5jJLfwTkGe8

Animal camouflage:
https://www.youtube.com/watch?v=YOIRci0CKzg

Opossum plays dead:
https://www.youtube.com/watch?v=UpGwt_baExk

Bird digestive system: https://www.pgc.pa.gov/Education/ForEducators/Documents/Bird%20Digestive%20System.pdf

Additional Useful Content Knowledge for the Teacher:

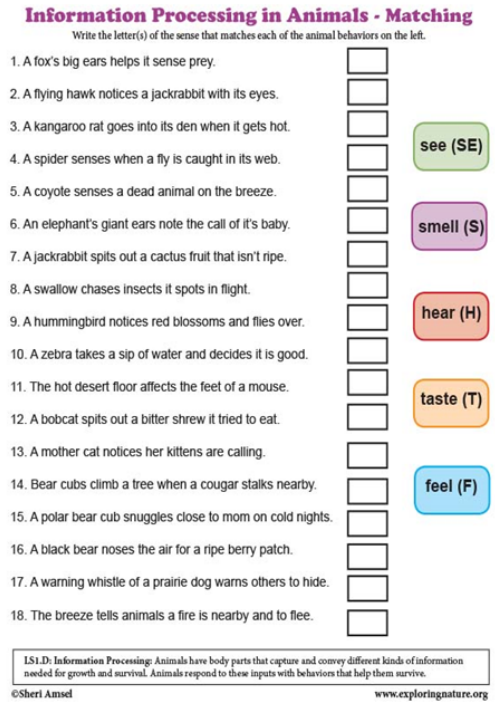
Description	Survival Function
Teeth on a Hutia Rodent	Digging for food or shelter
Changing colors on a chameleon lizard	Hiding from predators
Heavy hair on a Highland cow	Staying warm in cold weather
Rockfish spines	Use a sting to ward off predators
Thick fat on an Artic seal	Keeping warm through an insulating coat
Quills on a porcupine	Warding off predators with sharp spines
Venom of jelly fish	Stinging predators
Grit in a bird gizzard	Grinding up food in the absence of teeth
Shell on a tortoise	Protecting soft body
Spots on Owl Butterfly wings	Mimicking a larger animal to ward off predators

Opportunities for Subject Integration:
Language Arts: Research and communication of topics understandings (posters, writing etc.)
HFLE: concerns associated with organ replacement.
Social Studies: The ethics of killing endangered species for their body parts. The ethics of organ donation.

Essential Learning Outcomes 3: Use a model to describe that animals receive different information through their senses, process it in their brain and respond to it differently

[Clarification Statement: Emphasis is on systems of information transfer.] [Assessment Boundary: Assessment does not include the mechanisms by which the brain stores and recalls information or the mechanisms of how sensory receptors function.]

Grade Level Expectations: Refer to grade level expectations at the beginning of this curriculum document.

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
Learners are expected to: **Knowledge** • Define the terms: o senses o nervous system o nerves o spinal cord o braille • Identify the five senses. • Account for the importance of each of the senses in human survival. • Give at least three examples of how animals use their specialized senses. • Draw a diagram to show they understand the input of sensory information to the brain and an output of bodily response. • Infer from a scenario, the steps involved in going from	**Which Senses are Used?**  Retrieved from: https://www.exploringnature.org/db/view/Information-Processing-in-Animals-Matching	**Review of Senses and Sense Organs** Students let's review our senses – sight, smell, hearing, taste and touch. Which body organ is used for each sense? Why do we need these senses? (*interact safely in the world, satisfy basic needs of food, warmth, shelter*) Now let's play a game to see which sense we use for each activity.  Retrieved from: https://www.baamboozle.com/slideshow/1138071 **Animals Use Their Senses Too!** Just like humans, animals gather information from their environment through different sensory organs.

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
a sensory input to a bodily response. • Classify sensory inputs. • Classify brain outputs. • Calculate % of global spinal injuries. • Communicate your research of animal use of senses in the form of a poster. • Construct a simple robot. (extended based on resources) for the purposes of mimicking sensory input and brain output. • Record data using bar graphs. (ST 2 ESS ER 2) • Outline what stimulates each of the five senses. (ST 2 LS ECS 14) • Name the organ that is stimulated by sound. (ST 2 LS ECS 15)	**The Sense of Touch** Have students explain in a paragraph or a diagram, the steps of sensory processing for each of these human activities that involve touch. ➢ A blind person reads a book written in **braille.** ➢ A physician feels an arm to see if it has a break. ➢ A violinist places their fingers on the fingerboard of their violin to play a song. ➢ A baker kneads the dough as they prepare a loaf of bread. **What is so special? A Research Project** Students should choose three of the following animals and prepare a poster and explanation why the animal's sensory systems are especially useful for their survival. *1)* What special sensory ability does a housefly possess that makes it so difficult to capture them? (*peripheral vision)* *2)* What special sensory ability does a female mosquito have that allows them to find their next blood meal? (*detecting carbon dioxide-breathing animals)* *3)* What special sensory ability does a colossal squid (*Mesonychoteuthis hamiltoni*) have that helps with hunting in the ocean? (*large eyes to receive minimal light in deep water*) 4) What sensory property does the Caribbean white-lipped frog take advantage of in attracting a mate? (*the frog sings but also creates a*	Have students look at the following pictures and suggest how the animals use their senses to receive information and respond. How do you think owls find their prey at night? *(Owls use their perfect night vision and hearing to find prey.)*  Retrieved from: https://hawkwatch.org/raptor-id/raptor-id-fact-sheets/great-horned-owl/ Why do you think dogs make good police assistants? *(Dogs have a powerful nose and an amazing sense of smell. Police and military service dogs are trained to detect drugs and explosives.)*  Retrieved from: https://www.customs.go.jp/moji/english/canine/canine.html

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
Attitudes/Values • Appreciation of the many senses animals access to function in the world safely and survive. • Interest/Curiosity in animal's unique senses. • Safety and care to avoid spinal cord injuries. • When conducting practical and group work, display sensitivity and offer assistance to peers who may have physical or learning challenges. • Participate actively in classroom discussions.	*vibration in the earth to accentuate the impact of attracting a female*) *5)* What sensory property does the Blue-footed Boobie take advantage of in attracting a mate? (*the sight of the bright blue feet elicits a response in the female bird)* *6)* What sensory property does a pod of whales access when they migrate as a group to other waters? (*water temperature is sensed and whales will move for better feeding or giving birth to offspring)* **Spinal Cord Injuries** The spinal cord is a crucial component of the nervous system that allows animals to transmit sensory information to and from the brain. It is very important to protect against injury to the spinal cord because the results can be very dramatic. If our brains can't receive information about our sense of touch we have difficulty operating our arms and legs which can seriously affect our mobility. Dangerous activities that can lead to spinal injury include but are not limited to: ➢ Jumping from high locations ➢ Diving into unknown bodies of water ➢ Driving in vehicles without seatbelts ➢ Riding bicycles in dangerous terrain without a helmet Statistics: (2019) retrieved from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9554757/ Globally 900,000 cases of spinal injury	How do you think snakes and lizards find prey? *(Snakes & lizards use their tongue for sensing prey)*  Retrieved from: **https://www.petmd.com/reptile/pet_lover/evr_rp_why_snakes_use_tongue** How do you think bats are able to fly in the dark of night? *(Bats use echolocation to navigate and find prey. They send out waves of sound from their mouths or noses, which bounce off their surroundings right back to their ears. By listening to the echoes, bats can build up a picture of exactly what's around them.)*  Retrieved from: https://www.britannica.com/list/5-surprising-facts-about-bats

<table>
<tr><th>Specific Curriculum Outcomes</th><th>Inclusive Assessment Strategies</th><th>Inclusive Learning Strategies</th></tr>
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<td></td>
<td>
Have the students calculate the % of each region of the total global incidence of spinal injury. From this data they should create a bar graph of country vs. % of spinal injuries globally. e.g. ((incidence/900000) x 100)
<table>
<tr><th>Location</th><th>Incidences (number of cases)</th><th>% of total Global</th></tr>
<tr><td>Caribbean</td><td>3000</td><td></td></tr>
<tr><td>Esat Asia</td><td>236000</td><td></td></tr>
<tr><td>Central Europe</td><td>17000</td><td></td></tr>
<tr><td>Central Latin America</td><td>25000</td><td></td></tr>
<tr><td>North Africa & Middle East</td><td>53000</td><td></td></tr>
</table>
Response Paper
Students should write a one-page essay about how their school can be made accessible to students who may be confined to a wheelchair because of spinal cord injury or other debilitating injury/disease.

Engineering Project: Students may decide to build a wheelchair ramp for the school which would access their mathematics and construction skills.

Extension Activity- Robotics
Most rudimentary robots accessible to schools have built in sensors that can be programmed around visual cues to stop, turn, reverse etc. These systems mimic processing undertaken by animal's brains based on sensory input.
</td>
<td>
How do you think mice avoid cats?
(Animals have a sense of smell to sense dangerous predators)

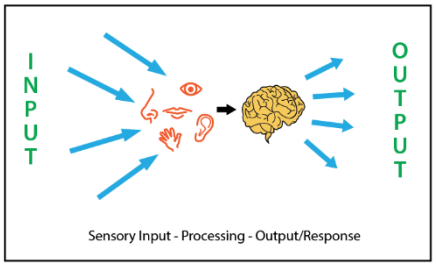
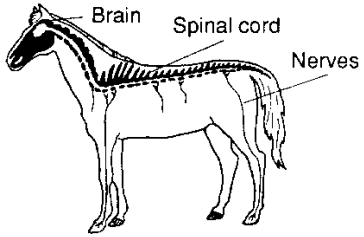
Retrieved from: https://en.wikipedia.org/wiki/House_mouse

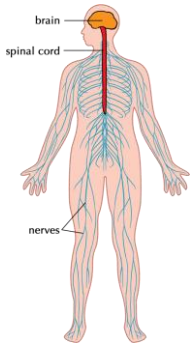
Why do you think animals have whiskers?
(Animals brush, or whisk, their whiskers against objects to guide them, measure things, and find food).

Retrieved from: https://en.wikipedia.org/wiki/Whiskers

How Do Animals Respond to Information from the Senses?

The nervous system in animals is made up of sensory organs that collect information and use biochemicals in our bodies and specialized signaling anatomy to pass messages to the brain. The brain interprets the information then sends a message back through the nerves to tell the animal how to respond.
(e.g. we touch something hot with our hand and the brain tells us to pull our hand away)
</td>
</tr>
</table>

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
	School Projects https://www.youtube.com/watch?v=iCc4Di3ycNc (2:46 mins) https://www.youtube.com/watch?v=dDQThRpDe1A (3:23 mins)	 Retrieved from: https://childsuccesscenter.com/home/resources/sensory-processing/ In many animals the sensory information is collected and transferred using something called a nerve receptor. The information can then be passed along a **spinal cord** to the brain.  Retrieved from: https://www.youtube.com/watch?app=desktop&v=12Cez7IFDY8 (11:52 mins)

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		 Retrieved from: https://www.twinkl.nl/teaching-wiki/nervous-system **What Is the Response from the Brain?** Discuss with students what happens when you give a stray dog some food. Have students explain the steps in that scenario? *Dog sees food > brain signals it resembles food > dog moves closer* *Dog smells food > brain signals it isn't spoiled > dog begins to eat* *Dog tastes food > brain signals it doesn't taste spoiled > dog continues eating*

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		 Retrieved from: https://milaap.org/fundraisers/support-feeding-street-dogs **Another example** for students to map out the stepwise response. Scenario: A cat spies a large dog coming towards them from afar and then as it gets closer, hear sit growling  Retrieved from: https://en.wikipedia.org/wiki/Cat%E2%80%93dog_relationship Possible student answers: *Cat sees dog > brain signals it could be a danger > cat tenses up & watches for aggressive behavior*

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		Cat hears growling > brain signals the dog could attack> cat raises back to appear larger *Dog recoils >cat brain signals to be more aggressive> cat hisses loudly* What else might the cat do to protect itself? (*move forward or lunge at the dog*)

Additional Resources and Materials

Animal Adaptation: Super Senses | Science: https://youtu.be/-cHB9dvtp_I (1:04 mins)
Animal Senses - Visual Perception, Hearing, Taste, Smell: https://youtu.be/zS_DXg8QKOE (3:29 mins)
Animal senses / Super senses in animals: https://youtu.be/3jW08wCQOWw (7:32 min)
Sensory Organs: https://www.generationgenius.com/videolessons/senses-video-for-kids/ (12:23 mins)

Additional Useful Content Knowledge for the Teacher:

How do nerve signals get transferred? https://www.youtube.com/watch?v=6qS83wD29PY (1:47 mins)
Bird Mating Rituals which take advantage of visual sensation to elicit a brain response:
https://www.youtube.com/watch?v=dhX8TI1bcy4 (4:55 mins)
https://www.youtube.com/watch?v=lcPHFQP9GN0 (2:24 mins)
https://www.youtube.com/watch?v=nPhVOZiPokA (2:05 mins)

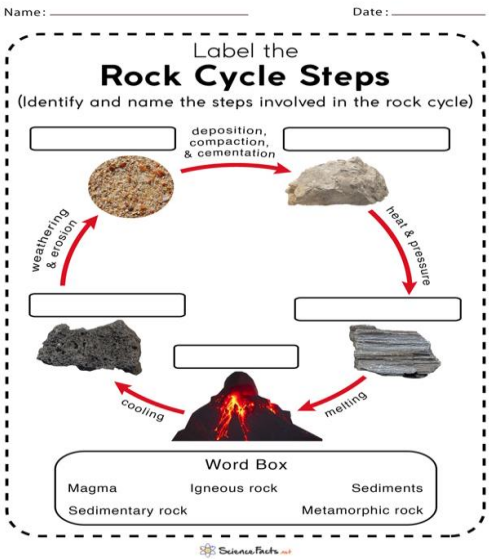
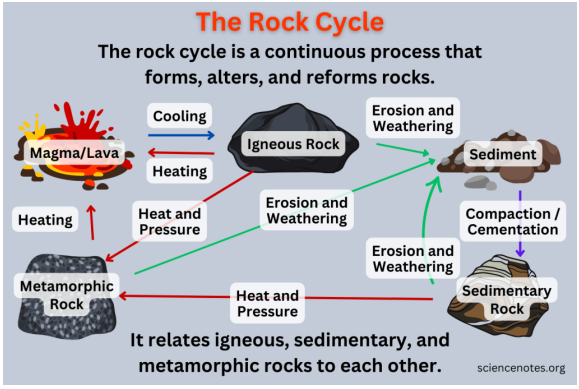
Opportunities for Subject Integration:

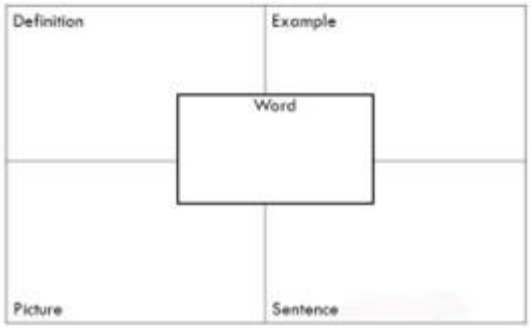
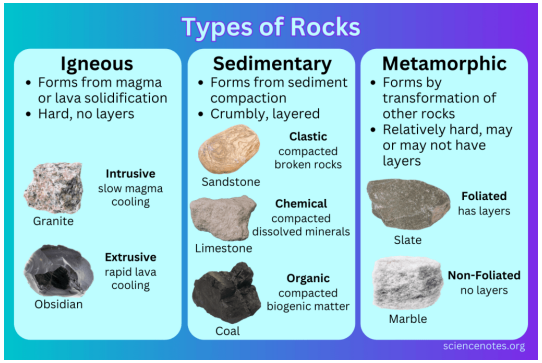
Language Arts: Research, reading of primary source materials, and communication of results in written and graphical forms.
Mathematics: Calculation of statistics around spinal injury
Social Studies: Care of endangered species, care & access issues re: humans with spinal cord injuries.
HFLE: healthy choices to avoid serious injuries

Earth Systems: Processes that Shape the Earth

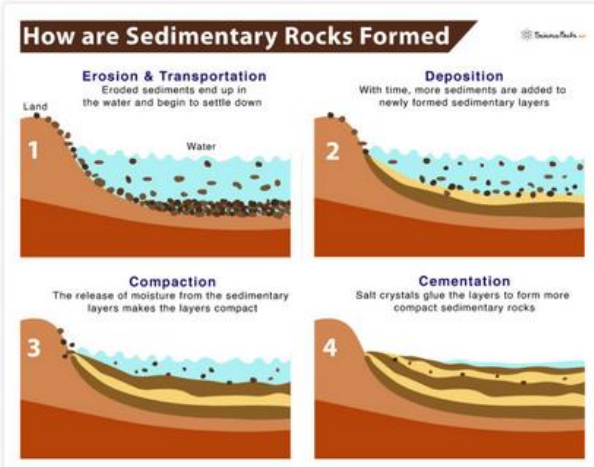
Introduction to the Subject: The study of science encompasses knowledge, processes and values. Scientifically literate persons will foster an attitude of caring not only for themselves, but as responsible citizens, for the world around them. Their decision making will be enhanced by a systematic study of the structure and behavior of the physical and natural world through observation and experiment. In learning science, students benefit from leveraging and evaluating available technological tools to study and therefore understand the world and their relationship to it
Strand (Topic): Earth Systems: Processes that Shape the Earth We live in a world where we watch natural processes shape the landscape. While we can't always prevent small and sometimes catastrophic events, our children should understand enough of these earth changes to be prepared to cope with the inevitable consequences.
Essential Learning Outcome 1: Identify evidence from patterns in rock formations and fossils in rock layers to support an explanation for changes in a landscape over time [Clarification Statement: Examples of evidence from patterns could include rock layers with marine shell fossils above rock layers with plant fossils and no shells, indicating a change from land to water over time; and a canyon with different rock layers in the walls and a river in the bottom, indicating that over time a river cut through the rock.] [Assessment Boundary: Assessment does not include specific knowledge of the mechanism of rock formation or memorization of specific rock formations and layers. Assessment is limited to relative time.]
Grade Level Expectations: Refer to grade level expectations at the beginning of this curriculum document

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
Knowledge: Define the terms: Igneous rock Sedimentary rock Metamorphic rock Weathering Minerals Erosion Deposition Fossils Slate Granite	**Terminology 1**: Complete the worksheet on how rocks are formed by filling in the key wors in the appropriate blanks in the diagram.	Students, look at these two pictures of rocks. Which one would you prefer to use for a bathroom shower wall or a tidal break? They have different properties which make them better suited for solving problems that humans have in their everyday life.  Retrieved from: https://www.stoneadd.com/Bianco-Carrara-White-Marble-Blocks-Italian-Marble-Rocks-P27450

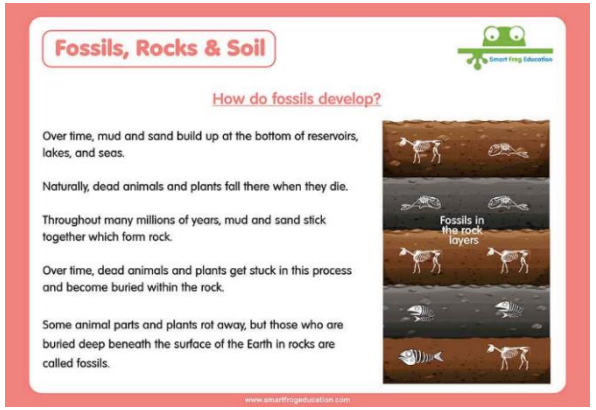
Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
Limestone Marble • Demonstrate an understanding of how layers of rocks are formed (layers and heating processes). • Recognise how rock formations result in the changes in the landscape. • Create a representation of a canyon to illustrate how a river changes the landscape overtime. • Illustrate changes in the landscape. • Outline how soils are made from a variety of rocks. (ST 3 ESS ER 3) • Collect and classify rocks in their country. (ST 4 ESS ER 1) • Describe with examples how people use rocks for different purposes. (ST 4 ESS ER 2)	 Retrieved from: https://www.sciencefacts.net/wp-content/uploads/2021/04/Earth-Science-Rock-Cycle-Worksheet-Label-the-Diagram.jpg **Terminology 2** Complete the Frayer Square by placing "Fossil "in the center and filling in the four squares.	 Retrieved from: https://www.zmescience.com/feature-post/natural-sciences/geology-and-paleontology/rocks-and-minerals/granite/ Students, did you ever wonder why rocks have so many different characteristics and properties? It is because they are formed differently. Looking at the **rock cycle** you will come to understand that there are actually only three different classifications of rocks (igneous/ sedimentary/metamorphic) and they are a part of cycle that involves short and long term events involving heat and pressure. Let us walk through the parts of this cycle. 

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
• Define the term soil erosion, listing the types of soil erosion, and ways and means of preventing it. (ST 5 ESS ER 1) **Skills** • Investigate how layers of rocks are formed. • Observe how fossils in layers of rocks and rock formations indicate a change in the landscape. • Communicate effectively how landscape changes • Interpret what fossils and rock formations may suggest about past environments. • Research information about landscape changes caused by glaciers and volcanoes. **Attitudes/Values**	Frayer Model (Four Square) Reinforcing Vocabulary  **Terminology 3** Fill in the blanks with the following words. oldest / sediment / weathering /ecosystem/ igneous/ environment/ youngest/ sedimentary 1) Fossils most often form in _____ rocks. 2) Fossils suggest to us what the _____ was like in a particular time frame. 3) _____ of rocks tell us the likely climate that the landform existed in. 4) We can tell something about the past _____ from fossils of plants and animals. 5) Animal fossils are often formed from the weight of _____ layers on top of bones that were encased in mud.	"The **rock cycle** is the natural, continuous process that forms, breaks down, and reforms rock through geological, chemical, and physical processes. Through the cycle, rocks convert between igneous, metamorphic, and sedimentary forms. It is a dynamic system that recycles Earth's materials in different forms, from molten magma deep below the surface to solid rock formations and sediments. Understanding the rock cycle is not only crucial for geologists but also provides insight into Earth's history, climate change, and the availability of natural resources." Picture and verbatim description retrieved from: https://sciencenotes.org/the-rock-cycle-diagram-and-explanation/ See also: https://www.youtube.com/watch?v=Vp_S3BDiR-I (5:27 min) Some examples of the different types of rocks in each category. 

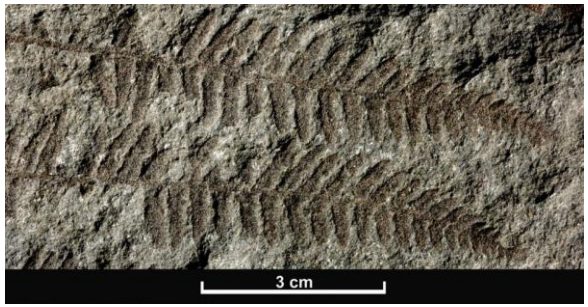
Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
• Express desire to find answers in patterns through exploring. • Willingly work with others, regardless of their age, their gender or physical or cultural characteristics. • Keep the work area clean and uncluttered, with only appropriate materials present. • Willingly contribute to group activity. • In group work, demonstrate sensitivity and assistance to students with physical challenges.	6) In weathered and eroded rock faces, the bottom layer is likely to be the _____ and the top layer may contain organic material because it is the _____. **Distinguishing Rocks** The teacher should show students three common rocks and ask them to place them in categories of igneous, metamorphic and sedimentary. (Samples should be obvious based on the table you presented in class: e.g. marble, mica, granite, slate, shale, sandstone, pumice.) *Possible Field trip* Students are taken on a field Trip to a river/site where students can collect and identify the different types of rocks. Students will sort the rocks correctly according to the 3 groups of rocks given in the checklist below. Rock Checklist Let students use a chart/pictures/samples of rocks to classify their rocks based on color, texture and layers. See possible classification table here: https://i.pinimg.com/originals/ee/68/c4/ee68c440f0fb48148a65680204afcbb1.jpg Students should take pictures with phones and create a PowerPoint presentation of their findings. *Rubric*: At least 3 Sedimentary rocks - 10 point At least 3 Igneous rocks - 10 points At least 3 Metamorphic rocks - 10 points	Retrieved from: https://sciencenotes.org/types-of-rocks-igneous-sedimentary-metamorphic/ Students, I want you to look at the following two pictures. What do you notice is similar? (*layers within the rock*)  Retrieved from: https://www.khanacademy.org/science/middle-school-earth-and-space-science/x87d03b443efbea0a:the-geosphere/x87d03b443efbea0a:fossils-and-rock-layers/a/fossils-and-rock-layers 

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
	PowerPoint field notes- 5 points **What Do Rocks and Fossils Tell Us?** 1. What type of fossil do you think a paleontologist would find if they thought a tropical climate may have existed on the dig site? (*rain forest plants, cold blooded animals, spiders, snakes, seeds from tropical plants*) 2. What evidence can you suggest that a volcano may erupt in a certain region? (*pumice, hardened lava flows*) *3.* What fossil evidence can you suggest that might indicate an ocean ecosystem? (*shells, fish, aquatic plants)* 4. How can water change the shape of the land? (*through weathering and erosion*) 5. What evidence do you think might have appeared to paleontologists those dinosaurs and men never lived together? (*no fossils showing they co-existed in same layers of rock*) **Research Essay** Glaciers from the ice age were said to have had a great impact on the landscape. Have students do research and bring back to class examples of glacier movement. **Tracking Landscape Changes in our Lifetime**	Retrieved from: https://www.varsitytutors.com/4th_grade_science-help/earth-and-space-science/patterns-and-fossils These layers that we see are characteristic of **sedimentary rocks** which are formed in a special 4 step process. How are Sedimentary Rocks Formed Several geologic processes together form sedimentary rocks. The steps involved in the process are discussed below in order:  Retrieved from: https://www.sciencefacts.net/sedimentary-rocks.html **Canyons** are formations with deep and steep sides. At the bottom of the canyon, we often see rivers or streams. We know, from our previous studies, that water can erode the walls of such a deep gorge.

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
	The pictures show a landform that has changed over thousands of years. Use the pictures to answer and complete the task. Retrieved from: https://rwu.pressbooks.pub/app/uploads/sites/7/2019/05/figure13.3.3-1.png   Questions: 1. How did the shape of the landform change? 2. Did you think water or wind changed the landform more? Explain your answer. 3. Draw a picture to show how the landform might look after many more years.	 See also: Erosion and sedimentation: How rivers shape the landscape - YouTube (3:04 min) "This is a graphic of a canyon, which is a type of rock formation. Changes can be noticed in the formation as it progresses upwards. The colors are light, almost gray color towards the bottom of the canyon closest to the water. The canyon is darker and burnt orange as it moves upwards. As the canyon changes in age, it also changes in colors. A canyon like the one pictured is an obvious way to see how the Earth has changed over the years. Scientists look for these changes and study how the Earth has changed over time." Graphic and description retrieved verbatim from: https://www.varsitytutors.com/4th_grade_science-help/earth-and-space-science/patterns-and-fossils?page=2 **What is in the layers?** When sediments from different sources are compressed to form layers, the bottom layer will always be the oldest layer that was formed. By inspecting those layers, we not only know something

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
	Volcanoes: Picture and Video Search Assignment Search the internet for pictures/video of how volcanic activity has shaped landscape across the world. Research the types of fossils they have found of humans and animals at the site of Mount Vesuvius in Pompei. Why are these fossils unique? (*many humans were caught by surprise, possible families and animals huddled together*)	of the relative age, but the composition sometimes tells us about what the environment would have been. Sometimes plants and animals from many years ago died and remained in a mud layer on land or in the ocean perhaps. Those layers were then covered with new layers and an **imprint** was made (much like a footprint on the beach) in the mud that then hardened. With pressure and additional sediment layers on top, that imprint was forever made in a stone and recorded as a period in time. A **fossil** is an imprint of a plant or animal in a rock, usually sedimentary. See: https://www.youtube.com/watch?v=ZKtkrqOpECI (4:31 mins) Also: https://www.youtube.com/watch?v=QPIDE_VWxsI (10:41 mins) 

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		Retrieved from: https://www.smartfrogeducation.com/files/gallery/pg-340/fossils-rocks-soil-1.jpg **Sample Fossils** What do they tell us? ***Fossil 1*** These fossils tell us that this rock layer was in the ocean at one time. Since it is now uncovered, perhaps that body of water dried up? This would change the landscape.   Retrieved from: https://www.varsitytutors.com/4th_grade_science-help/earth-and-space-science/patterns-and-fossils?page=3 https://www.wonderopolis.org/wonder/where-can-you-find-fossils ***Fossil 2*** This fossil tells us that this rock layer was near a forest with ferns at one time. Plants are a good indicator of the environment of the past. Certain types of plants, for example, require specific temperature and moisture conditions in order to thrive.

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		 Retrieved from: https://www.bgs.ac.uk/discovering-geology/fossils-and-geological-time/fossils/ ***Fossil 3*** This fossil was found of two animals fighting. For that layer of rock, we know that these animals existed in a predator/prey relationship at a particular time. Sometimes fossil scientists (paleontologists) find large and small skeleton fossils and or younger animals or eggs indicating a parent caring for offspring at that period of time. We know then that, those animals existed in that time frame and were reproducing. 

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		Retrieved from: https://www.economist.com/science-and-technology/2023/07/19/a-spectacular-new-fossil-shows-a-mammal-making-a-meal-of-a-dinosaur "Most fossils are formed when an animal dies and gets buried in mud or silt. Over time, sedimentary rock forms on top of the animal's bones, creating a fossil. This is evidence of change to the landscape because we can age the fossil-based on the different layers of sediment in which it is encased, which also gives us insight into the changes that have occurred in that area of the world over time." Quote from: https://www.varsitytutors.com/4th_grade_science-help/earth-and-space-science/patterns-and-fossils **What do rocks tell us?** Indicators of erosion and weathering of rocks can tell us something of the environment change after the rock was formed. "This sandstone on the beach shore demonstrates the patterns of change that can be seen in rock formations. The rock changes colors as it progresses; there are stripes of different oranges, tans, and reds. Some sections are covered in holes, and those parts are grey, black, and white. There are changes in textures throughout the rock formation. Some parts are smooth, and others are covered in holes. As rocks are weathered and eroded with wind and water over the years, there are visible changes to the formations and structure."

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		 Picture and description retrieved verbatim from: https://www.varsitytutors.com/4th_grade_science-help/earth-and-space-science/patterns-and-fossils?page=2 **Information from the Layers** The earth's layers of rock arise from different places and processes. This gives us indicators of the environment. **Earth's Layers** | Rock | Appearance | Source | | --- | --- | --- | | Basalt | Black particles, medium sized | Volcanic ash | | Shale | Light brown particles, large, circular, and flat | Sediment from swamps or pond water | | Limestone | White particles, fine, and tiny | Ocean floor far from land | | Sandstone | Yellow particles, medium sized | Sand deposited from wind and water, then pressurized | | Granite | Dark brown particles, large, and teardrop shaped | Cooled magma | | Aquatic (water) animal fossils | Black, white, or grey particles, large, and teardrop shaped | Remains of water animals | | Terrestrial (land) animal fossils | White particles, large, round or cylindrical shaped | Remains of land animals |

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		"This table shows the different layers of rocks, how they are formed, and what they are created from. What is noticeable about the changes in the rock layers is that each one is built from something different, has unique characteristics, and is formed in its ways. There are no two layers that are the same. Each layer is different, which demonstrates there is a change in the formation as well as the environment with the creation of each new layer." Table and description retrieved verbatim from: https://www.varsitytutors.com/4th_grade_science-help/earth-and-space-science/patterns-and-fossils?page=2 **Other Indicators of Landscape Change** Example #1 Teacher presents the picture below to generate discussion with pupils.  Retrieved from: https://www.geographyrealm.com/rivers-change-landscape/ *Questions* 1. What are some of the changes observed in the picture?

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		2. What do you think causes the changes? 3. What do you think it would be like in ten years from now? Example #2 **How Canyon and Gorges are formed** Pupils watch the video on how the Canyon was formed and answer questions. https://www.youtube.com/watch?v=8gCQv7Fzt6Q (3:44 mins)  **Guided questions for discussion** The rock layers of the Grand Canyon were formed by volcanic rock and layers of: (Sediments) The erosion that formed the Grand Canyon was mainly caused by what**?** **(***water*) What was Grand Canyon probably like, that very first day, where the water started to flow before visible erosion was happening? (*a very flat massive piece of land*) or (*It looks like a massive river that dried up over millions of years, the erosion is visible on the rocks, it used to be filled with water all the way up).*

Additional Resources and Materials

Some Useful Websites

Earth Layers:

https://www.sciencefacts.net/wp-content/uploads/2020/12/Layers-of-the-Earth-Worksheets-212x300.jpg

https://imgv2-1-f.scribdassets.com/img/document/198385534/original/05b653776d/1590021817?v=1

Additional Useful Content Knowledge for the Teacher:

Answers for above worksheets

https://ecdn.teacherspayteachers.com/thumbitem/Rock-Introduction-and-Investigation-Activity-Center-1807462-1507719974/original-1807462-4.jpg

Answers for above worksheet at https://ecdn.teacherspayteachers.com/thumbitem/Rock-Introduction-and-Investigation-Activity-Center-1807462-1507719974/original-1807462-3.jpg

Opportunities for Subject Integration:

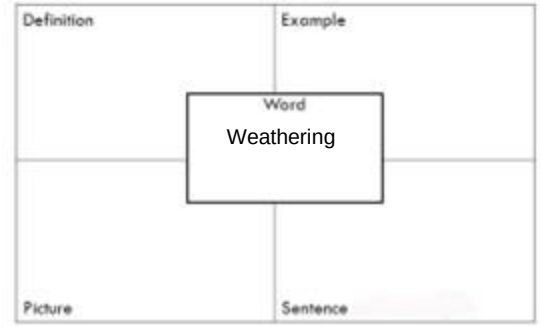
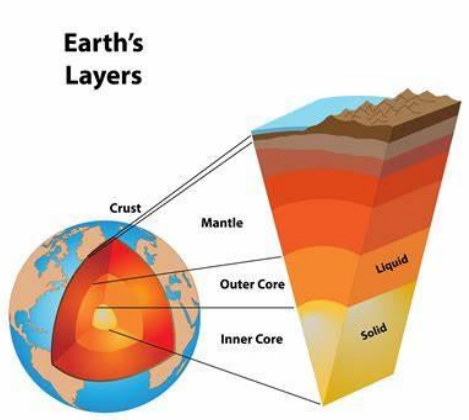
Elements that are integrated across subjects:

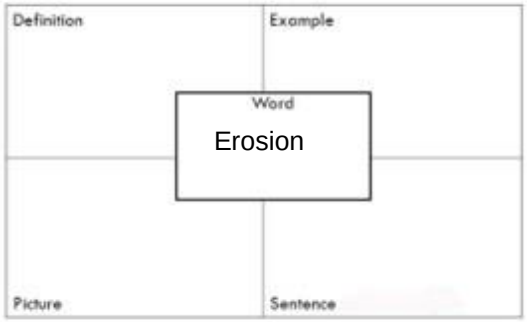
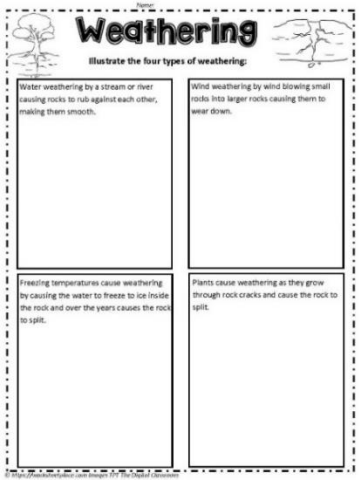
- Mathematics: Sorting types of rocks using a table
- Language Arts: Research glaciers and volcanos as landscape changers. Write a composition on types of rock and fossils.
- Social- Science: Pupils identify different rocks in their environment and places where they can identify changes in the landscape.
- Elements from Local Culture, Technology, TVET, Environment that are integrated:

Essential Learning Outcomes 2: Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation

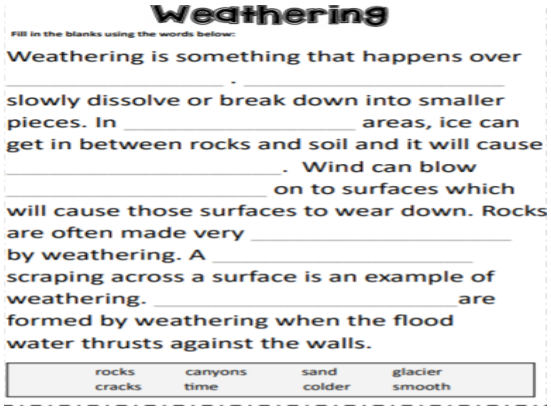
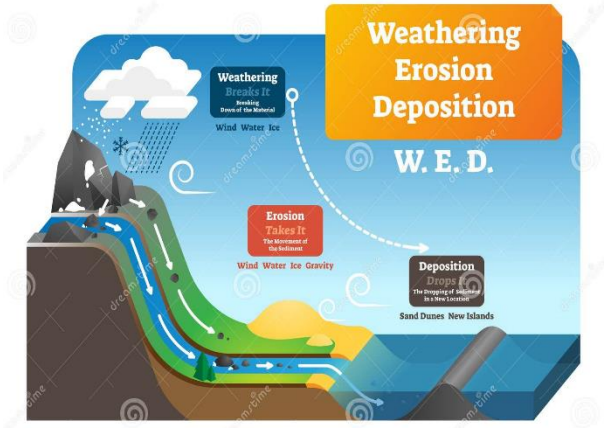
[Clarification Statement: Examples of variables to test could include angle of slope in the downhill movement of water, amount of vegetation, speed of wind, relative rate of deposition, cycles of freezing and thawing of water, cycles of heating and cooling, and volume of water flow.] [Assessment Boundary: Assessment is limited to a single form of weathering or erosion.]

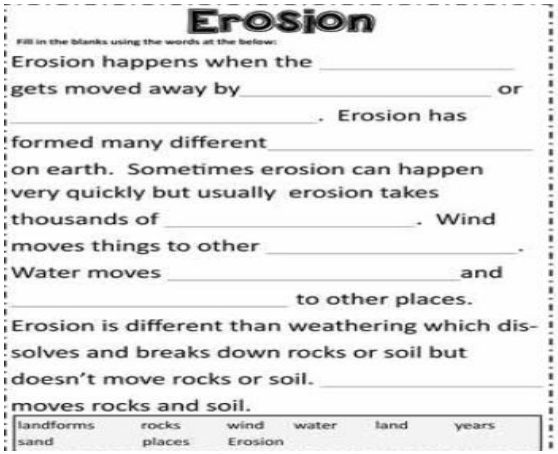
Grade Level Expectations: Refer to grade level expectations at the beginning of this curriculum document

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
Learners are expected to: **<u>Knowledge:</u>** Define the terms**<u>:</u>** Core Crust Mantle Weathering Mechanical /Physical weathering Biological weathering Chemical weathering Erosion Sediment Deposition Deforestation Delta Meandering river Identify the layers of the earth: crust, mantle and core. Demonstrate an understanding of weathering and the factors that contribute to the same.	Demonstrate that you know the difference between weathering and erosion by completing the Frayer squares below. Frayer Model (Four Square) Reinforcing Vocabulary 	Introduction Students did you know that the earth is made up of several layers? We know from volcanic activity in the region, that there is molten rock called magma in the core of the earth and that sometimes bubbles to the top, overflowing over the outer layer called the crust.  Retrieved from: https://www.worldatlas.com/upload/0f/ae/ca/earth-s-four-layers.png See also: https://www.youtube.com/watch?v=eXiVGEEPQ6c (3:12 mins)

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
Demonstrate an understanding of erosion. Describe the factors that increase or reduce the rate of erosion in a particular area. Identify meandering rivers in the Caribbean Define the term soil erosion, listing the types of soil erosion, and ways and means of preventing it. (ST 5 ESS ER 1) Name and describe methods of soil conservation. (ST 5 ESS ER 2) **Skills:** Observe (a) the layers of the earth (b) evidence of weathering and erosion in a particular area. Make inferences about the factors that contribute to weathering and erosion. Classify the types of weathering as mechanical/physical and chemical	Frayer Model (Four Square) Reinforcing Vocabulary  Make drawings below to explain the different types of weathering.  	Ask students: On what part of the Earth do we live? (crust) The crust is subjected to all kinds of forces including what we call weathering and erosion. Have you heard these words before? What do they mean to you? Sometimes people use these words to mean the same thing but actually they refer to two separate processes. Changes we have seen in the crust Look at these pictures, do you think these rocks always looked this way? (probably not). What caused them to change? (pic1 wind, pic2 water) 

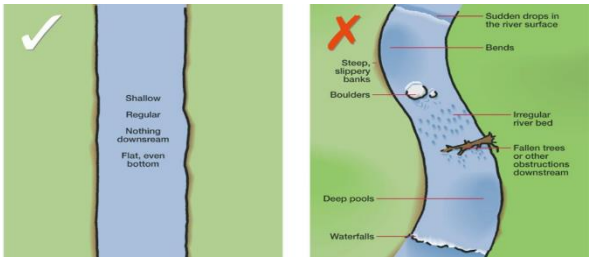
Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
Investigate the factors that contribute to weathering and erosion. Compare and contrast weathering and erosion. Observe and account for erosion behaviours in a water table. Use a model to investigate the variables that may impact the extent of erosion. Communicate experimental results by making a model. **<u>Attitudes/Values</u>** When conducting practical and group work, display sensitivity and offer assistance to peers who may have physical or learning challenges. Express the desire to explore the factors that contribute to weathering and erosion and contribute solutions to erosion challenges in your community.	Retrieved from: https://www.worksheetplace.com/mf_pdf/Weathering-printable.pdf Guided by the teacher, students are asked to complete the worksheet below. **Recall Questions True/False** Write True or False for each statement. 1. There are three different types of weathering. true or false (*true*) 2. Frozen water through rocks causes them to crack. true or false (*true*) 3. Mechanical weathering happens when the minerals inside the rocks experience chemical change. true or false. (*false*) Name some living things that can cause biological weathering. (*trees/ roots, worms, rabbits etc.*) **Classification of Weathering** Let students classify the examples below for the different types of weathering. 1. A plant growing in a crack - (biological) 2. Rain reacts on mineral grains in a rock to form new minerals and salts. (chemical)	Retrieved from: https://en.wikipedia.org/wiki/Weathering  Retrieved from: https://www.reddit.com/r/geography/comments/98rnc3/rock_weathered_by_waves/ Sometimes the forces of nature can cause dangerous conditions like this road where the foundations have fallen away. 

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
Show concern and present community solutions to the problems of deforestation which leads to erosion, and eventually global warming. Consider solutions to solve the problem of flooding/run-off that washes away arable lands. Participate actively in classroom discussions.	3. A rabbit/worm burrowing in the crack of a rock - (biological) 4. The breaking down of rocks by waves. (mechanical) 5. As rocks become hot and cold, they expand and break down into smaller rocks. (mechanical) **Practice with Terminology** Students will complete a cloze passage on weathering.  **Weathering** Fill in the blanks using the words below: Weathering is something that happens over _____ - _____ slowly dissolve or break down into smaller pieces. In _____ areas, ice can get in between rocks and soil and it will cause _____. Wind can blow _____ on to surfaces which will cause those surfaces to wear down. Rocks are often made very _____ by weathering. A _____ scraping across a surface is an example of weathering. _____ are formed by weathering when the flood water thrusts against the walls. rocks cracks canyons time sand colder glacier smooth **Retrieved from:** https://www.worksheetplace.com/mf_pdf/Weathering-worksheet.pdf **Students will complete a cloze passage on erosion.**	Retrieved from: https://upload.wikimedia.org/wikipedia/commons/5/5e/Eroded_Road_at_Whatarangi_Bluff%2C_Palliser_Bay-2.jpg What are the Processes? This picture shows a rock at the top of a hill that gets broken up and the pieces deposited at the bottom of waterfall. Students, there are three processes outlined in this diagram 1) weathering, 2) erosion and 3) deposition We will look at each one separately, but the basic sequence is: the rocks are broken into pieces-the rocks are transported and the rocks are laid down as sediment (deposition)  Retrieved from https://images.app.goo.gl/VyR3FvcCC8kjD5pg7 The following video is an excellent introduction to weathering. Students should be posed with the following questions in advance to promote active listening. https://www.youtube.com/watch?v=mQAOe-0vxdc (6:32) mins

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
	 **Erosion** Fill in the blanks using the words at the below: Erosion happens when the _____ gets moved away by _____ or _____. Erosion has formed many different _____ on earth. Sometimes erosion can happen very quickly but usually erosion takes thousands of _____. Wind moves things to other _____. Water moves _____ and _____ to other places. Erosion is different than weathering which dissolves and breaks down rocks or soil but doesn't move rocks or soil. _____ moves rocks and soil. landforms rocks wind water land years sand places Erosion **Retrieved from** https://worksheetplace.com/mf_pdf/Erosion-worksheet.pdf **Game-based Practice with Terminology** Students will be engaged in interactive word wall games on weathering, erosion and deposition. See: https://wordwall.net/resource/12800870/science/weathering-erosion-deposition **Individual Project**: Students will create a booklet on weathering and erosion regarding their community. Their booklet will include	1. What is weathering? Weathering is the process of breaking down or dissolving rocks and minerals. 2. What are the three types of weathering? (Mechanical or physical weathering chemical weathering and biological weathering.) 3. What factors contribute to weathering? Mechanical weathering: Flowing water and blowing wind can chip away at rocks and minerals, Water when it freezes in the cracks of rocks can expand and break them. Animals can trample rocks under foot and chip off pieces. They can also burrow holes through soft rocks or in cracks of rocks. Plant roots can form around rocks and open cracks. The weight of large plants can cause breaks in rocks. Chemical weathering Oxygen can react with metals in the rock to cause a chemical change (think of rusting of your bicycle) Salt in the water can react with certain rocks and break them down Rainwater can contain mild acid from industrial gases from factories. This reacts with rocks like limestone etching them. Ground water can leach (wash through) rocks and dissolve chemicals in the rocks.

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
	descriptions and drawings/pic of examples in their own community. Include 3 pictures (drawn or digital) of weathering in their community and label them as one the three types (mechanical, chemical or biological) (6 marks) Give an example of chemical weathering in their community where rocks may have turned color from exposure to oxygen? (2 marks) Include 3 pictures (drawn or digital) of erosion in their community. (6 marks) For each of those 3 community examples, explain the factors that may have led to the erosion. (6 marks) For those community examples of erosion, what efforts have been made to prevent further erosion? Or what would you suggest should be done to prevent further erosion? (5 marks) Presentation - 5 marks Content - 25 marks **Total - 30 marks** **Research and Response** In a single page response, which may include a picture, answer the two following prompts.	Biological weathering Plants can grow up through existing cracks in rocks and make them bigger. Root systems of plants can push through cracks underground and disturb the rocks in the soil. Root systems on hillsides may help hold soil together but if the weight of a plant is too great, it may topple rocks and cause them to break. Deforestation (removal of trees) can weaken riverbanks and lead to physical weathering. Students, the second process in our waterfall diagram is erosion. In that diagram, water causes the rock pieces to be moved. This is the key difference from weathering, the movement of the rock pieces after they are broken. Erosion occurs when tiny pieces of the Earth's surface are moved from one place to another. This is usually caused by moving water, wind, ice or gravity. As a review of erosion, the teacher may wish to access a read-aloud book online posing "watching questions" before the read-aloud begins. See: **EROSION read aloud for kids**! (9:04 mins) (by Robin Cooks) Students will answer the following questions. 1. Where do we see three examples of erosion in the book? (crack in the building/crack in the road/crumbling building in the hillside) 2. Give examples of erosion that happen quickly and slowly. (rocks tumbling down hillsides, rivers washing pebbles to a valley) 3. List three things which cause erosion?

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
	Why might deforestation be a contributing factor to erosion? What causes landslides and why are they an example of erosion? **Writing About Landforms** Choose a landform in your region that is particularly notable due to the weather and or erosion that has shaped that landform. Draw or capture a digital picture of the landform so the reader can appreciate the subject of your writing. Write a short 5-stanza poem that describes how that landform has been shaped over time and the forces that are responsible. **Rubric:** Picture 5 marks Descriptive poem 5 marks Creativity 2 marks Spelling/Grammar 3 marks	(heavy rain, roaring rivers, melting of glaciers, crashing waves, tsunami, wind) 4. Name two factors which increase the rate of erosion. (heavy rains and high wind) 5. Name a human action that promotes erosion. (cutting down of trees/ removing plants with extensive root systems) 6. What natural sources/disasters can cause erosion? (floods, hurricanes, tsunami) 7. How can we help reduce or slow down erosion? (Building drains to allow water to run away, planting trees along slopes.) The final process in our initial diagram is deposition. Deposition occurs when collected sediment having being eroded, is deposited in a resting place where it may form layers or a bed of sediment. Probably the best example is when particles of rock are broken off and are washed down a hillside and end up at the mouth of a river or stream. When we have storms and heavy rainfall there is more erosion and the build up of deposited sediment is more noticeable. When large amounts of sediment are deposited at the mouth of a river, a delta is formed. The river slows down at the mouth, so it doesn't have the energy to carry all the silt, sand, and clay anymore. These sediments form the flat, usually triangle-shaped land of a delta and can form very fertile soil. Another Example of Erosion and Deposition: The meandering river

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		Let students view and compare the diagram of two rivers and generate a discussion.  Retrieved from https://images.app.goo.gl/ijadAkUZJMVX3Abd7 What do you notice about the flow of water in picture 1 and picture 2? (The water in picture 1 flows in a straight path, but the water in picture 2 flows in a curved path). What do you think caused the curve in picture 2? (When soil and stones erode along the riverbank this causes the water to shift its course and form curves). What effects will that have on the river? (The river will become shallower and flow slower. An oxbow lake might be formed - An oxbow lake is a U-shaped Lake or pool that forms when a wide meander of a river is cut off, creating a free-standing body of water.). Students may view a video on a river meandering and how weathering can potentially begin the process. https://youtu.be/8a3r-cG8Wic?si=kA-nChkbO6bz_F8R (2:57 mins)

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		Possible Field Trip Take students on a field trip to observe weathering and erosion in an area. They will use a worksheet to record their observations. They will report on their findings. 1. What are the factors/agents of weathering in that area? (wind, water, ice, plants, animals) 2. What effects does weathering have on the rocks? (The rocks will get smaller, smoother, and can take different shapes). 3. What caused the land to erode in that area? (moving water, wind) 4. What do you think will happen to the natural landscape if it continues to erode? (Mountain: It will get smaller and smaller and the roads will become narrower/ beach: the rocks will change shape, there will be more sand on the seashore.) Rate of Erosion Experiments You will need to create a water table from a pan r wooden box to do these experiments (see picture below and watch video. These experiments have been adapted from the following website: https://www.maine.gov/dacf/mgs/education/lessons/act15.pdf  Retrieved from https://www.youtube.com/watch?app=desktop&v=-MFLgtti51I

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		(3:34) mins You will need the following: A wooden box or pan with a hole in the bottom end. A watering can with at least 6 litre capacity A protractor to measure angles A pail to catch the water as it runs off the end of the water table Wooden blocks to elevate the table at the upper end. Packed soil to apply to the upper half of the water table. ***You can choose to vary the soil type for each experiment. Mulch such as hay, leaves, pine needles, shredded paper etc. A small pail of pebbles Note: In each of the following tests, approximately the same amount of water will be poured near the top of the table to simulate a heavy rainfall falling on the soil. The soil should be packed approximately 5cms from the top of the table. Experiment #1 The Effect of Incline of the Field Raise the upper end of the water table with wooden blocks to 4 cms and use the protractor to measure the angle of the table to the horizontal. Pour 0.5 litres of water and record in your own words, the effect of erosion on the soil. *be sure to place the pail at the bottom to collect the water run-off. Use wooden blocks to raise the table end to heights indicated below and repeat the experiment completing the data table below.

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies

Table Height (cms)	Angle in degrees	Description of Erosion
4		
7.5		
11.5		
15		
19		

Note: 19 CMS should give you an angle close to 30 degrees which is close to the limit for row crop farming.

Experiment # 2: The Effect of a Check Dam

By the end of experiment #1 you should have created a gully or depression down the middle of your soil. If not, you should add a larger amount of water in a spot near the top to make a gully.
Add pebbles across the gully to make a dam.
Add 0.5 litres of water to your table at the top and describe the impact of the dam on the erosion.

Experiment # 3: The Effect of Contour Plowing

Elevate the upper end of the water table to 15 cms
Smooth out all previous signs of erosion in the soil.
Makea series of 0.5 cm furrows (2.5cms apart) parallel to the direction of the water flow down the table.
Pour 0.5 litres at the top of the table and record your observation with respect to the erosion observed.
Smooth out the soil once again
Make a series of 0.5 cm furrows (2.5cms apart) perpendicular to the direction of the water flow down the table.
Pour 0.5 litres at the top of the table and record your observation with respect to the erosion observed.

<table>
<tr><th>Specific Curriculum Outcomes</th><th>Inclusive Assessment Strategies</th><th>Inclusive Learning Strategies</th></tr>
<tr><td></td><td></td><td>Experiment # 4: The Effect of Mulching
Elevate the upper end of the water table to 15 cms
Smooth out all previous signs of erosion in the soil.
Spread your first mulch type evenly over the soil.
Pour 0.5 litres at the top of the table and record your observation with respect to the erosion observed.
Repeat the above with a range of mulch choices and complete the table below.

<table><tr><td>Mulch Type</td><td>Observation of Erosion</td></tr><tr><td>Hay</td><td></td></tr><tr><td>Leaves</td><td></td></tr><tr><td>Shredded paper</td><td></td></tr><tr><td>Other?</td><td></td></tr></table>
Summative Questions for Students to Answer

At what angle did the slope begin to cause severe erosion?

How effective was contour plowing in slowing erosion? Which approach seem to work the best and why?

What affect did mulching /ground cover have on the erosion process? Did some mulches work better than others?

If you or your peers tested more than one type of soil, how did the results compare? Did some soils resist erosion better in your testing? Which ones and why?</td></tr>
</table>

Additional Resources and Materials

The difference between weathering and erosion. See: https://www.youtube.com/watch?v=QJUs4e2X5Uo (7:14 mins)
Building Stream tables:
https://sciencelessonsthatrock.com/stream-table-erosion-lab/
https://gislab.utk.edu/outreach/diy-stream-table/
Four Types of Water erosion: https://study.com/academy/lesson/water-erosion-lesson-for-kids.html

Preventing Soil Erosion: https://www.youtube.com/watch?v=jYjJktQeUVA (8:37 mins)

The Erosion Song: https://www.youtube.com/watch?v=xBqFq88Bcp4 (1:03 mins)

Weathering and Erosion worksheet: **https://www.liveworksheets.com/w/en/natural-science/1261918**

Cracking up- A Read Aloud About Erosion **https://www.youtube.com/watch?v=V-g30sNrI7k (12:13 mhttps://brainly.com/question/24650448**

Storyboard the Weathering /Erosion /Deposition process: **https://www.storyboardthat.com/storyboards/isabella2507/my-weathering--erosion-and-deposition-journey-**

Additional Useful Content Knowledge for the Teacher:

Weathering and Erosion: https://www.generationgenius.com/weathering-erosion-and-deposition-for-kids/

Weathering/Erosion/Deposition Resources:

- **https://educatorpages.com/site/Riversideschoolscience/pages/weathering-and-erosion-images**
- **https://slideplayer.com/slide/60736**

Opportunities for Subject Integration:

Elements that are integrated across subjects:

Mathematics: measuring angles. Predicting water flow. Tabulating observations.
Language Arts: Vocabulary building word list related to weathering and erosion. Write poems related to erosion and weathering, comprehension passages on erosion. Write a composition/report on weathering and erosion and their effects.
Social- Science: Weathering and erosion – the impact of weathering and erosion on our daily activities and the environment.

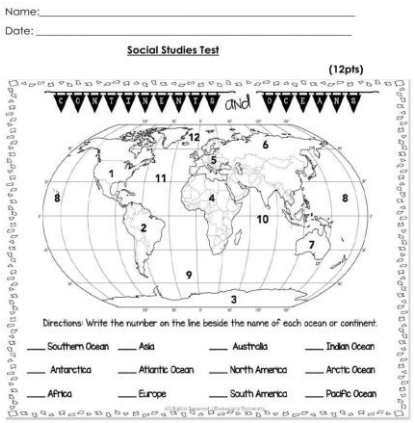
Elements from Local Culture, Technology, TVET, Environment that are integrated:

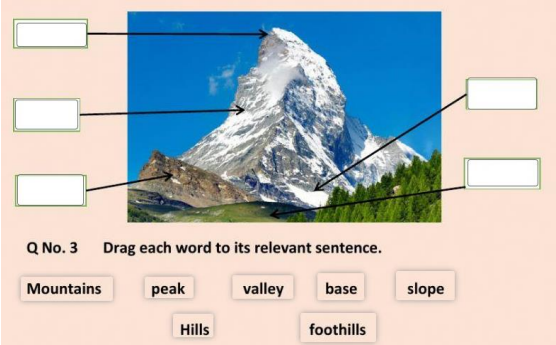
Creativity in designing solutions to reduce the impact of erosion. Awareness of the solution to other parts of the country and the world.

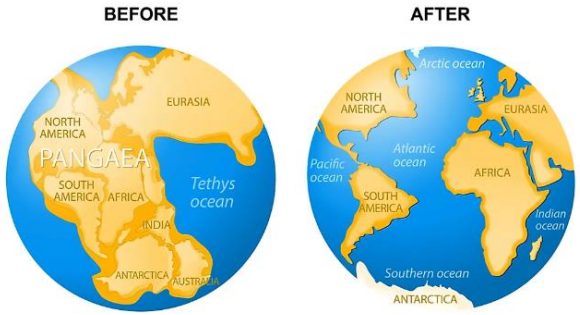
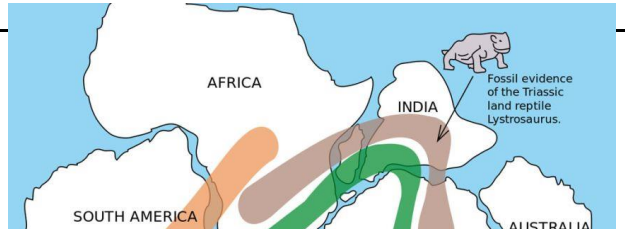
Essential Learning Outcome 3: Analyze and interpret data from maps to describe patterns of Earth's features
[Clarification Statement: Maps can include topographic maps of Earth's land and ocean floor, as well as maps of the locations of mountains, continental boundaries, volcanoes, and earthquakes.]

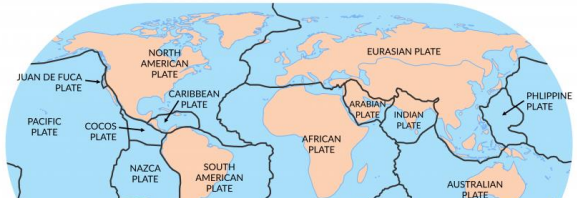
Grade Level Expectations: Refer to grade level expectations at the beginning of this curriculum document

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
Learners are expected to: **Knowledge:** Define the following terms: ➢ Map ➢ Globe ➢ Boundary ➢ Continent ➢ Mountain ➢ Mountain Range ➢ Volcano ➢ Ocean ➢ Ocean trenches ➢ Crust ➢ Ridge ➢ Earthquake ➢ Features ➢ Landscape ➢ Pangaea ➢ Continental drift ➢ Tectonic plates	Students will play the "**continents** and **oceans**" game. How to play: • Teacher will provide game cared which include the names of either "continent" (North America, South America, Africa, Asia, Australia, Antarctica, Europe) or "Ocean" (Arctic, Southern, Pacific, Indian, Atlantic) • Each student will get the opportunity to choose a random card and then locate that feature on a blank map as well as tell the class whether this is a continent or ocean. Students will complete the following worksheet on identifying the continents and oceans.	**Introductory lesson** Teacher will present a large **map** and/or **globe** which displays the world's **oceans** and **continents**.  Retrieved from: https://www.etsy.com/dk-en/listing/269559657/labeled-world-practice-map Teacher will generate discussion by asking students the following questions: **Question: what do you think this image represents and why do you think it is important?** *A map is a drawing of all or part of Earth's surface. Its basic purpose is to show where things are. Maps may show visible features, such as rivers and lakes, forests, buildings, and roads.* *They also show more complex structures such as continents, oceans, mountain ranges, volcanoes and even where earthquakes may occur.* *A map displayed on a round surface is called a globe.* **What are some of the Earth's features which can be found on**

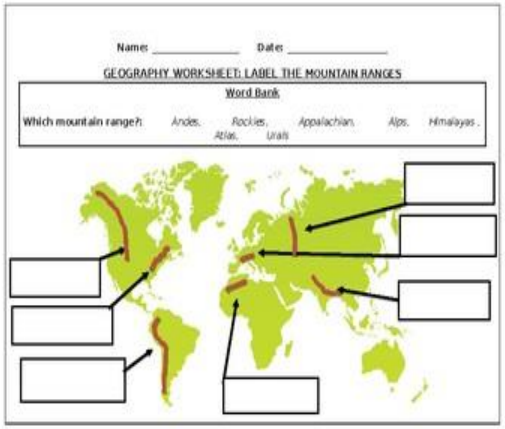
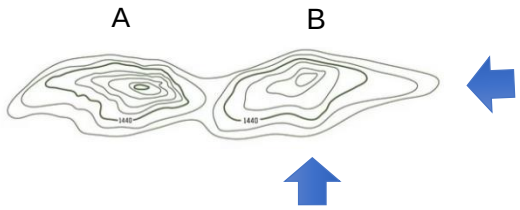
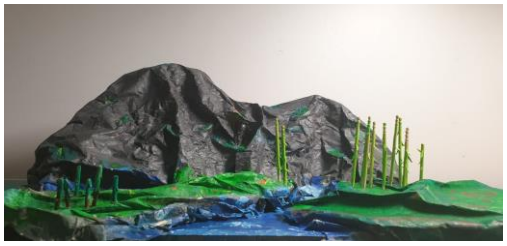
Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
➢ Complementary shapes ➢ Lithosphere ➢ Oceanic crust ➢ Continental Crust ➢ Convergent Boundaries ➢ Divergent Boundaries ➢ Transform fault ➢ Mountain ranges ➢ Summit ➢ Base ➢ Folded Mountains ➢ Fault Block Mountain ➢ Dome Mountains ➢ Continental Shelf ➢ Oceanic Trench ➢ Abyssal Plain ➢ Continental Slope ➢ Continental Rise ➢ Elevation ➢ Contour lines ● Identify on a world map and diagram: mountains, continents, oceans, ocean floor structures, volcanoes and earthquakes areas ● Identify patterns in the location of the earth's	 Name:_____ Date:_____ **Social Studies Test** (12pts) and Directions: Write the number on the line beside the name of each ocean or continent. ___ Southern Ocean ___ Asia ___ Australia ___ Indian Ocean ___ Antarctica ___ Atlantic Ocean ___ North America ___ Arctic Ocean ___ Africa ___ Europe ___ South America ___ Pacific Ocean **Fill the blank to make each statement correct. (9pts)** 1. The largest continent is _____. 2. The smallest continent is _____. 3. No one lives on the continent of _____. Retrieved from: https://www.liveworksheets.com/w/en/social-studies/413955	**a map?** What is meant by **Earth Features**? *(the various landforms which can be seen such as: mountains, continents, oceans, volcanoes, etc.)* Let's discuss some of these **features**: A focused segment of the lesson can be given in which the **map** of the world or **globe** is presented again. Teacher will introduce the words: **continent (a large body of land)** and **ocean (a large body of water)** by writing them on the board. Teacher will ask the students to gather round the map and point out a "large body of land" and a "large body of water". Students will be asked to guess how many **continents** and **oceans** there are by looking at the **map**. Teacher will point to the **map** and identify the seven **continents** and ask students to repeat each name. The same can be done for the **oceans**. Students will watch the following video on the continents and oceans and answer the following questions: *Video #1* *www.youtube.com/watch?v=VGxssWl99U8 (5:54 mins)* 1. How many continents and oceans are there? *(7 continents, 5 oceans)* 2. Name the seven continents. *(Africa, Asia, North America, South America, Antarctica, Australia, Europe)* 3. Name the five oceans. *(Pacific, Atlantic, Indian, Arctic, Southern)* 4. Which is the largest continent? (*Asia*)

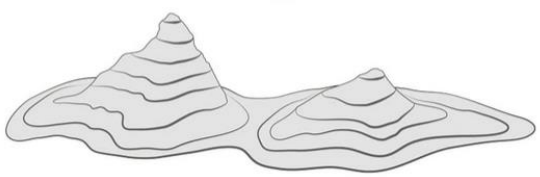
Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
features, e.g. locations of mountain ranges, ocean floor structures, earthquakes and volcanoes • Explain the concept of continental drift. • Relay the evidence and logic that continental drift of the tectonic plates is a viable theory. • Demonstrate an understanding of the use of the terms tectonic plate continent, ocean, mountain range, volcano, earthquake, ocean trench, ocean floor, etc. by using drawings and descriptions • Explain that mountains, volcanoes, earthquakes and ocean trenches are formed because of the movement of tectonic plates. • Explain how the knowledge of the location of mountains, earthquakes and volcanoes affects the lives of people.	Students can play the following game to explore how **tectonic plates** affect our planet:  Retrieved from: https://www.amnh.org/explore/ology/earth/plates-on-the-move2/game  Rubric: 1 mark per question- 5 marks total Retrieved from: https://www.liveworksheets.com/w/en/social-	5. Which is the smallest continent? (*Australia*) 6. Which continent has the largest population (*Asia*) 7. Name two animals found on the continent of Africa (*zebra and giraffe*) 8. The Amazon rainforest is found on which continent? (*South America*) 9. This continent has no human residents (*Antarctica*) Students will also learn the following song: **Song: Continents and Oceans** Tune: London Bridge There are seven continents, Continents, continents There are seven continents, On the earth. North and South American, Africa, Asia Europe and Antarctica Don't forget Australia! There are also five oceans, Five oceans, five oceans There are also five oceans On the earth. Indian, Atlantic, Arctic, Pacific. Then there is the Southern Ocean. That makes five! **Continents Moving?** There is a theory that the continents were once altogether as one land mass (called **Pangaea**) and they slowly over millions of years, began moving apart (called **continental drift**). The map below shows how the current continents could have been together like

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
• Describe an earthquake as a natural occurrence and explain what causes it. (ST 5 LS ECS 15) • Identify volcanic activity as a natural process and explain how volcanoes are formed, as well as the likely impact on the environment. (ST 5 LS ECS 16) • Identify ways in which earthquakes impact the environment. (ST 6 LS ECS 16) • Describe the safety measures to be put in practice during an earthquake, explaining the need for each measure. (ST 6 LS ECS 17) • Explain how volcanoes are formed and discuss the impact that these eruptions cause. (ST 6 LS ECS 18) • Outline useful and harmful effects of the presence of a volcano in their	studies/332305 Students will complete the following live worksheet on labelling a **mountain**: https://www.liveworksheets.com/w/en/social-studies/332305  Students will complete the following mountain ranges quiz: Retrieved from: https://www.geoguessr.com/vgp/3131	puzzle pieces. **What Is Continental Drift?**  Retrieved from: https://www.worldatlas.com/articles/what-is-continental-drift.html This was not just an idea because of **complementary shapes** (pieces that fit together), scientists found evidence that this theory had substance. ***What did they find?*** Scientists found identical fossils on and across the borders of where continents were once joined! Unless they were actually once together as one continent (**Pangaea**) this finding is highly unlikely. 

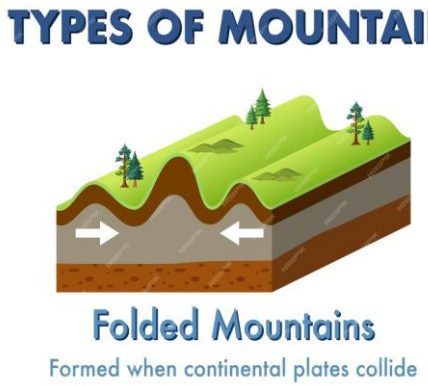
Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
environment. (ST 6 LS ECS 19) **Skills** ● Draw diagrams or formulate models to represent some features of the earth, e.g. an ocean floor, continents, etc. ● Predict locations where earthquakes or volcanoes could take place. ● Use crayons/markers/seeds to locate features of the earth on a blank map, e.g. continents, mountain ranges, volcanoes, trenches, etc. ● Draw diagrams that show that you understand three ways plate boundaries can interact (divergent, convergent and transform). ● Account for how plate interactions can create mountains and furthermore cause earthquakes and volcanoes. ●	**Dome mountain formation activity** Materials for pairs of students: ● tube of toothpaste ● one large index card ● pencil ● dried grass ● scissors ● Procedures: 1. Punch a small, pencil size hole in the index card. 2. Cover the surface of the card with finely cut dried grass to represent rock layers and the surface of the earth. 3. Have one student hold the index card while the other student places the tube of toothpaste under the hole and slowly squeezes until the grass is pushed up into a small dome over the squeezed toothpaste (alternate method – take the cap off the tube of toothpaste, drill a hole in the cap, place the index card hole over the neck of the toothpaste tube, and place the cap back on so the card is fastened between the cap and the tube). Retrieved from: https://geology.utah.gov/map-pub/survey-notes/teachers-corner/teachers-corner-geological-features-and-processes-in-utah-dome-mountains/ Students can also follow the YouTube video below:	Retrieved from: https://education.nationalgeographic.org/resource/continental-drift/ A useful overview of continental drift here: https://www.youtube.com/watch?v=AqrInJ8_Nes&t=1s (6:53 mins) ‘ As we learned before about earth’s layers, the crust of the earth that we walk on each day covers the mantle. That mantle is made up of plates that can actually move around due to the molten core beneath. **Tectonic plates** are pieces of Earth's crust and uppermost mantle, together referred to as the **lithosphere**. The plates are around 100 km (62 mi) thick and consist of two principal types of material: **oceanic crust** and **continental crust**. In the diagram below, the 7 tectonic plates are labeled with black lines. 

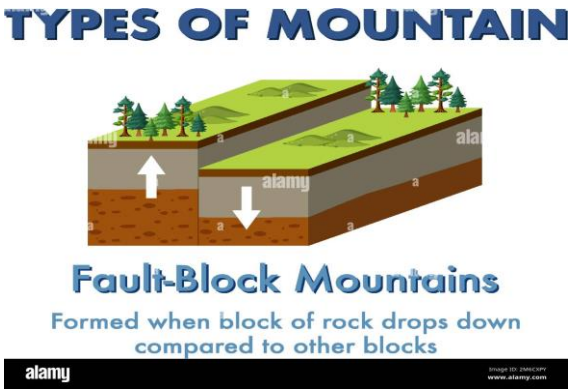
Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
Identify mountains and/or volcanoes in your country and account for why volcanic activity is prevalent in the Caribbean region. • Effectively communicate information based on observation of patterns of the earth's features **Attitudes/Values** • Actively participate in class discussions. • When conducting group work, display sensitivity and offer assistance to peers who may have physical or learning challenges • Work respectfully with each other while analysing maps and charts and videos to describe patterns of earth's features. • Develop awareness that earth events and changes in earth's feature can affect the environment and the lives and habitats of living things	https://www.youtube.com/watch?v=KL8fAnK6y6k Students answer the following questions based on the activity.: 1. What does the toothpaste represent? (*Magma*) 2. What could happen inside the earth that would create the same effect? (*Magma can squeeze and move like toothpaste).* 3. What does the grass represent? *(Rock layers and the surface of the Earth).* 4. How is this landform different from a volcano? (*The magma does not erupt onto the surface of the earth).* **Students complete the following diagram using the words below:** **Andes Rockies Appalachian Alps Himalayas Atlas Urals**	Retrieved from: https://earthhow.com/7-major-tectonic-plates/ **What Happens at the Boundaries of Tectonic Plates?** When the boundaries of tectonic plates are moving, they can cause big changes on the land and under the sea. They can be moving apart (**divergent)** and cause deep rifts in the ocean floor and sometimes magma can move upwards in these rift valleys and form volcanoes underwater. The plates can be colliding (**convergent**) causing volcanoes and new mountain ranges. If the plates are moving horizontally across each other it puts great stress on the crust and a **transform fault** may form with earth movement that could culminate in an earthquake. **PLATE BOUNDARIES** 

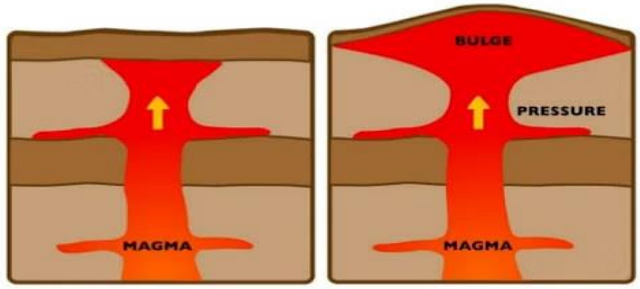
Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
	 Rubric: 1 mark per question- 7 marks total Retrieved from: https://www.madebyteachers.com/products/geography-worksheets-label-the-mountain-ranges/ **Extension Assessment- Topographic Maps** If you were given the following topographic map, and told you could hike the mountain B from the front or from the right, which would be the easier hike and why? 	Retrieved from: https://theory.labster.com/plate_boundaries/ See also: Have students work in pairs as they explore the Mechanisms of Plate Movement media gallery (https://contrib.pbslearningmedia.org/WGBH/conv16/conv16-int-mmes-1/index.html). **Mountains, Volcanoes and Earthquakes**  Retrieved from: https://www.youtube.com/watch?app=desktop&v=PufrYH3xeu8 ***Mountains:*** A mountain is a landform that rises high above its surroundings. Taller than a hill, it usually has steep slopes and a rounded or sharp peak. Mountains are rarely found alone. Groups of mountains are called **mountain ranges**

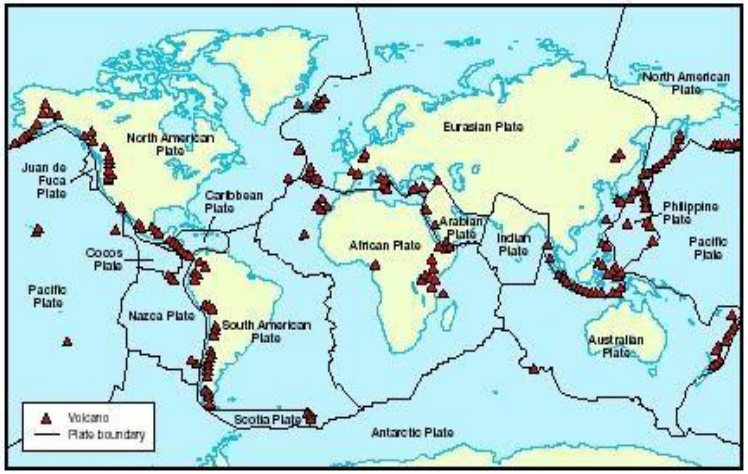
Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
	Teacher: This is the 3d equivalent to show students afterwards. The contour lines on the right are further apart so the slope is more gradual than those on the front and that is reflected in the 3d representation.  Retrieved from: https://www.rei.com/learn/expert-advice/topo-maps-how-to-use.html	Students will look at the following YouTube video and answer the following questions: https://www.youtube.com/watch?v=ZgvAaTZdpLo *(4:33)* 1. What are groups of mountains called? (*ranges*) 2. What are the top and bottom of a mountain called? (*summit, base*) 3. What are two ways which mountains can form? (*volcanic eruptions*, *plate tectonics*) 4. Where are mountains typically found? *(on every continent and beneath the oceans*) 5. What is a mountain system? (*A group of mountain ranges*) The inner chain of the Lesser Antilles developed along a line of weakness in the earth's crust. A series of submarine **volcanoes** formed which rose above sea level to form the islands. These islands are known to be very mountainous. Teacher will generate discussion by asking students the following question: Can you name any **mountains** found in the Caribbean region? Students will be presented with the following map of mountains found in different Caribbean islands.

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		 Photo retrieved from: https://www.freeworldmaps.net/caribbean/map.html Using the map above, students are to complete the following table: **Mountain** | **Island** Pic Du Paradis | *Saint Martin* Mount Gimie | *Saint Lucia* Mount Sage | *British Virgin Islands* Blue Mountain | *Jamaica*

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		Types of mountains **Folded Mountains** Pupils are shown the following diagram of folded mountains.  They are formed when two plates move towards each other. This causes the plates to buckle and pushes the crust upwards, forming a mountain. ● Every student is given a piece of paper ● Each student is asked to push the two ends of the paper towards each other. This will create an upward fold in the paper, ● This is similar to how a fold mountain is formed ● The Himalayas are good example of a range of folded mountains

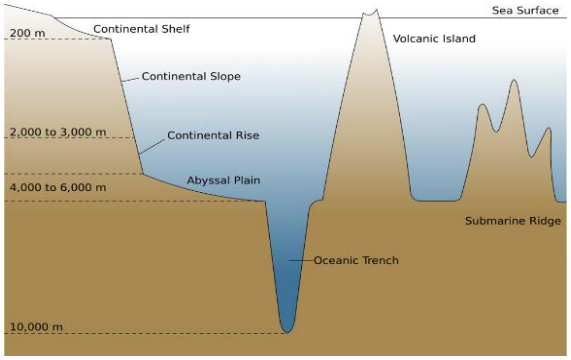
Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		Fault Block Mountain These are formed when two plates move towards each other.  Students are asked how they think a mountain gets it "mountain shape"(*Erosion changes the shape of rocks and land*) Activity ● Have a chocolate bar that represents the rocks in the Earth's plates. ● Break it in half by pulling the two sides apart. ● What happens to the 'rocks' in the middle? Have all the 'rocks' moved downwards? ● How many have moved upwards? ● What would happen if you tried to push the plates back together again? Photos retrieved from: https://www.freepik.com/free-vector/four-different-types-mountains_35822393.htm

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		Dome Mountains  Photo retrieved from: https://prepp.in/news/e-492-dome-mountains-classification-of-mountains-geography-notes Dome mountains are the result of a great amount of molten rock (magma) pushing its way up under the Earth's crust. **Mountain Ranges:** A mountain range is a series of mountains that are connected together generally to form a long line of mountains. There are several mountain ranges which we should know: Himalayas ● Andes ● Alps ● Rockies ● Atlas ● Appalachian ● Ural Students are given the assignment to research the continent where these mountain ranges are found.

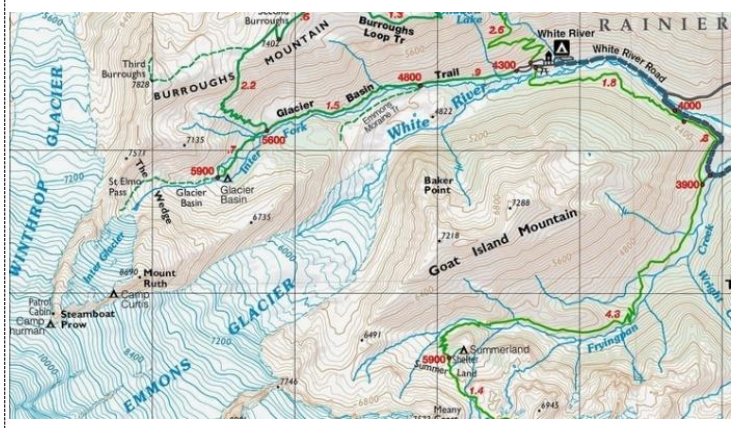
Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		Volcanoes **Class poll**: before the lesson, students are asked the questions below. students will raise their hands to answer. the teacher will write their answers on the board to generate discussion. 1. What is a volcano? (*A volcano is an opening in the Earth's surface. Usually found in a mountain, the opening allows gas, hot magma and ash to escape from beneath the Earth's crust)* 2. Can you name any famous volcanoes in the Caribbean? (*La Soufriere, Morne Watt, La Grande Soufriere*) 3. Do you know where volcanoes occur? (*along fault lines*) Teacher will show students the following map and ask them to answer the following questions to generate discussion.  Retrieved from: http://www.scienceclarified.com/landforms/Ocean-Basins-to-Volcanoes/Volcano.html

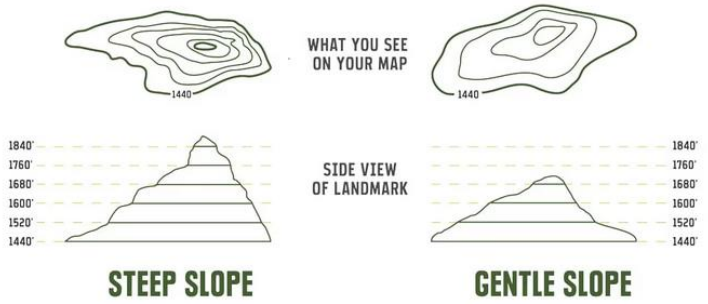
Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		1. What is the first thing you notice about this map? (*continents, oceans, black lines around the continents*) 2. What do you think the black lines and triangles on the map represent? (*triangles-volcanoes, black lines- plate boundaries or fault lines)* 3. What do you notice about the location of all the triangles/volcanoes? *(they are mostly found along the black lines or fault lines)* Teacher will explain to students that this map details the location of volcanoes around the world. Most volcanoes usually occur along the **fault** lines that separate the tectonic plates that make up the Earth's crust. **Volcano formation:** https://www.youtube.com/watch?v=oPZS6U2thyI *(1:53)* **Earthquakes** Students are presented with the following image and are asked to discuss amongst themselves what might have caused the occurrence seen.  Photo retrieved from: https://www.ready.gov/kids/disaster-facts/earthquakes

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		Based on their discussion, the teacher will guide students towards creating their own definition of the word "**earthquake**". ***Earthquakes**: Earthquakes are the shaking, rolling or sudden shock of the earth's surface. They are the Earth's natural means of releasing stress* Students can also discuss their own experiences with earthquakes. Teacher will explain to students that we cannot predict when **earthquakes** will occur, but we can make some kind of prediction as to where they may occur. Most **earthquakes** occur along fault lines as we discussed in the formation of **volcanoes** and **mountains**. **The Ocean Floor Structure** To introduce the topic, the teacher will present the students with the following image to generate discussion. 

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		Retrieved from: https://www.google.com/url?sa=i&url=https%3A%2F%2Fwww.wsj.com%2Farticles%2FSB123748748295986887&psig=AOvVaw3HEP49znGjGOddvm840KK7&ust=1703973919558000 Teacher will use the following questions to probe students' general knowledge: ● What do you think this picture is about? ● Can you imagine a red-hot volcano under the water? ● What do you call an underwater volcano? There are hills, mountains, valleys, and volcanoes on land. ● Did you know that these structures also exist on the ocean floor? The ocean floor has many interesting structures that are also a part of the Earth's crust. ● Can you name any of these underwater features? Let's look at the following diagram of the ocean floor. How many features can you see? 

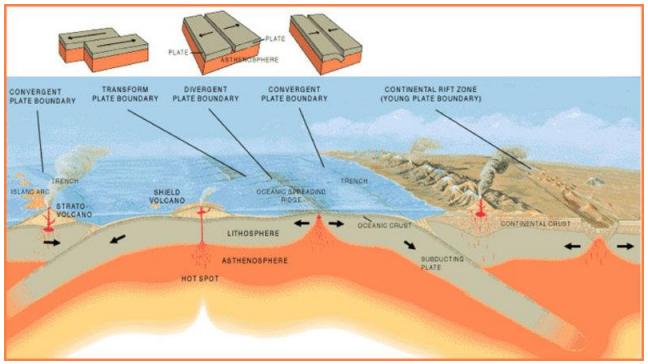
Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		Retrieved from: https://hi-static.z-dn.net/files/d61/24f6631a3015d191971dc9806ad4ac90.jpg Students will watch the following informative video and answer the questions which follow: **https://www.youtube.com/watch?v=KirNCAjA6KY** 3:18 mins***)*** 1. What are some of the various landscapes which we can find on the ocean floor? (*mountains, valleys and plains*) 2. Place the following ocean floor structures in the order they are found. **Continental shelf, oceanic trench, abyssal plain, continental slope, continental rise.** (*continental shelf, continental slope, continental rise, abyssal plain, oceanic trench)* 3. What is one of the flattest places on earth called? (*abyssal plain)* 4. _____ is the name given to large underwater mountains or volcanoes *(seamounts*) 5. What is an ocean trench? *(a "V shaped" valley that is long and narrow and the deepest part on Earth)* **Extension Activity- Reading Topographic Maps** Students, the following is an example of a topographic map. What do you notice that is different from other maps? (*it has lines that join to enclose an area, they aren't circles or ovals, but they join and they never cross*)

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		 Retrieved from: https://www.rei.com/learn/expert-advice/topo-maps-how-to-use.html What do you think these lines mean? (*maybe they have something to do with the height of the land*?) When are describing the height of land we use the word **elevation.** The lines are called **contour lines,** and they make sort of a wobbly circle!

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		Look at the following diagrams. You should note a few important features of this type of map tool. **1)** The inner wobbly circles are the highest elevation. **2)** If the wobbly circles on the outside are close that means the hill is steep. **Contour lines indicate the steepness of terrain.** Contour lines connect points that share the same elevation: Where they're close together (they never intersect), elevation is changing rapidly in short distance and the terrain is steep. Where contour lines are wide apart, elevation is changing slowly, indicating a gentle slope.  Retrieved from: https://www.rei.com/learn/expert-advice/topo-maps-how-to-use.html

Additional Resources and Materials

Earthquakes: https://www.youtube.com/watch?v=dJpIU1rSOFY (3:42 mins)



Retrieved from: https://oceanexplorer.noaa.gov/facts/media/plate-boundaries-800.jpg

Plate tectonics: https://www.youtube.com/watch?v=bVn04eJRjV4&t=1s

Divergent/Convergent/Transform Plates see: https://theory.labster.com/plate_boundaries/

Additional Useful Content Knowledge for the Teacher:
Plate tectonics and earthquakes: https://www.pbslearningmedia.org/resource/ess05.sci.ess.earthsys.lp_earthquakes/earthquakes/

Opportunities for Subject Integration: *(Additional ideas about how the inclusive learning strategies might be adapted and/or applied to include other subjects in the curriculum)*

Elements that are integrated across subjects:

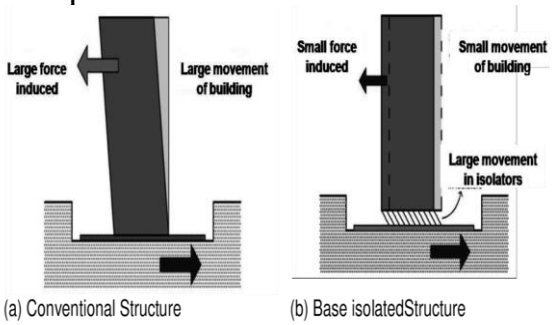
- **Mathematics:** creation of models and analysis of data to describe earth features and their formation. Reading and interpreting contours on maps
- **Language Arts:** Develop and use vocabulary words to describe various earth features and their formation over time in essay type questions.
- **Social- Science:** Analyzing maps to locate and name the various Earth features such as mountains and volcanoes around the region and the world.

- **HFLE:** Understand the importance of map reading skills as it relates to the impact of volcanoes and earthquakes
- **Elements from Local Culture, Technology, TVET, Environment that are integrated:**

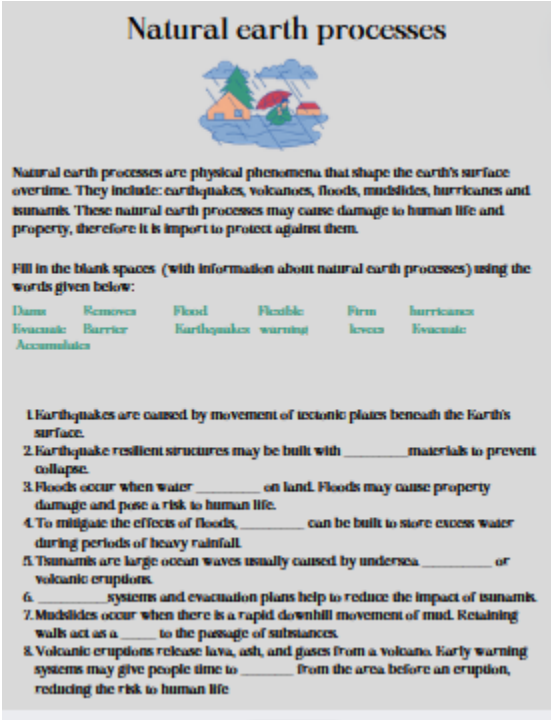
Essential Learning Outcome 4: Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans [Clarification Statement: Examples of solutions could include designing an earthquake resistant building and improving monitoring of volcanic activity.] [Assessment Boundary: Assessment is limited to earthquakes, floods, tsunamis, and volcanic eruptions.]
Grade Level Expectations: Refer to grade level expectations at the beginning of this curriculum document

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
Learners are expected to: **<u>Knowledge:</u>** Define the terms: Earthquake Flood Volcanic eruption Tsunami Hurricane Mudslides Risk assessment Risk reduction Describe causes of Earthquakes Hurricanes floods tsunamis volcanic eruptions mudslides	**Community Solutions to Combat Flooding** Students to be presented with the following scenario, which they will research and work on and present to the class: Imagine that a community in your country keeps flooding every time it rains. This poses a safety risk for the people living there and when it rains heavily people's property gets damaged also. You would like to address this flood problem. Create a plan for dealing with this, considering factors such as land use and building construction. How would your plan help to reduce the impact of floods in your community? **<u>Answer Key:</u>** land use (Any 3 properly explained-6 marks) Restriction of construction in flood prone areas- Reduces risk to people and their property as they will less likely experience flooding Proper drainage- Reduces accumulation of water Building levees- Prevents water from the sea and rivers reaching the land	Students will observe the following picture:  Retrieved from: https://reliefweb.int/sites/default/files/styles/large/public/images/reports/df/bf/dfbf354c-8a09-35ce-8136-b283c9cc3086.jpg

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
Describe mechanisms of Earthquakes Hurricanes floods tsunamis volcanic eruptions mudslides Assess risks associated with natural earth processes (hurricanes, floods, tsunami and earthquakes) Demonstrate an understanding of monitoring systems used for detection of different natural earth processes Explain the significance of early warning signals in reducing the impact of natural earth processes Demonstrate an understanding of structural factors that contribute to the stability of buildings Apply understanding of structural principles to ensure that buildings can withstand seismic forces Describes methods of reducing flooding and the impacts of flooding Apply understanding of structural principles to designing of buildings that	Building dams and reservoirs-Store excess water during periods of heavy rainfall, reducing the impact of flooding Structures (Any 1 properly explained- 2 marks Building elevated structures- Prevents water from easily accumulating in buildings Using waterproof materials-Prevents water easily going into structures **Hurricane Resistant House** Draw a picture of a hurricane resilient house or an earthquake resilient house, including features that would allow the house to have this characteristic.  Retrieved from: https://acropolis-wp-content-uploads.s3.us-west-1.amazonaws.com/hurricane-proofing-hero.gif	Ask students: "What do you think of when you see this?" (students to discuss based on prior knowledge – (Hurricane/damaged houses/strong winds) Ask students: "Have you ever experienced an earthquake, hurricane, flood, volcano or tsunami?" "Have you heard of anyone else who has?" "What was the experience like?" (students to discuss, based on prior experiences) Students will create models (using paper/cotton/foil/ play dough) depicting earthquakes, flood, volcano and tsunami. Students will be asked to describe model and its causes and mechanisms Example of tsunami model: 

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
are able to withstand the force of a tsunami Describe methods of reducing the impacts of mudslides Describe an earthquake as a natural occurrence and explain what causes it. (ST 5 LS ECS 15) Identify ways in which earthquakes impact the environment. (ST 6 LS ECS 16) Describe the safety measures to be put in practice during an earthquake, explaining the need for each measure. (ST 6 LS ECS 17) Explain how volcanoes are formed and discuss the impact that these eruptions cause. (ST 6 LS ECS 18) Outline useful and harmful effects of the presence of a volcano in their environment. (ST 6 LS ECS 19) **<u>Skills</u>** Brainstorm with peers the ways to reduce the impact or prepare for forces of nature such as hurricanes, volcanoes, mudslides etc.	**Earthquake resilient house**  Retrieved from: https://www.researchgate.net/publication/292982602/figure/fig2/AS:391364413018148@1470319955592/Principles-of-conventional-and-base-isolated-structure.png **Include:** ***Hurricane resilient house***-window shutters, elevated house, gently sloping roof, roof secured to house, walls made of concrete or treated wood ***Earthquake resilient house***- House containing pads placed between foundation and building, house made of flexible material (e.g. wood or steel) **What has your community done?** Interview community leaders to determine the precautions they have put in place in the extreme likelihood that hurricanes will invariably impact the Caribbean region. Write a report outlining	Retrieved from: https://pbs.twimg.com/media/EHbjEGPXkAA_ku8?format=jpg&name=medium Important points: Causes and mechanisms of natural earth processes: Earthquake-Forceful shaking of the earth caused by movement of tectonic plates beneath the earth's surface Volcanic eruption-A release of magma from the earth's crust as a result of a build up of pressure Tsunami-Massive Ocean waves caused by underwater earthquakes or volcanoes Hurricane- A powerful tropical cyclone that develops because of warm ocean temperatures. They bring heavy rainfall and strong winds Flood-Build up of excess water on land. Floods typically occur because of heavy rainfall or storms Mudslide-A rapid downslope movement of water, soil and rocks, often occurring due to heavy rainfall **Flooding** Students observe the following picture: 

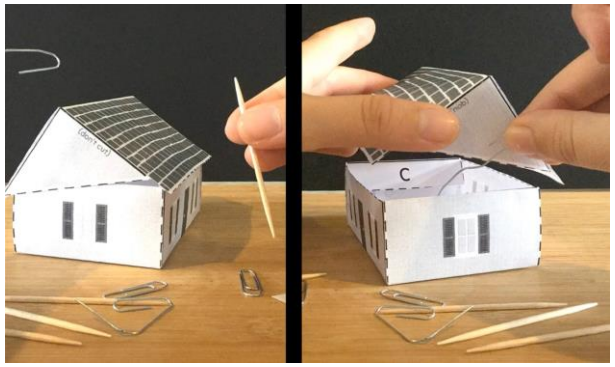
Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
Identify the problems in their community with respect to the natural forces. Problem solve solutions to the challenges that arise form natural forces. Secure feedback from leaders of the community on how to prepare for and mitigate problems. Predict how a building's design would affect its ability to withstand the effect of natural earth processes Observe and identify features of buildings that make them resilient to natural earth process Design a simple earth-resistant structure using everyday material Design a simple structure that would be appropriate for a tsunami prone area **Attitudes/Values** Develop a sense of concern for persons affected by natural earth processes	the precautionary strategies you found n your various interviews. Create posters highlighting the importance of preparedness and early warning systems in mitigating against the risks associated with a hurricane, tsunami or volcanic eruption. **Scoring Rubric:** Content: 5 marks Visual appearance: 5 marks Creativity: 5 marks **Response to Impending Natural Event** Students may assume different roles and work together simulating a response to one of the natural earth processes. Students are placed into groups of 6 to work on the following: Imagine that a hurricane/ volcanic eruption/ flood/tsunami was likely in the next 48 hours. work together as a group to simulate an appropriate response. Persons in the groups are to be assigned various roles e.g. government official, citizen, police, national disaster coordinator Include: Activation of early warning system, Activation of disaster plan, securing of property, ensuring that surroundings are appropriate, opening of shelters, evacuation	Retrieved from: https://dominicanewsonline.com/news/wp-content/uploads/2011/09/flooding-in-Dominica5.jpg The Teacher asks: "What do you observe here?" (destruction by-flooding) "How can flooding affect us (flood waters damage property, may pose a danger to people) "How can we reduce the impact of flooding?" (building stronger houses, putting barriers along waterways, moving away from flood prone areas) What do you see in this picture that may help prevent flooding?  Retrieved from: https://www.youtube.com/watch?v=cCZWkMXJwQE (1:11 mins) Based on the picture or the complete video, groups should assemble responses to the following questions: How does this method reduce the impact of flooding? Do you think it would be effective? Is there anything else that could be done to further reduce impacts?

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
Appreciate the importance of developing resilient structures that can withstand the effects of natural earth processes Appreciate the importance of paying attention to early warning signals so as to reduce the impact of natural earth processes Value practices that lead to flood prevention Recognize the importance of teamwork and collaboration in mitigating against the effects of natural earth processes	Students will complete the following worksheet about natural earth processes  **Natural earth processes** Natural earth processes are physical phenomena that shape the earth's surface overtime. They include: earthquakes, volcanoes, floods, mudslides, hurricanes and tsunamis. These natural earth processes may cause damage to human life and property, therefore it is import to protect against them. Fill in the blank spaces (with information about natural earth processes) using the words given below: Dam Removes Flood Flexible Firm hurricanes Evacuate Barrier Earthquakes warning levees Evacuate Accumulates 1. Earthquakes are caused by movement of tectonic plates beneath the Earth's surface. 2. Earthquake resilient structures may be built with _____materials to prevent collapse. 3. Floods occur when water _____ on land. Floods may cause property damage and pose a risk to human life. 4. To mitigate the effects of floods, _____ can be built to store excess water during periods of heavy rainfall. 5. Tsunamis are large ocean waves usually caused by undersea _____ or volcanic eruptions. 6. _____systems and evacuation plans help to reduce the impact of tsunamis. 7. Mudslides occur when there is a rapid downhill movement of mud. Retaining walls act as a _____ to the passage of substances. 8. Volcanic eruptions release lava, ash, and gases from a volcano. Early warning systems may give people time to _____ from the area before an eruption, reducing the risk to human life Retrieved from: https://www.canva.com/design/DAF4MrZ1-nA/c9oJezDa8CVQ7Uvj2ADAJQ/edit?utm_content=DAF4MrZ1-nA&utm_campaign=designshare&utm_medium=link2&utm_source=sharebutton	Each group will present one method to the class Important points Effect of flooding: Floodwaters may damage property, be a danger to persons and cause contamination of our drinking water We may reduce the impact of floods by: Building levees and floodwalls along rivers and the coast to prevent water from reaching the land Building dams and reservoirs that can store excess water during periods of heavy rainfall and then reduce it gradually Preventing people from building in flood prone areas Building elevated buildings, above the expected level of water during a storm Using waterproof materials in building Having proper drainage to allow water to leave the affected area Having early warning systems to allow persons to plan for floods or evacuate from flood prone areas if necessary Dredging rivers- Removes debris from river beds, improving the flow of water reducing the likelihood of it overflowing its banks Hurricanes Students to observe the following picture again: 

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
	Project: Students will choose topics related to resilience and present to the class. Topics include: **My future disaster resilient house**- (Explain how you are going to design your future house. Include special features that would allow it to withstand a particular natural earth process) **How my community became hurricane, flood, tsunami resilient**- (Discuss mechanisms that can be put in place in a community to ensure that it is more resilient to one of the natural earth processes. Include-early warning systems, building codes, structures such as drains and levees, processes such as river dredging) **The reason why we were so badly affected by the last major flood/ volcanic eruption/ hurricane/ mudslide/earthquake in my country**-(Include methods of risk reduction for the particular disaster and what was lacking in the particular case that resulted in so much damage being done) **<u>Scoring Rubric:</u>** Content; 10 marks Organisation: 5 marks Use of language: 3 marks	Retrieved from: https://reliefweb.int/sites/default/files/styles/large/public/images/reports/df/bf/dfbf354c-8a09-35ce-8136-b283c9cc3086.jpg Ask students: "What are some risks associated with hurricanes?" (Hurricanes bring strong winds and rain that can damage houses, crops and injure people) "Do you think that we can build a house that is able to withstand a hurricane?" (maybe with the right design and materials) "What special features should these (hurricane resilient) houses have?" (made of strong materials, secure roofs, protected windows, elevated to reduce flooding) Those are great ideas…let us look at what professional builders suggest in this diagram: (review each point with the students) 

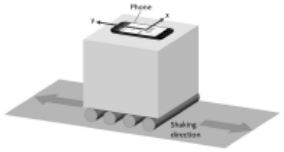
Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		Retrieved from: http://www.ccearch.com/hurricane-resistant-design.html Students to listen to the following read-aloud story: Tree House in a Storm | a Book about Hurricanes for kids https://www.youtube.com/watch?v=YZqsQji-Jpo (0-12:00 mins) Students to discuss how the impact of hurricanes can be reduced, following from the story. Questions: How did the family try to minimize the impact of the storm? (reinforcing structures, protecting windows, evacuating) Is there anything else that they could do to prevent or reduce damage? (cut down trees) Is there anything that made the hurricane shelter stronger? (It was built out of brick) Are there any other features that could make a house more hurricane resilient? (houses with secured roofs, elevated structures) Why were some of the houses damaged? (Made of weak materials, uncovered windows) Do you think having early warning systems helped? How? (Yes, as it gave time for preparation)

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		Important points Risks associated with hurricanes: High winds-Damages houses, throws down trees Storm surge- May cause flooding, damage structures, injure people Flooding-Damages structures, may injure people Landslides- Damages structures, causes loss of crops, may injure people Features of a hurricane resilient house: Window shutters and impact resilient glass to prevent debris shattering windows Walls made of concrete or specially treated wood which would be stronger Elevated house to prevent flooding Gently sloping roofs that are strongly secured to the rest of the house to prevent its removal during high winds Students in groups will be provided with the following materials: play dough, straws, popsicle sticks, toothpicks, paper clips, straws, aluminum foil, manila paper, construction paper, glue, tape, scissors. Students will discuss in groups how they would design their house to be hurricane resilient. Groups will first sketch their design and then work together to construct the hurricane resilient house.

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		Example of structure:  Retrieved from: https://images.app.goo.gl/XLibvswJiZvdfug97 Students will present their work to the class, they may use a fan of varying speeds or a spray bottle to show how their house is able to withstand the effects of wind and rain. Students should explain why they chose their particular design

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		Earthquakes Students observe the following picture:  Retrieved from: https://www.dpsninc.org/images/Earthquake-Portsmouth2.jpg Ask students: "Can an earthquake really damage a house in such a manner?" (Expected answer-yes) "What can we do to prevent this?" (build stronger houses that can withstand earthquakes) Students to view the following video (on constructing earthquake resilient houses): Earthquakes for kids |Earthquake proofed buildings explained |Earthquake Facts for Kids |Earthquakes

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		https://www.youtube.com/watch?v=PHaiuE028AI (1.01 min) Testing Earthquake Resistant Structures with a Teacher -built Tester A construction project for teachers to make from an overturned table and bungee cords. The structure can be place on the platform held up the bungees on four corners. Students can build and test "earthquake-resistant "buildings.  Photograph of a Classroom Model for Testing Structures Used with permission (G MacKinnon) Testing The Earthquake Resistant House with a Phone App Students to complete the following worksheet where they construct and test a model of an earthquake resilient house:

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		Build an Earthquake-Resistant House!—Page 2 Name: _____ **Directions:** Follow these steps to test your earthquake-resistant house. After testing, try to modify your design to make it better and repeat these steps. Record the results for each test in your data table. **2. Test your house at your desk** a. Attach an object that weighs about as much as the phone to the top of the house. b. Shake the cardboard base back and forth. Use a ruler and a stopwatch to measure and time how you shake the cardboard (for example, +/-1cm, 15 times in 10 seconds). Shake it the same way for each test you do. c. Observe how much the house moves. *Does it move as much as the cardboard does? Does it appear to stay in place while the cardboard moves back and forth under it?* **3. Test your house using a sensor app such as phyphox** a. Take your house to the classroom testing station. b. Use double-sided tape to attach the phone to the top of your house, with the screen facing up and the phone's long direction lined up with the direction you will shake the house. c. Open the acceleration (without g) function in the phyphox app and go to the "Absolute" tab to measure the absolute acceleration. Then press the play button to start the recordings for your measurements (ask your teacher if you need help using the phyphox app). d. Shake the cardboard base back and forth using a ruler and stopwatch to measure your shaking. e. Stop recording and make sure to save your data. f. Review your graph and record the maximum accelerations in the table. With the pick data tool in the app you can select individual data points in your graph to view their values.  | Test #	Maximum acceleration (m/s²)
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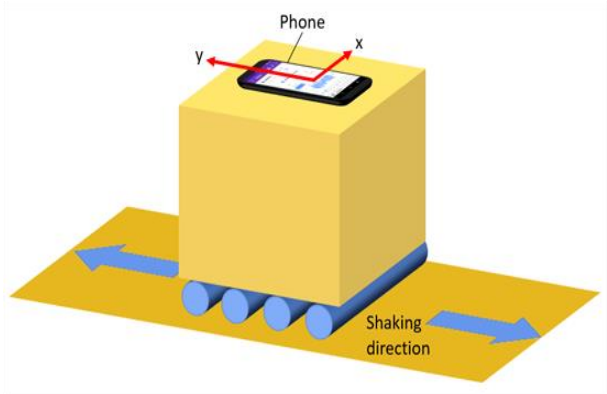
1	
2	
3	
4	
5		 Retrieved from: https://www.sciencebuddies.org/Files/8636/25/ScienceBuddies-Earthquake-worksheet-phyphox.pdf Testing the structures: Earthquake-Resistant Building Lesson Plan with Google's Science Journal app https://www.youtube.com/watch?v=FfrFYW4TDQQ (2.36 mins)

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		 Retrieved from: https://encrypted-tbn0.gstatic.com/images?q=tbn:ANd9GcREGqbotRbXto6Tzft0lVLbX98CQhyOREbAQ4Y2OzeenXgMhjd6rlis1ZPiNB4d7CEklfE&usqp=CAU Students will present their structures to the class, explaining their choice of design Important points Effect of earthquakes on houses: Forces may cause the walls or roof to collapse Features of an earthquake resilient house:

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		Contain isolation pads that are placed between the building and foundation that are able to absorb seismic energy and reduce the amount transmitted to the building. Are built with flexible structures such as wood and steel that are able to bend and move without breaking Contain strong foundations that are properly anchored in order to withstand seismic forces **Volcanoes and Tsunamis** Working individually, students will observe the following videos: Vincy Voices - Lessons From La Soufriere Short Film https://www.youtube.com/watch?v=Cz-GYXemZKs (7.46 mins) NTCES CH6 2004 Indian Ocean Tsunami Lessons Learnt https://www.youtube.com/watch?v=jrKaH0jjAYs (1.53 mins) They will then write a passage describing how they would prepare to reduce the risks associated with an imminent volcanic eruption and tsunami in their country – What should the government do? (Notify citizens when a disaster may be more likely to occur, provide shelters that citizens may access if evacuation becomes necessary) What should the citizens do? (Act fast when a warning is given, secure property, evacuate properly) Students should emphasize the need for early warning systems (Allows for efficient preparation to reduce the risks associated with these disasters). Important points:

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		Reducing the risk of volcanoes and tsunamis: Scientists use instruments such as seismometers to detect earthquakes and they observe and measure volcanic gases. These can provide an indication of an impending volcanic eruption. Underwater earthquakes and volcanic eruptions can lead to tsunamis. We are therefore able to determine beforehand that an event may be approaching. Early warning systems are important in reducing the risks associated with volcanoes and tsunamis. These allow for procedures such as evacuation and securing property that reduce injury and property damage. It also gives communities the opportunity to take necessary precautions such as opening shelters. Citizens should have an emergency plan that come into effect when warnings are given **Mudslides** Students will observe the following picture 

Specific Curriculum Outcomes	Inclusive Assessment Strategies	Inclusive Learning Strategies
		Retrieved from: https://media-cldnry.s-nbcnews.com/image/upload/t_fit-760w,f_auto,q_auto:best/ap/645d2dd6-c0ce-4d81-bdaf-ca9db4afa53f.jpg Students to discuss the picture. Questions "How can mudslides affect us?" (Mudslides may damage homes, cause loss of crops and threaten human life) "How can we reduce the impact of mudslides?" (Do not build in mudslide prone areas, plant trees/ do not cut down trees on slopes/ build retaining walls) Important points The force of following mud can pose a danger to people, damage structures and cause loss of crops. It can also result in blockage of roadways and interruption and delays in transportation. In order to reduce the impact, we should not build in areas prone to mudslides. We should also ensure that there is adequate tree cover on the slopes by planting and not cutting down trees. This reduces the impact of erosion. Retaining walls can also be built as barriers to the passage of substances. Finally, early detection is also important to allow for plans and evacuation if bad weather such as heavy rainfall is expected.

Additional Resources and Materials

New Ways of Flood proofing Homes *https://www.chiefscientist.qld.gov.au/__data/assets/image/0027/49662/property-modification-lrg.jpg*

Eight Tips for Building Hurricane Safe Homes: https://www.dth.com/our-learning-center/homeowner-tips/8-tips-for-building-hurricane-safe-homes/

Child's Project (Earthquake proof building): Earthquake Proof Buildings? Science Fair Project with Justin (5:57 mins)
Earthquake proof buildings: https://www.youtube.com/watch?v=9N8iQ9Ch8nw (5.57 mins)

Pinellas County fifth graders learn about the STEM of building hurricane houses!
https://www.youtube.com/watch?v=7CLiOMqPJ50 (2.22 mins)

5 Methods of Flood Protection - Flood Control Asia
https://www.youtube.com/watch?v=-0e2wZ32CAA (3.08 mins)

How to Prepare for a Volcanic Eruption: https://www.youtube.com/watch?v=Z-w_z9yobpE (133 mins)

How to Prepare in Case of a Tsunami | Disasters
https://www.youtube.com/watch?v=m7EDddq9ftQ&t=13s (2.08 mins)

Additional Useful Content Knowledge for the Teacher:
NASA Resource for Earth Systems Lesson Planning**:** https://mynasadata.larc.nasa.gov/all-earthsystem-lesson-plans
Unit Plan:
https://nj02202607.schoolwires.net/cms/lib/NJ02202607/Centricity/domain/39/ngss%20science%20maps/4th%20grade%20science%20curriculum%202017.pdf

Opportunities for Subject Integration: *(Additional ideas about how the inclusive learning strategies might be adapted and/or applied to include other subjects in the curriculum)*

Elements that are integrated across subjects:

- **Mathematics:** Creation of graphs showing seismic activity or hurricane data over a period of time
- **Language Arts:** Develop and use vocabulary related to resilience and these natural earth processes, use these topics for writing assignments (e.g. descriptive writing where students are asked to describe the scene after the occurrence of one of these natural earth processes
- **Social- Science:** Mechanism of development of these natural earth processes, response of communities to those processes

- **HFLE:** Examine the psychological impact of these processes on individuals living in affected areas
- **Elements from Local Culture, Technology, TVET, Environment that are integrated: Construction of structures that are able to withstand these natural earth processes**