

Week 7: Recreational Diving

Many people enjoy visiting coral reefs to witness the marine ecosystems. Boaters, snorkelers, scuba divers, free divers, and spear fisherman all visit the coral reefs around the world. Scuba diving has been a popular recreational activity for over 50 years. As scuba diving has gained popularity so has the impact the divers have made on the environment, both positively and negatively. Like any tourist spot, divers have affected coral reefs. The industries near corals reefs benefit from the tourists who want to visit the reefs, such as the hotels, restaurants, transportation services, and scuba businesses. However, with tourist traffic comes some negative consequences, like littering, anchor damage to corals, and coral damage from careless divers. While tourists do not mean to cause harm to the environment it seems to happen in areas with high traffic. In an attempt to combat these negative impacts educational classes, rules and regulations, and new technology have been developed and enacted to help lessen the human impacts on the reefs. The recreational diving organization PADI, teach diving students to control their buoyancy in order to avoid hitting the corals. They also have AWARE specialties that teach divers about the impacts of humans on the environments, for example Shark Aware specialties focus on the impacts of humans on the shark populations.

Permanent mooring lines have also been established at popular dive sites so that boats do not have to drag anchors on the bottom possibly harming the corals. Florida laws have also been passed in support of the use of the mooring lines. According to state law, if there is a mooring line open boaters are not allowed to drop anchor in that area. If boaters do not follow these laws, they are subjected to heavy fines. While the mooring lines and the educational programs do not completely stop, the negative effects of tourists they do help lessen the impact.

Exercise 1:

Rubber Band Energy

Materials:

- Rubber bands
- tape measure (multiple tape measures make this easier but are not necessary)
- ruler
- tape or chalk (to mark where the location of the firing line)

Teachers: You will need a flat open area to do this lab such as a field or gym. Depending on the weather, you could modify this to be done in the classroom if needed.

Have students predict what will happen when they pull back on a rubber band and then release it. Ask them to predict if the rubber band will travel further if it is pulled back further. Have the students make a table or hand out copies of the table below. Divide the class up into groups of three students (again this depends on class size). One student will be the rubber band launcher, one student will be the spotter, and one will measure. The students will be investigating the distance the rubber band is stretched vs. the distance it travels. The stretch distances are 5cm, 10cm, 15cm, 20cm, 25cm, and 30cm. Using the tape or chalk mark a line on the ground where the students will launch the rubber bands. Have the launcher stand behind the marked line, pull the rubber band back the needed distance, and let the rubber band fly. The third student needs to hold the ruler and measure the rubber band stretch right before it is launched. The spotter will then run to where the rubber band landed from and mark it. Next, the students will measure the distance traveled by measuring from the marked line to the rubber band. This distance will be recorded on the table in the appropriate box. This is repeated for each of the distances. This allows everyone in the group a chance to be the launcher.

Chart:

Stretch distance in cm	5cm	10cm	15cm	20cm	25cm	30cm
Example:	1m	1.5m	4m	5.2m	5.9m	6m
Group 1						
Group 2						
Group 3						
Group 4						
Group 5						
Group 6						

Group 7						
Group 8						
Group 9						
Group 10						
Class Average						

What is happening?

There are two main types of energy, potential energy, and kinetic energy. Potential energy is stored energy. A ball sitting on the top of a hill is an example of potential energy. It is not moving yet but it has the potential to roll down the hill. The rubber band being stretched is potential energy. Potential energy can come from the position of the object relative to other objects such as the ball is sitting at the top of the hill.

Just by being positioned at the top of the hill gives the ball potential energy. Potential energy can also come from the stress within itself such as the rubber band being stretched. The Kinetic energy is the energy of a body or a system with respect to the motion of the body or of the particles in the system. That means that kinetic energy is the energy that is in motion. Moving water and wind are examples of kinetic energy.

The rubber band flying through the air is also kinetic energy. Energy can easily change forms. The potential energy stored in the stretched rubber band changes into kinetic energy when the rubber band is released. Another example of energy changing forms would be on a roller coaster. When the coaster is climbing the hill it is using kinetic energy because it is in motion but the moment the car stops on top of the hill it has potential energy. When the coaster comes down the hill, it changes back into kinetic energy. The more energy that is stored the more energy can become kinetic energy so the more the rubber band is stretched the more kinetic energy it will have and the farther it will travel. A ball that is sitting on top of a high hill will have more potential energy and more kinetic energy (it will travel faster) than a ball that is sitting on a small hill.

How this relates to Jessica and Bruce:

This week's lecture was on recreational diving. While many recreational divers just dive, some recreational divers become interested in sports like spearfishing. According to the Florida spearfishing regulations, spearfishing is "the catching or taking of a fish through the instrumentality of a hand or mechanically propelled, single or multi-pronged spear or lance, barbed or barbless, operated by a person swimming at or below the surface of the water". Spear fishermen use a slingshot type of gun that shoots a spear or lance into a fish. Spear fishermen rely on the energy stored in the rubber bands to shoot the spear. They can adjust how far/fast the spear goes by adjusting the number of rubber bands they use. Spear fishing is quickly gaining popularity both recreationally and commercially. Commercially spear fishing gets just the target fish, which means that there is no accidental by catch.

Definitions:

-Kinetic energy: the energy of a body or a system with respect to the motion of the body or of the particles in the system.

-Potential energy: The energy possessed by a body by virtue of its position relative to others, stresses within itself, electric charge and other factors.

Questions:

1. What is potential energy?
2. What is kinetic energy?
3. What are some examples of kinetic energy?
4. What are some examples of potential energy?
5. How does the stretched distance affect the distance traveled?

Related topics:

Overfishing

Exercise 2:

Hydropower

Easy Introduction

Materials:

- Plastic spoons (8)
- hot glue/hot glue gun
- marker
- sharp knife or X-acto knife
- scissors
- 2 corks
- 1 wooden skewer or knitting needle
- sewing thread or thin string
- Sink (if using outdoors a water hose)
- Duct tape
- Large funnel
- paper clips
- small objects to lift

Teachers:

Hydropower can be a complicated topic. You can adjust this up or down to suit the level of your students. Here are some helpful links to modify this activity.

<http://www.juliantrubin.com/fairprojects/renewableenergy/waterenergy.html>

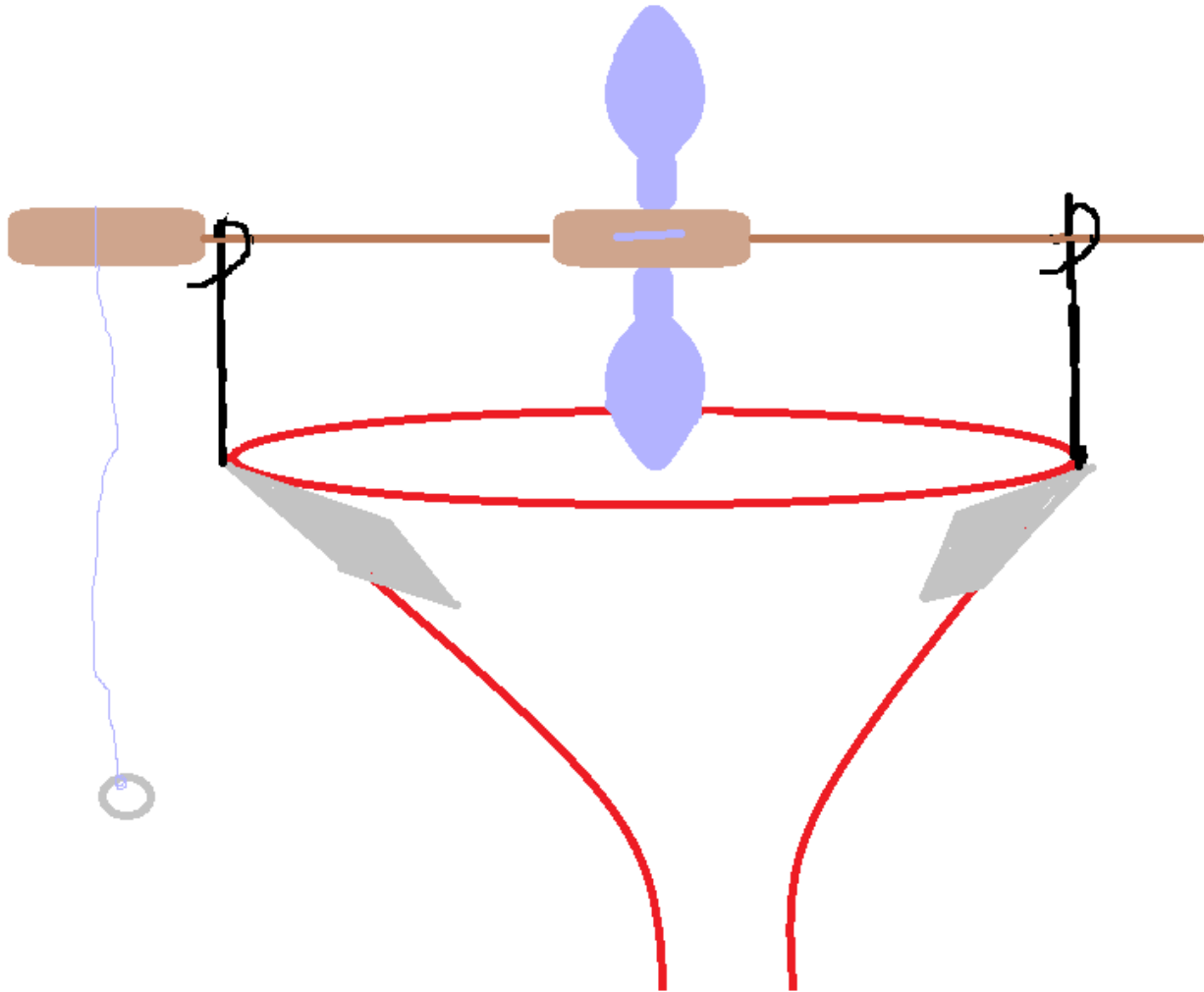
For an easier version:

<http://dteenergy.com/pdfs/hydroKids.pdf>

For a more advanced version:

http://www.sciencebuddies.org/science-fair-projects/project_ideas/Energy_p021.shtml#procedure

First, push the wooden skewer into the center of one end of the cork. Push the skewer all the way through and position the cork in the center of the skewer. Cut the spoon handles off leaving just enough of the handle to use to attach to the cork (about 1-1.5cm). Glue the spoons onto the cork so they are evenly spaced and face the same way. Depending on the size of the cork will depend on the number of spoons. For a standard wine cork about eight spoons should work. Un-bend the paper clips once so that you have an "s" shape. Now take the top end of the paper clip wire and bend it to make a loop to hold your skewer. This loop should be large enough to allow the skewer to spin freely when placed inside. Do this to both paper clips and then attach the clips to the side of your bowl or funnel using duct tape. Make sure that the top loops of the clip are high enough to give the spinning spoons clearance from the edge of the bowl. Slide the skewer into the loops of the paper clips. At one end of the skewer, attach the second cork by pushing the skewer through the center of one end of the cork. Tie the string tightly around the second cork. Cut the loose end of the string so that when an object is tied to the cork it hangs below the hydropower setup. Tie a small household object to the loose end of the string. Pour water over the spoons and watch as it raises the object. Have the students try with other small objects.



What is happening?

This experiment demonstrates the basic concepts of hydropower. The water is the potential energy because it is above the ground and it has the potential to fall due to the forces of gravity. The moving water is kinetic energy that is exerting force on our water wheel, or turbine. The rotational force that causes the turbine to rotate is known as torque. When the turbine turns the skewer and the second cork it causes the string to wrap around the cork and lift the small objects. This is a form of mechanical energy.

This is similar to what happens in a dam that produces electricity. The water will flow through a turbine located on the inside of the dam. The other side of the turbine is connected to a generator, which converts the energy from the spinning turbine into electricity. This electricity is then distributed to the nearby city to provide power to the city.

How this relates to Jessica and Bruce:

Scientists are currently trying to find a better source for renewable energy. One avenue that scientists are exploring is from wave motion from the ocean. Renewable energy from wave motion is not commercially used yet. However, there are some types of generators that have been created and work. One example is the point absorber wave energy converter. These are very similar to the mooring buoys. An anchor holds it into the ground and a line that runs to the surface of the water where a buoy is attached.

There are various different configurations of the point absorbers. One configuration has a small turbine in the linkage from the sea floor to the buoy. When the buoy is lifted by the wave, it pulls on the rope that causes the turbine to contract. When the wave passes and the buoy settles, back to the original position the turbine expands.

This contracting and expanding motion is what the generator uses to produce the electric energy.

Jessica and Bruce are living 25ft underwater but they still rely on energy. How do they get the electricity? They have to have the electricity ran from the surface, much like using a large extension cord to have power outside your house. If they were in an area where waves were constant, they could use one of the point absorber energy converters and they could make their own electricity. If they could do that, they would be less reliant on the surface support systems. This would greatly reduce the operating costs of having underwater habitats and it would make long-term underwater habitation closer to a reality.

Definitions:

-Torque: a twisting force that tends to cause rotation

-Mechanical energy: The energy of an object or a system due to its motion or its position. It is the sum of the potential and kinetic energy.

-Renewable energy: energy from a source that does not deplete when used such as wind or solar power.

-Turbine: a machine for producing continuous power in which a wheel or rotor, typically fitted with vanes, is made to revolve by a fast moving flow of water, steam, gas, air or other fluid.

-Kinetic energy: the energy of a body or a system with respect to the motion of the body or of the particles in the system.

-Potential energy: The energy possessed by a body by virtue of its position relative to others, stresses within itself, electric charge and other factors.

-Hydropower: is power derived from the energy of falling water and running water, which may be harnessed for useful purposes.

Questions:

1. What is mechanical energy?
2. What is the potential energy in this experiment?
3. What is the kinetic energy in this experiment?
4. How is this experiment similar to dams that create electricity?
5. What would be some advantages and disadvantages of having point absorber wave energy converters?

Related topics:

- renewable energy
- wave energy
- environmental effects of power plants
- "fish stairs" at dams

Exercise 3:

Water Surveys

Materials:

- water samples from lake, pond, or aquarium
- Microscopes
- pictures of micro-organisms found in typical water samples (this may vary by location)
- slides
- cover slips

Teachers if you do not have access to microscopes it is possible to do a virtual version of this.

<http://www.microscopy-uk.org.uk/ponddip/>

<http://micro.magnet.fsu.edu/moviegallery/pondscum.html>

Have students write out a description of the water source. What are the estimated size, depth, and average temperature? What are some environmental contaminants that are nearby? Have the students list out the biotic and abiotic factors. Have students make and look at wet mounts of the water sample. To make a wet mount simply drop a small drop of the water sample onto the middle of a clean dry slide. Place the cover slip on the edge of the water droplet and lower the cover slip down at an angle.

Depending on the size of the class and the availability of materials, it may be more feasible to make one or two wet mounts and pass them around the class. Have students find and identify organisms that are present in the slide.

Helpful sources:

http://www.funsci.com/fun3_en/guide/guide1/micro1_en.htm

<http://www.microscopy-uk.org.uk/index.html?http://www.microscopy-uk.org.uk/pond/index.html>

What is happening?

Looking at a water sample can tell a scientist a lot about the health of the ecosystem. The role of microorganisms is varied from decomposer, to oxygen production, some

are parasites and some have symbiotic relationships with higher organisms, but they are vital to the health of the ecosystem. If there are environmental factors such as pollution, the ecosystem can be negatively affected. By knowing what type of microorganism is common to a specific area scientists can tell if the ecosystem is stressed by the presence or absence of a particular microorganism. Some common microorganisms that the students probably saw are paramecium, cyanobacteria, diatoms, rotifers, mosquito larvae, and algae. For a more complete guide see the above links.

How this relates to Jessica and Bruce:

One problem that scientists have to face when they are trying to implement anything new to the natural environment is they need to understand how it may affect the environment. For example, the point absorber wave energy converter seems harmless enough but scientists need to study the effects that they may have on the immediate ecosystem. One possible impact is the sound frequency that is generated within the turbine. If the sound frequency is loud enough it may drive away fish populations. Power plants and dams also affect the environment. While they are good for the surrounding communities, they also can have a negative impact on the local ecosystems. The immediate area around a power plant may for example have a slightly higher temperature than the water would have if the power plant was not there. This increase in temperature may be minute to some of the higher animals such as the fish but to a microorganism, this slight water change may have a huge impact. Scientists can take samples at various spots near and around the power plant and compare them to previous data or data from other spots on the river to determine if the power plant is affecting the local environment.

Organizations like Reef.org and Reef Check train divers to survey coral reefs. They work on a volunteer basis and the volunteers work in teams to collect data about what wildlife is present at a particular site. The data is then uploaded so that other scientists can access the data and help determine if the sites are healthy or if something is affecting the dive sites. These surveys are done on reefs all across the world. Some sites have been surveyed for multiple years, which give scientists a good record of what is normal for that area. These surveys can act like a snapshot of the reef. If every year a snapshot is taken scientists can compare the reef's health to the previous year and can determine if the health of the reef is declining or increasing. If scientists did not have these surveys they would not know what is normal for that reef and they would not be able to determine if the reef was healthy or not.

Definitions:

-Microorganism: microscopic organisms especially a bacterium, virus or fungus

-Protists: Protists are eukaryotic and mostly unicellular organisms. Protists are very large, diverse group of organism, including the plant-like protists, fungi-like protists, and the animal-like protists.

-Ecosystem: a biological community of interacting organisms and their physical environment

-Biotic: of or relating to living things especially in their ecological relations

-Abiotic: physical rather than biological; not derived from living organisms

Questions:

1. What does biotic mean?
2. What is an ecosystem?
3. What biotic factors could contribute to the population of microorganism seen in the water sample?
4. What abiotic factors could contribute to the population of microorganism seen in the water sample?
5. How could a power plant or a point absorber wave energy converter affect the immediate area?

Related topics:

Reef.org

Reef check

PADI AWARE

Local fish surveys

Links:

Rubber bands

http://www.sciencebuddies.org/science-fair-projects/project_ideas/ApMech_p017.shtml#procedure

<http://scienceline.ucsb.edu/getkey.php?key=3473>

<http://www.joediveramerica.com/page/jda/diving-snorkeling-spearfishing#v8mKPkjvC6ezWk0r.99>

Hydropower:

<http://www.education.com/science-fair/article/water-produce-energy/>

http://www.ducksters.com/science/environment/wave_and_tidal_energy.php

http://www.ucsusa.org/clean_energy/our-energy-choices/renewable-energy/how-hydrokinetic-energy-works.html

<http://water.usgs.gov/edu/hyhowworks.html>

Bill Nye

<https://www.youtube.com/watch?v=btLU2lb3-xs> (energy)

Water Surveys:

<http://sciencespot.net/Pages/pondsurvey.html>

<http://www.sciences360.com/index.php/roles-of-microorganisms-in-ecosystems-17985/>

Answers:

1. What is potential energy?
 - a. The energy possessed by a body by virtue of its position relative to others, stresses within itself, electric charge and other factors.
2. What is kinetic energy?
 - a. The energy of a body or a system with respect to the motion of the body or of the particles in the system.
3. What are some examples of kinetic energy?
 - a. Answers vary. The answers should have some kind of movement involved.
 - b. Running water, a roller coaster traveling downhill, a ball rolling downhill, rubber band flying, etc.
4. What are some examples of potential energy?
 - a. Answers vary. The answers should not have movement involved.
 - b. Bucket of water sitting on top of the desk, ball sitting on top of a hill, roller coaster at the peak of the hill, a rubber band stretched etc.
5. How does the stretched distance affect the distance traveled?
 - a. The more the rubber band is stretched the farther it will travel
1. What is mechanical energy?
 - a. The energy of an object or a system due to its motion or its position. It is the sum of the potential and kinetic energy.
2. What is the potential energy in this experiment?
 - a. Water sitting above the setup
3. What is the kinetic energy in this experiment?
 - a. Water pouring over the spoons. The spoons spinning and the object lifting is also kinetic energy.
4. How is this experiment similar to dams that create electricity?
 - a. They use water movement to turn a turbine. The turbine in this experiment was the spoons on the cork.
5. What would be some advantages and disadvantages of having point absorber wave energy converters?
 - a. Answers will vary
 - b. Examples of advantages: Offshore operations would be able to generate their own electricity and they would not be as dependant on surface or land support. Point absorber wave energy converters could be a new source of electricity that uses renewable resources.
 - c. Examples of disadvantages: They may have negative impacts on ecosystems. They may be costly to build or maintain. It may be costly to connect the point absorber wave energy converters to the shore where the electricity would be needed.
1. What does biotic mean?
 - a. Of or relating to living things especially in their ecological relations
2. What is an ecosystem?

- a. A biological community of interacting organisms and their physical environments
- 3. What biotic factors could contribute to the population of microorganism seen in the water sample?
 - a. Answers will vary. Healthy levels of food and low levels of predators
- 4. What abiotic factors could contribute to the population of microorganism seen in the water sample?
 - a. Answers will vary. Ideal water conditions, pH, salinity, temperature. Low levels of pollution.
- 5. How could a power plant or a point absorber wave energy converter affect the immediate area?
 - a. Answers will vary

Tennessee State Standards:

Grade 6 :Embedded Inquiry

Conceptual Strand

Understandings about scientific inquiry and the ability to conduct inquiry are essential for living in the 21st century.

Guiding Question

What tools, skills, knowledge, and dispositions are needed to conduct scientific inquiry?

Grade Level Expectations

GLE 0607.Inq.1 Design and conduct open- ended scientific investigations.

GLE 0607.Inq.2 Use appropriate tools and techniques to gather, organize, analyze, and interpret data.

GLE 0607.Inq.3 Synthesize information to determine cause and effect relationships between evidence and explanations.

GLE 0607.Inq.4 Recognize possible sources of bias and error, alternative explanations, and questions for further exploration.

GLE 0607.Inq.5 Communicate scientific understanding using descriptions, explanations, and models.

Checks for Understanding

0607.Inq.1 Design and conduct an open-ended scientific investigation to answer a question that includes a control and appropriate variables.

0607.Inq.2 Identify tools and techniques needed to gather, organize, analyze, and interpret data collected from a moderately complex scientific investigation.

0607.Inq.3 Use evidence from a dataset to determine cause and effect relationships that explain a phenomenon.

0607.Inq.4 Review an experimental design to determine possible sources of bias or error, state alternative explanations, and identify Questions for further investigations.

0607.Inq.S Design a method to explain the results of an investigation using descriptions, explanations, or models.

State Performance Indicators

SPI 0607.Inq.1 Design a simple experimental procedure with an identified control and appropriate variables.

SPI 0607.Inq.2 Select tools and procedures needed to conduct a moderately complex experiment.

SPI 0607.Inq.3 Interpret and translate data in a table, graph, or diagram.

SPI 0607.Inq.4 Draw a conclusion that establishes a cause and effect

relationship supported by evidence.

SPI 0607.Inq.5 Identify a faulty interpretation of data that is due to bias or experimental error.

Grade 6 : Embedded Technology & Engineering

Conceptual Strand

Society benefits when engineers apply scientific discoveries to design materials and processes that develop into enabling technologies.

Guiding Question

How do science concepts, engineering skills, and applications of technology improve the quality of life?

Grade Level Expectations

GLE 0607.T/E.1 Explore how technology responds to social, political, and economic needs.

GLE 0607.T/E.2 Know that the engineering design process involves an ongoing series of events that incorporate design constraints, model building, testing, evaluating, modifying, and retesting.

GLE 0607.T/E.3 Compare the intended benefits with the unintended consequences of a new

GLE 0607.T/E.4 Describe and explain adaptive and assistive bioengineered products.

Checks for Understanding

0607.T/E.1 Use appropriate tools to test for strength, hardness, and flexibility of materials.

0607.T/E.2 Apply the engineering design process to construct a prototype that meets certain specifications.

0607.T/E.3 Explore how the unintended consequences of new technologies can impact society.

0607.T/E.4 Research bioengineering technologies that advance health and contribute to improvements in our daily lives.

0607.T/E.5 Develop an adaptive design and test its effectiveness.

State Performance Indicators

SPI 0607.T/E.1 Identify the tools and procedures needed to test the design features of a prototype.

SPI 0607.T/E.2 Evaluate a protocol to determine if the engineering design process was successfully applied.

SPI 0607.T/E.3 Distinguish between the intended benefits and the unintended consequences of a new technology.
technology.

SPI 0607.T/E.4 Differentiate between adaptive and assistive engineered products (e.g., food, biofuels, medicines, integrated pest management).

Grade 6: Standard 10 - Energy

Conceptual Strand 10

Various forms of energy are constantly being transformed into other types without any net loss of energy from the system.

Guiding Question 10

What basic energy related ideas are essential for understanding the dependency of the natural and man-made worlds on energy?

Grade Level Expectations

GLE 0607.10.1 Compare and contrast the three forms of potential energy.

GLE 0607.10.2 Analyze various types of energy transformations.

GLE 0607.10.3 Explain the principles underlying the Law of Conservation of Energy.

Checks for Understanding

10607.10.1 Compare potential and kinetic energy.

10607.10.2 Create a poster that illustrates different forms of potential energy.

0607.10.J Design a model that demonstrates a specific energy transformation.

0607.10.4 Explain why a variety of energy transformations illustrate the Law of Conservation of Energy.

State Performance Indicators

SPI 0607.10.1 Distinguish among gravitational potential energy, elastic potential energy, and chemical potential energy.

SPI 0607.10.2 Interpret the relationship between potential and kinetic energy.

SPI 0607.10.3 Recognize that energy can be transformed from one type to another.

SPI 0607.10.4 Explain the Law of Conservation of Energy using data from a variety of energy transformations.

Grade 7 : Embedded Inquiry

Conceptual Strand

Understandings about scientific inquiry and the ability to conduct inquiry are essential for living in the 21st century.

Guiding Question

What tools, skills, knowledge, and dispositions are needed to conduct scientific inquiry?

Grade Level Expectations

GLE 0707.Inq.1 Design and conduct open- ended scientific investigations.

GLE 0707.Inq.2 Use appropriate tools and techniques to gather, organize, analyze, and interpret data.

GLE 0707.Inq.3 Synthesize information to determine cause and effect relationships between evidence and explanations.

GLE 0707.Inq.4 Recognize possible sources of bias and error, alternative explanations, and questions for further exploration.

GLE 0707.Inq.5 Communicate scientific understanding using descriptions, explanations, and models.

Checks for Understanding

0707.Inq.1 Design and conduct an open-ended scientific investigation to answer a question that includes a control and appropriate variables.

0707.Inq.2 Identify tools and techniques needed to gather, organize, analyze, and interpret data collected from a moderately complex scientific investigation.

0707.Inq.3 Use evidence from a dataset to determine cause and effect relationships that explain a phenomenon.

0707.Inq.4 Review an experimental design to determine possible sources of bias or error, state alternative explanations, and identify questions for further investigation.

0707.Inq.5 Design a method to explain the results of an investigation using descriptions, explanations, or models.

State Performance Indicators

SPI 0707.Inq.1 Design a simple experimental procedure with an identified control and appropriate variables.

SPI 0707.Inq.2 Select tools and procedures needed to conduct a moderately complex experiment.

SPI 0707.Inq.3 Interpret and translate data in a table, graph, or diagram.

SPI 0707.Inq.4 Draw a conclusion that establishes a cause and effect relationship supported by evidence.

SPI 0707.Inq.5 Identify a faulty interpretation of data that is due to bias or experimental error.

Grade 7 : Embedded Technology & Engineering

Conceptual Strand

Society benefits when engineers apply scientific discoveries to design materials and processes that develop into enabling technologies.

Guiding Question

How do science concepts, engineering skills, and applications of technology improve the quality of life?

Grade Level Expectations

GLE 0707.T/E.1 Explore how technology responds to social, political, and economic needs.

GLE 0707.T/E.2 Know that the engineering design process involves an ongoing series of events that incorporate design constraints, model building, testing, evaluating, modifying, and retesting.

GLE 0707.T/E.3 Compare the intended benefits with the unintended consequences of a new technology.

GLE 0707.T/E.4 Describe and explain adaptive and assistive bioengineered products.

Checks for Understanding

0707.T/E.1 Use appropriate tools to test for strength, hardness, and flexibility of materials.

0707.T/E.2 Apply the engineering design process to construct a prototype that meets certain specifications.

0707.T/E.3 Explore how the unintended consequences of new technologies can impact society.

0707.T/E.4 Research bioengineering technologies that advance health and contribute to improvements in our daily lives.

0707.T/E.5 Develop an adaptive design and test its effectiveness.

State Performance Indicators

SPI 0707.T/E.1 Identify the tools and procedures needed to test the design features of a prototype.

SPI 0707.T/E.2 Evaluate a protocol to determine if the engineering design process was successfully applied.

SPI 0707.T/E.3 Distinguish between the intended benefits and the unintended consequences of a new technology.

SPI 0707.T/E.4 Differentiate between adaptive and assistive engineered products (e.g., food, biofuels, medicines, integrated pest management).

Grade 7 : Standard 11 - Motion

Conceptual Strand 11

Objects move in ways that can be observed, described, predicted, and measured.

Guiding Question 11

What causes objects to move differently under different circumstances?

Grade Level Expectations

GLE 0707.11.2 Apply the equation for work in experiments with simple machines to determine the amount of force needed to do work.

GLE 0707.11.3 Distinguish between speed and velocity.

GLE 0707.11.4 Investigate how Newton's laws of motion explain an object's movement.

GLE 0707.11.5 Compare and contrast the basic parts of a wave.

GLE 0707.11.6 Investigate the types and fundamental properties of waves.

Checks for Understanding

0707.11.2 Compete an investigation to determine how machines reduce the amount of force needed to do work.

0707.11.3 Summarize the difference between the speed and velocity based on the distance and amount of time traveled.

0707.11.4 Recognize how a net force impacts an objects motion.

0707.11.5 Create a graphic organizer to illustrate and describe the basic parts of a wave.

0707.11.6 Compare how transverse and longitudinal waves are produced and transmitted.

State Performance Indicators

SPI 0707.11.1 Differentiate between the six simple machines.

SPI 0707.11.2 Determine the amount of force needed to do work using different simple machines.

SPI 0707.11.3 Apply proper equations to solve basic problems pertaining to distance, time, speed, and velocity.

SPI 0707.11.4 Identify and explain how Newton's laws of motion relate to the movement of objects.

SPI 0707.11.5 Compare and contrast the different parts of a wave.

SPI 0707.11.6 Differentiate between transverse and longitudinal waves in terms of how they are produced and transmitted.

Grade 8 : Embedded Inquiry

Conceptual Strand

Understandings about scientific inquiry and the ability to conduct inquiry are essential for living in the 21st century.

Guiding Question

What tools, skills, knowledge, and dispositions are needed to conduct scientific inquiry?

Grade Level Expectations

GLE 0807.Inq.1 Design and conduct open- ended scientific investigations.

GLE 0807.Inq.2 Use appropriate tools and techniques to gather, organize, analyze, and interpret data.

GLE 0807.Inq.3 Synthesize information to determine cause and effect relationships between evidence and explanations.

GLE 0807.Inq.4 Recognize possible sources of bias and error, alternative explanations, and questions for further exploration.

GLE 0807.Inq.5 Communicate scientific understanding using descriptions, explanations, and models.

Checks for Understanding

0807.Inq.1 Design and conduct an open-ended scientific investigation to answer a question that includes a control and appropriate variables.

0807.Inq.2 Identify tools and techniques needed to gather, organize, analyze, and interpret data collected from a moderately complex scientific investigation.

0807.Inq.3 Use evidence from a dataset to determine cause and effect relationships that explain a phenomenon.

0807.Inq.4 Review an experimental design to determine possible sources of bias or error, state alternative explanations, and identify questions for further investigation.

0807.Inq.5 Design a method to explain the results of an investigation using descriptions, explanations, or models.

State Performance Indicators

SPI 0807.Inq.1 Design a simple experimental procedure with an identified control and appropriate variables.

SPI 0807.Inq.2 Select tools and procedures needed to conduct a moderately complex experiment.

SPI 0807.Inq.3 Interpret and translate data into a table, graph, or diagram.

SPI 0807.Inq.4 Draw a conclusion that establishes a cause and effect relationship supported by evidence.

SPI 0807.Inq.5 Identify a faulty interpretation of data that is due to bias or experimental error.

Grade 8 : Embedded Technology & Engineering

Conceptual Strand

Society benefits when engineers apply scientific discoveries to design materials and processes that develop into enabling technologies.

Guiding Question

How do science concepts, engineering skills, and applications of technology improve the quality of life?

Grade Level Expectations

GLE 0807.T/E.1 Explore how technology responds to social, political, and economic needs.

GLE 0807.T/E.2 Know that the engineering design process involves an ongoing series of events that incorporate design constraints, model building, testing, evaluating, modifying, and retesting.

GLE 0807.T/E.3 Compare the intended benefits with the unintended consequences of a new technology.

GLE 0807.T/E.4 Describe and explain adaptive and assistive bioengineered products.

Checks for Understanding

0807.T/E.1 Use appropriate tools to test for strength, hardness, and flexibility of materials.

0807.T/E.2 Apply the engineering design process to construct a prototype that meets certain specifications.

0807.T/E.3 Explore how the unintended consequences of new technologies can impact society.

0807.T/E.4 Research bioengineering technologies that advance health and contribute to improvements in our daily lives.

0807.T/E.5 Develop an adaptive design and test its effectiveness.

State Performance Indicators

SPI 0807.T/E.1 Identify the tools and procedures needed to test the design features of a prototype.

SPI 0807.T/E.2 Evaluate a protocol to determine if the engineering design process was successfully applied.

SPI 0807.T/E.3 Distinguish between the intended benefits and the unintended consequences of a new technology.

SPI 0807.T/E.4 Differentiate between adaptive and assistive engineered products (e.g., food, biofuels, medicines, integrated pest management).

National Standards:

Middle School Earth and Space Science:

Human Impacts:

1. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment. MS-ESS3-3
 - a. Clarification Statement: Examples of the design process include examining human environmental impacts, assessing the kinds of solutions that are feasible, and designing and evaluating solutions that could reduce that impact. Examples of human impacts can include water usage (such as the withdrawal of water from streams and aquifers or the construction of dams and levees), land usage (such as urban development, agriculture, or the removal of wetlands), and pollution (such as of the air, water, or land).
 - b. Assessment Boundary: none

Middle School Physical Science:

Forces and Interactions:

1. Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object. MS-PS2-2
 - a. Clarification Statement: Emphasis is on balanced (Newton's First Law) and unbalanced forces in a system, qualitative comparisons of forces, mass and changes in motion (Newton's Second Law), frame of reference, and specification of units.
 - b. Assessment Boundary: Assessment is limited to forces and changes in motion in one-dimension in an inertial reference frame and to change in one variable at a time. Assessment does not include the use of trigonometry.

Energy:

1. Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system. MS-PS3-2
 - a. Clarification Statement: Emphasis is on relative amounts of potential energy, not on calculations of potential energy. Examples of objects within systems interacting at varying distances could include: the Earth and either a roller coaster cart at varying positions on a hill or objects at varying heights on shelves, changing the direction/orientation of a magnet, and a balloon with static electrical charge being brought closer to

a classmate's hair. Examples of models could include representations, diagrams, pictures, and written descriptions of systems.

- b. Assessment Boundary: Assessment is limited to two objects and electric, magnetic, and gravitational interactions.

Middle School

Engineering Design

1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions MS-ETS1-1
 - a. Clarification Statement: none
 - b. Assessment Boundary: none