# Week 9: Wrap up and connections

Globally we are connected by water. Everyone on the planet needs water to survive. About 70% of the earth's surface is covered in water and only a fraction of that is freshwater. The demand for freshwater far outweighs the supply and if humans are not careful we will have a water crisis. Some places are already experiencing shortages of water. This week is all about connections. Sometimes it is hard for people to understand the importance of something if they are personally not connected or involved. "Why should I care what happens to the ocean I live in the desert thousands of miles away from the ocean?" This week the labs are all geared towards helping make these connections.

Here are a few introduction videos about the importance of water

https://www.youtube.com/watch?v=Iht9WBBXepA

https://www.youtube.com/watch?v=lC6BR7vYS28 (cartoon musical for younger kids)

https://www.youtube.com/watch?v=oNWAerr_xEE (what is groundwater)

**Exercise 1**:

Water Cycle

**Materials:**

-large plastic or glass bowl

-coffee mug

-hot water

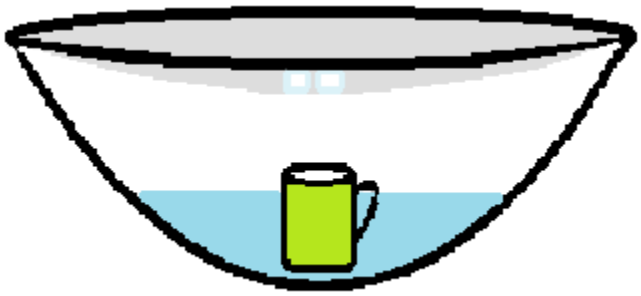
-ice

-plastic wrap

-tape or a rubber band to secure plastic wrap

In this activity, we will be making a model of the water cycle. To do this we will need a large plastic or glass bowl and a coffee mug. Pour hot water into the bottom of the

bowl and place the coffee mug in the center of the water. Make sure the coffee mug stays dry on the inside when you set it down. Now cover the bowl with plastic wrap and secure the edges with a rubber band or tape. Now place a couple of ice cubes in the center of the plastic wrap above the coffee mug. You want the plastic to be a little heavy in the middle to direct the water droplets into the mug. Now wait for about 10-20 minutes. Carefully remove the plastic wrap and the ice, be careful not to let any ice water spill into the mug. What do you see inside the mug?



**What is happening**?

The water cycle is happening! The hot water represents our oceans/lakes/rivers etc. We used the hot water to speed up the process. It would have worked the same if we had used room temperature water and placed the setup in the sun. The water molecules become so spread out and excited because of the heat they will evaporate into a gas. When the water vapor cools because of the ice, it will condense back into a liquid state on the plastic wrap (our atmosphere). When the small water droplets combine to form bigger water droplets, they become too heavy to stay on the plastic (clouds). When they are too heavy, they precipitate or rain down onto the mug (island). The mug should have water inside when you remove the plastic wrap from all the precipitation.

**How this relates to Jessica and Bruce:**

The water cycle can connect us all. Some places have very little rainfall while other places have an abundance of rainfall. About 70% of the earth's surface is covered by water. This is the source for the water cycle. If water from the ocean evaporates and then condenses into a storm cloud moving north, that water could precipitate down into a completely different area. Even if you do not live near the ocean, some of your rainwater may be coming from the ocean. When rainwater travels through our streets,

farms, buildings etc it can pick up very small traces of chemicals and pollutants. These pollutants can travel with the rainwater and be carried to local waterways. If the pollutants are small, enough they may make it into the water cycle with the water. If the water droplets have chemicals in them when it rains, it brings not only the water molecules but also possibly other chemicals, or pollutants. There have been studies that show that runoff from a big city can cause drastic changes to neighboring rural communities or farms. We need to be careful about putting chemicals and pollutants into our waters because those pollutants will not stay.

**Definitions**:

-precipitation: rain, snow sleet or hail that falls to the ground

-condensation: water that collects as droplets on a cold surface when humid air is in contact with it. The conversion of a vapor or gas to a liquid.

-evaporation: The process by which a liquid or a solid changes into a vapor.

-water cycle: The cycle of process by which water circulates between the earth's oceans, atmosphere, and land, involving precipitation as rain and snow drainage in streams and rivers, and return to the atmosphere by evaporation and transpiration.

**Questions:**

1. What happened to the hot water in the bowl?
2. What is the difference between condensation and precipitation?
3. What would happen if we used room temperature water and sat the bowl in the sun?
4. Why is rainwater salty if some of the water came from the ocean?
5. What makes the water condense after it evaporates?

**Related topics**:

Acid rain

Trace the run off/rainfall patterns in your area to the ocean

Follow the closest water system to your area to the ocean

Discuss how big cities factories may be influencing the quality of water in the system.

## Exercise 2:

Ground Water Runoff

**Materials**:

-2 two-liter soda bottles

-scissors or knife to cut holes in bottles

-Two small clear bowls or glass to catch the runoff

-Two larger clear bowls to catch the ground water from the 2 liters

-Two clear handles from a milk jug or clear tubes (whichever is easiest to find)

-water

-graduated cylinder, beaker, measuring cup

-duct tape or hot glue

-soil

-peat moss

Teachers

This lab will need to be assembled before class to make things move smoothly.

For the original lab, please see the following link:

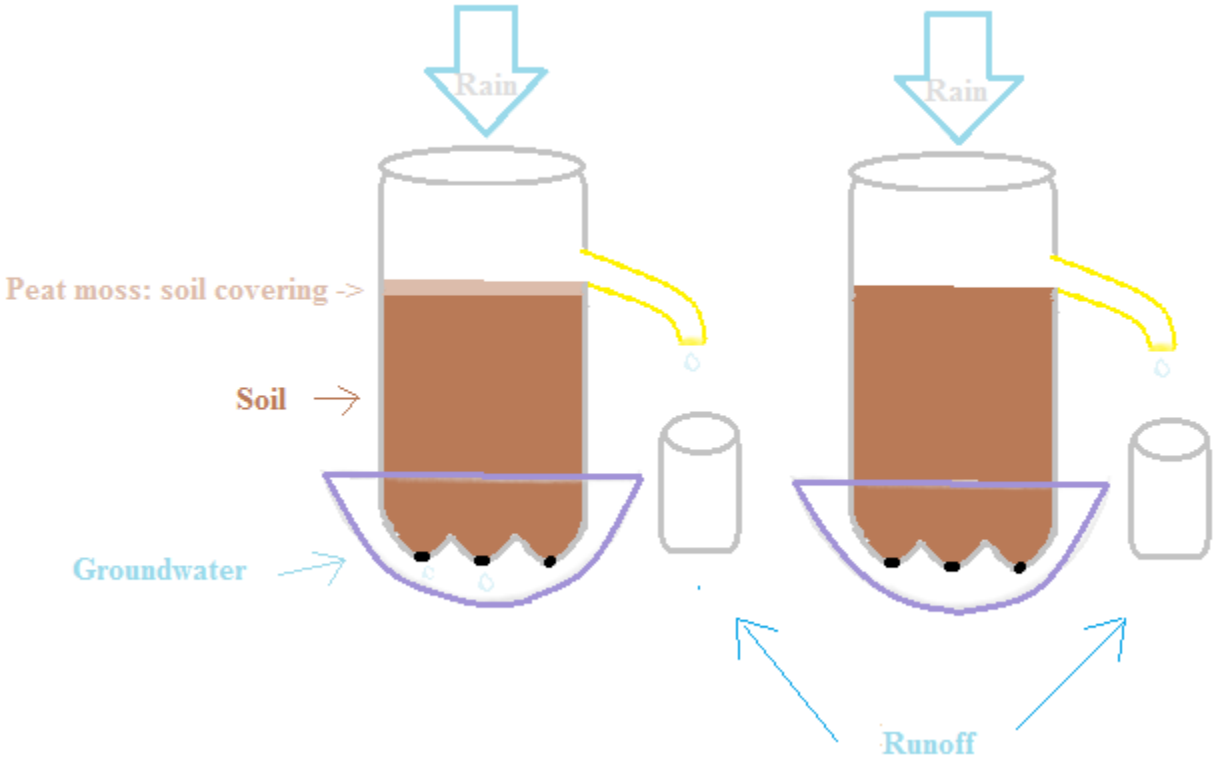
http://managingwholes.com/water-cycle-demo-jugs.htm

https://www.youtube.com/watch?v=og9cQKxlFnE (This is the video of the experiment)

You will need two bottles with the tops cut off. Cut the top off just below the shoulder of the bottle. Make holes in the bottom for our ground water to escape. About an inch below the rim of the newly cut bottle cut a hole that will fit your milk jug handle, your drain. Insert the tube into the bottle and secure it in place with glue or duct tape. Pack the first bottle with soil, level with the opening of the drain. Make sure the soil is packed tight. Pack the second bottle with soil slightly below the opening of the drain. Make sure the soil is packed tight. Add a layer of peat moss and pack it making sure

the top of the peat moss is level with the drain opening. You may want to break the peat moss up before you pack it. Now place the two bottles into the large clear bowls. Place your smaller glasses under the tube so they will catch the runoff water.

You are ready for the experiment! Ask the students to hypothesize what will happen in each bottle. Now measure 8-10oz of water and gently pour into each bottle. You want to use the same amount of water for each bottle.




**<u>What is happening</u>**?

When it rains, some of the water is absorbed into the ground while other water becomes what is known as runoff. Runoff is water that is not absorbed into the soil but flows on the top of the land downhill. When we add the water to the bottle that has bare soil we see the water quickly drains into the glass. The water that collects in the glass represents the runoff. When we add water to the bottle that has peat moss covered soil it will absorb much more of the water resulting in less runoff. The runoff from the bare soil is typically much dirtier than the covered soil. The water that is

absorbed by the covered soil will eventually collect in the bowl below the bottle, which represents our groundwater. This is known as groundwater recharge because it is replenishing the source of groundwater. Notice that the bare soil bottle does not have any groundwater dripping from the bottle.

**How this relates to Jessica and Bruce**?

Water runoff has major impacts areas around the world from flash floods, to soil erosion to pollution. These can affect not just the ocean but freshwater bodies also. An example scientists are seeing in the ocean is the impact on coral reefs. Coral reefs that are near major cities have seen an increase in chemical pollution causing a wide range of adverse affects on the sea life.

Not all runoff can be bad. Did you know Manatees drink freshwater? Manatees or sea cows rely on fresh water to help maintain homeostasis in their bodies. While most manatees live in saltwater or brackish water, they still use freshwater. Manatees are known to come to the surface where the fresh water runoff can be found. In many cases, manatees will frequent boat slips where people will rinse the salt off the boats or in coves where there is high fresh water runoff. As we found before fresh water is less dense so it will float on top of the salt water. Sometimes when the manatees come to the surface to drink, a boater who did not see the manatee can injure them.

**Definitions**:

-Runoff: Flow of water that occurs when the excess water from rain, snow, or other sources flows over the land surfaces.

-Groundwater: water that is located beneath the earth's surface in soil pore spaces and in the fractures of rock formations.

-aquifer: a body of permeable rock that can contain or transmit groundwater.

**Questions:**

1. Which bottle produced the most runoff?
2. Which bottle produces the cleaner runoff?

3. What caused the difference in the runoff?
4. Why is important for contractors to understand before they build?
5. How is groundwater used?

**Related topics**:

Deforestation effects on runoff

Using wells

Building codes for contamination of our drinking water

Grazing management

Manatee protection

## Exercise 3:

Permeability and Porosity of Soil

**Materials**:

-water

-fine sand

-gravel (aquarium gravel works best)

-soil

-clay

-graduated cylinder (measuring cup would work too)

-Beakers (100 mL)

-4 test tubes

-Small funnel

-round filter paper (coffee filters may work as a substitute)

Part 1:

Porosity:

Mark a line about halfway up the beaker. Fill the beaker to the line with water. Measure the water in the beaker with a graduated cylinder. This should be recorded as the total volume. Make sure the beaker is dry and fill to the line with gravel. Measure 100mL of water and slowly pour it into the beaker with the gravel until the water reaches the line. Find how much water it took to reach the line (Subtract the remaining water in graduated cylinder from 100mL). This volume is the pore space volume. Now repeat with the other substances. Note: use the same line for all the substances.

Part 2:

Permeability:

Mark the test tube about halfway up. Place the funnel inside the opening of the test tube. Take the filter and fold it in half. Fold the paper in half again and then pull out one of the folds so that you have a filter "cone." The filter cone should fit inside the funnel. Pour gravel into the cone stopping about a half inch from the top of the funnel. Time how long it takes the water to fill the test tube up to the mark.

**What is happening**?

When it rains, the water either can be absorbed into the ground or can be runoff. What the ground is made up of makes a difference in how much and how fast the water can be absorbed. Porosity is the amount of space between the soil particles. The porosity was measured by determining how much water each substance could hold. Therefore, if the porosity is how much rainwater the ground can hold, the permeability then is how fast it can absorb the water. Permeability by definition is a measure of the ability of a material to transmit fluids. This means that permeability is not a measure of how *fast* but how *easily* water can travel though the material. Now, think about that for a second, if water can travel easily though a substance it means that most likely it will be able to travel quickly also right? The faster water is absorbed the less runoff is seen.

**How this relates to Jessica and Bruce**:

The major source of fresh water is found in ground water. If we deplete these sources of freshwater, we will have to find fresh water elsewhere. After seeing what happens in the previous two labs we can start to make connections with not only local areas but also global areas that are experiencing deforestation, high amounts of construction and development, and pollution. We now understand the importance of ground cover and ground composition and how it influences local waterways. When an area experiences development with driveways, roads, and parking lots, the ground composition has changed to concrete, which behaves differently from soil with respect to water absorption. Now, the areas that used to absorb water cannot and this leads to a higher than normal runoff amount for that area. This can be seen in areas where there are large parking lots for example shopping centers. In many areas, there are large grassy areas that look like big pits next to the concrete parking lots. These help manage the runoff from the developed areas.

**Definitions**:

-Porosity: the amount of space between soil particles

-Permeability: a measure of the ability of a material to transmit fluids

-Runoff: Flow of water that occurs when the excess water from rain, snow, or other sources flows over the land surfaces.

-Groundwater: water that is located beneath the earth's surface in soil pore spaces and in the fractures of rock formations.

-Aquifer: a body of permeable rock that can contain or transmit groundwater.

**Questions**:

1. What does permeability mean?
2. What does porosity mean?
3. How does this relate to the amount of runoff?
4. Will different areas have different soil compositions that affect the porosity and permeability?
5. Would there be any water absorption in a parking lot?
6. What would runoff collect when it travels?

**Related topics**:

Ground water filtration the composition of soil makes a big difference!

Ideal soil compositions for plants

Ideal soil compositions for buildings

What is a leach field?

**Links:**

Water cycle

http://thewaterproject.org/resources/lesson-plans/create-a-mini-water-cycle

http://www.metoffice.gov.uk/education/kids/things-to-do/experiments/water-cycle

Ground Water Runoff

https://www.youtube.com/watch?v=og9cQKxlFnE

https://www.youtube.com/watch?v=RGrlWAyMiSE (ground water with sinkholes)

http://www.ngwa.org/Fundamentals/Adventurers/Pages/Water-Experiments.aspx

Permeability and Porosity

http://dnr.wi.gov/org/caer/ce/eek/teacher/groundwaterguide/How_Groundwater_Moves_activity.pdf

http://deepblueblogx.blogspot.com/2010/09/all-water-leads-to-ocean.html

Answers:

1. What happened to the hot water in the bowl?
    a. It evaporated
2. What is the difference between condensation and precipitation?
    a. Condensation is where the vapor molecules condense and become water molecules. Precipitation is when the molecules become too large to stay in the atmosphere and they fall back to the ground.
3. What would happen if we used room temperature water and sat the bowl in the sun?
    a. The same thing would happen it would just happen slower.
4. Why is rainwater not salty if some of the water came from the ocean?
    a. When the water evaporates, the salt molecules are too heavy to be carried with the water vapor.
5. What makes the water condense after it evaporates?
    a. Cooler atmospheric temperatures.

1. Which bottle produced the most runoff?
    a. The bottle with uncovered soil
2. 2. Which bottle produces the cleaner runoff?
    a. The bottle with the covered soil
3. What caused the difference in the runoff?
    a. The layer of organic matter that covers the soil
4. Why is this important for contractors to understand before they build?
    a. Answers will vary. They need to know how the new ground composition will be affected when it rains.
5. How is groundwater used?
    a. Humans use ground water as a source of fresh water.

1. What does permeability mean?
    a. A measure of the ability of a material to transmit fluids
2. What does porosity mean?
    a. The amount of space between soil particles
3. How does this relate to the amount of runoff?
    a. If the porosity and permeability are small, the water takes longer to absorb into the ground and the ground will have high amounts of runoff.
4. Will different areas have different soil compositions that affect the porosity and permeability?
    a. Yes
5. Would there be any water absorption in a parking lot?

    a. No. There may be a little if the asphalt was broken in places or if there was any sections of plants in the parking lot.
6. What would runoff collect when it travels?
    a. Answers vary. Garbage, dirt, grease, oil, etc

## 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.1Design 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.1Design 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.1Explore 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.1Use 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.1Identify 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 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 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.
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**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 Life Science:

Interdependent Relationships in Ecosystems

1. Evaluate competing design solutions for maintaining biodiversity and ecosystem services. MS-LS2-5
    a. Clarification Statement: Examples of ecosystem services could include water purification, nutrient recycling, and prevention of soil erosion. Examples of design solution constraints could include scientific, economic, and social considerations.
    b. Assessment Boundary: none

Middle School Earth and Space Science

Earth's Systems

1. Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity. MS-ESS2-4
    c. Clarification Statement: Emphasis is on the ways water changes its state as it moves through the multiple pathways of the hydrologic cycle. Examples of models can be conceptual or physical.
    d. Assessment Boundary: A quantitative understanding of the latent heats of vaporization and fusion is not assessed.
2. Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes. MS-ESS3-1
    a. Clarification Statement: Emphasis is on how these resources are limited and typically non-renewable, and how their distributions are significantly

changing as a result of removal by humans. Examples of uneven distributions of resources as a result of past processes include but are not limited to petroleum (locations of the burial of organic marine sediments and subsequent geologic traps), metal ores (locations of past volcanic and hydrothermal activity associated with subduction zones), and soil (locations of active weathering and/or deposition of rock)

b. Assessment Boundary: none

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

Structure and Properties of Matter

1. Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed. MS-PS1-4
    a) Clarification Statement: Emphasis is on qualitative molecular-level models of solids, liquids, and gases to show that adding or removing thermal energy increases or decreases kinetic energy of the particles until a change of state occurs. Examples of models could include drawing and diagrams. Examples of particles could include molecules or inert atoms. Examples of pure substances could include water, carbon dioxide, and helium.
    b) Assessment Boundary: none

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