# SCIENCE GRADE 6

# SPRING BREAK LEARNING

# MARCH 10-14

# 2025

**The Department of Curriculum & Instruction**

Hello MSCS Family,

This resource packet was designed to provide students with activities that can be completed during the Spring Break Academy independently or with the guidance and supervision of family members or other adults. The activities are aligned to the TN Academic Standards for Science and will provide additional practice opportunities for students to develop and demonstrate their knowledge and understanding.

A suggested pacing guide is included; however, students can complete the activities in any order over three days. Below is a table of contents that lists each activity.

**Table of Contents**

| Analyzing the Life Cycle of a Paper Cup | |
|---|---|
| **Grade Level Standard(s)** | **6.ESS3.1** Differentiate between renewable and nonrenewable resources by asking questions about their availability and sustainability. |
| **Caregiver Support Option** | Provide support as needed with reading and discussing questions. |
| **Materials Needed** | writing utensil (pencil, paper, etc.) |
| **Essential Question(s)** | How can we evaluate our use of natural resources? |
| **Student Directions** | Directions for you to follow are provided. Answer any questions for which space is not provided on a separate sheet of paper. |

A product's life cycle includes all the phases in its "life," from getting raw materials to disposing of it once it has served its purpose. Most steps in the life cycle of paper product affects the environment in some way.

**Impact of a Paper Cup**

A life cycle analysis of a paper cup shows that making it requires trees, water, ink, and plastic for a waterproofing lining. The process also uses several different kinds of fuel, such as natural gas and diesel truck fuel for energy to make and transport the cups. The whole process releases about 110 grams (about ¼ pound) of carbon dioxide per cup into the atmosphere. This amount is 3 to 4 times the weight of a cup itself. And because of the plastic lining, paper cups are difficult to recycle.

Newspaper awaiting recycling.

1. **Estimate**

   Assume that a recycled paper cup is made up of only paper, and that paper could be recycled 5 times. About how much carbon dioxide would this prevent from being released into the atmosphere?

   _____

   _____

   _____

These paper cups probably will not be recycled.

**Recycling Paper Products**

Many paper products are more easily recycled that paper cups are. Over 70% of newspaper is recycled to make various products such as cereal boxes, egg cartons, and tissue paper. Many paper products can be recycled 5 to 7 times, after which the paper fibers are too short and no longer stick together well enough to make paper. Recycling paper products not only saves trees but also saves a lot of water, electricity, and gas and reduces air pollution.

2. **Infer**

   Most newspaper is recycled. Most paper cups are not. What is the one difference in environmental impact between burial and incineration for used paper products?

   _____

   _____

Most newspapers are recycled, saving trees and energy used in logging.

The life of a paper product starts with trees. Loggers gut the tree, and a paper mill grinds it into pulp.

The mill mixes the pulp with water and other chemicals to make paper, which is used to make paper products such as paper cups.

Most paper cups end up in a landfill.

These products are used by all of us and then either recycled, incinerated, or buried in a landfill.

**You Try It!**

Now it's your turn to analyze the life cycle of a paper cup. You'll consider things such as the benefits of paper cups and their cost in both money and environmental impact. Then you can suggest some ways to improve the cycle.

1. **Identify Benefits**

   Research the benefits of making and using paper cups. List those benefits below.

   _____
   _____
   _____
   _____

2. **Evaluate Cost of Technology**

   A. A paper mill uses about 16,000 gallons of water and about 400 kWh of electricity to produce one ton of paper cups. Using the information shown in the chart to the right, what is the cost of the water and electricity that are used to make one ton of paper cups?

      _____
      _____

   B. A modern paper mill costs around $1 billion to build. How many cups would a company need to sell to pay for the cost of the plant, the water, and the electricity?

      _____
      _____

   - Water costs about $0.0007 per gallon.
   - Electricity costs about $ 0.072kWh
   - 33,000 cups weigh about a ton.
   - One ton of cups sells for $2,000.

3. **Evaluate Environmental Impact**

   Think about possible impacts of the life cycle of a paper cup on the environment. Consider things such as the harvesting of trees, the use of chlorine-based chemicals to bleach the pulp, the energy required by the paper mill, problems associated with disposal of paper cups after their use, etc. Record your thoughts below.

   _____
   _____
   _____

4. **Propose Improvements**

   Think about some improvements to the process of making or disposing of paper cups that might help make the life cycle of paper cups more environmentally friendly. Record your thoughts below.

   _____
   _____
   _____

5. **Communicate Results**

   What is the most important thing you have learned about the life cycle of a paper cup and explain why you think it is important?

   _____
   _____
   _____

| Alternative Thinking: Different Forms of Energy | |
|---|---|
| **Grade Level Standard(s)** | **6.ESS3.2** Investigate and compare existing and developing technologies that will utilize renewable and alternate energy sources. |
| **Caregiver Support Option** | Provide support as needed with reading and discussing questions. |
| **Materials Needed** | writing utensil (pencil, pen, etc.) |
| **Essential Question(s)** | How can we evaluate alternative energy? |
| **Student Directions** | Directions are provided for you to follow. Answer any questions for which space is not provided on a separate sheet of paper. |

**Alternative Thinking: Different Forms of Energy**

Alternative energy is a field that is growing quickly. Many forms of alternative energy rely on renewable resources. Water, geothermal, wind, and solar power are renewable. Unlike fossil fuels, these alternative energy sources do not produce greenhouse gases. Alternative energy can also reduce the need to mine fossil fuels. Mining can often damage ecosystems, so many scientists believe that alternative energies are better for the environment.

**Making the Switch**

Switching to alternative energy sources is not always easy. Sunshine, wind, and flowing water are not plentiful everywhere. Also, switching to alternative energy sources may cost a lot of money up front. Building a dam, erecting wind turbines, or installing solar panels can be very expensive.

1. **Brainstorm**
   What local factors might affect a community's alternative energy choices?
   _____
   _____
   _____

The Hoover Dam generates enough hydroelectric power each year to serve 1.3 million people in Nevada, Arizona, and California. It relies on the steady flow of the Colorado River into Leak Mead. This artificial lake was created by building the dam.

**Challenges**

Most alternative energy systems have some drawbacks. Solar panels produce lots of power during the long, sunny days of summer. But on cloudy days, they make much less power. During the winter, there are fewer hours of daylight. Then solar panels make relatively small amount of power.

Wind turbines make power only when the wind blows. Hydroelectric turbines make power if water is flowing, but a drought will decrease water levels and reduce power output. Geothermal energy provides a more reliable source of

energy, but it requires drilling into Earth. This can be costly and impractical, especially in densely populated cities and towns.

Solar panels need direct access to sunlight to produce power.

One way engineers can make wind turbines more reliable is to build them taller. At higher altitudes, wind speeds are greater, and winds are not blocked by buildings and trees.

2. **Infer**
   Solar panels are more effective on long, sunny days. What areas of the United States do you think would benefit most from solar power?

   _____
   _____
   _____

**You Try It!**

Now it's your turn to analyze and compare different forms of renewable energy. You'll consider the benefits of different sources, come up with arguments, and create an energy plea.

1. **Identify Benefits**
   Choose one of the following types of pf renewable energy: hydroelectric, solar, geothermal, or wind power. List the benefits below.

_____
_____
_____

2. **Evaluate Cost of Technology**

   A. Look at the list of cons for renewable energy. How would you address this point in your energy plan?

   _____
   _____
   _____

   B. What would be the costs involved in your energy plan? Explain how your plan might save costs over the long run.

   _____
   _____
   _____

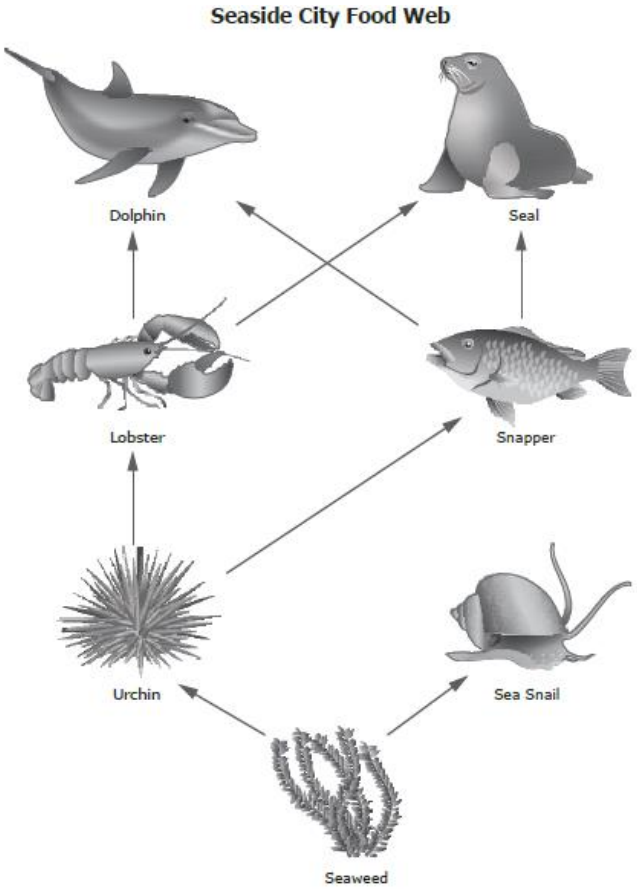
Cons of Renewable Energy Systems

- Clouds can reduce electricity from solar power plants.
- Days with low winds can reduce electricity from wind farms.
- Periods of drought reduce the energy a hydroelectric plant can produce.
- Geothermal energy still needs electricity to operate heat pumps.

| Seaside City | |
|---|---|
| **Grade Level Standard(s)** | **6.ESS3.3** Assess the impacts of human activities on the biosphere including conservation, habitat management, species endangerment, and extinction. |
| **Caregiver Support Option** | Provide support as needed with reading and discussing questions. |
| **Materials Needed** | writing utensil (pencil, pen, etc.) |
| **Essential Question(s)** | How do human activities impact the environment? |
| **Student Directions** | Directions are provided for you to follow. Answer any questions for which space is not provided on a separate sheet of paper. |

Seaside City has been a popular vacation spot for the past 25 years. Each year more tourists visit, and more people come to live there. A wide range of organisms can be found in the sea near the city. The following food web shows you the feeding relation- ships between some of these organisms. Seaweed also provides a safe environment for many types of organisms not shown on the food web below.

Visitors love to watch the seals and dolphins. Both tourists and residents enjoy eating lobster or snapper at local restaurants. However, the increasing human population has led to increased demand for lobster and snapper. The table below provides data about the sea near Seaside City. The data indicate that both species have become overfished.




| Year | Number of species in the sea near Seaside City | Number of lobsters per 10 square meters | Number of snappers per 10 square meters | Number of sea urchins per 10 square meters | Percentage of the sea with seaweed |
|---|---|---|---|---|---|
| **1990** | 325 | 5 | 5 | 10 | 50 |
| **1995** | 324 | 3 | 3 | 15 | 40 |
| **2000** | 320 | 2 | 2 | 20 | 30 |
| **2005** | 315 | 1 | 1 | 25 | 25 |
| **2010** | 305 | 1 | 0.5 | 30 | 20 |
| **2015** | 285 | 0.5 | 0.5 | 35 | 15 |

1. Construct an explanation about how the overfishing of lobsters and snappers affects the amount of seaweed in the ecosystem. Support your claim with evidence from the table.

_____
_____
_____
_____
_____
_____
_____
_____
_____

2. In 2015 the people of Seaside City decided that the changes in this ecosystem were a problem. Two solutions were proposed. A short list of criteria and constraints were also developed by Seaside City. You were selected as one of the team of scientist and engineers to examine the solutions. The solutions, criteria, and constraints are described on the next page.

   Read the proposed solutions and construct an argument that answers the questions, "Which is the best proposed solution, based on the criteria and why?"

| Proposed Solution A |
| --- |
| The sea near Seaside City would become a protected area, where no fishing is allowed. The area would extend 5 km (about 3 miles) out to sea and around the city. The cost of creating the protect-ed area would be 1.5 million dollars. Scientists estimate that it will take at least 20 years for the numbers of lobsters and snappers to recover to the 1990 levels. It is estimated that 250 fishing jobs would be lost. However, it is believed that tourism will increase by 20% because of the protected area. As the number of tourists increases, new hotels could be built, creating more jobs. New businesses, such as boat trips for tourists and scuba diving, could also be developed. It is estimated that at least 100 new jobs would be created over the next 5 years. Scientists expect that the number of species in the protected area will take about 30 years to recover to the level that it was in the year 2000. |

| Proposed Solution B |
| --- |
| Five hundred lobsters and one thousand snappers will be brought from other parts of the country. The cost of introducing the species would be $200,000. They will be added to the ocean near Seaside City. They are different, but related, species from the lobsters and snappers that are found near Seaside City. The introduced species are larger and grow more quickly than the existing species. Sales tax will be increased by 1% to cover the cost of the bringing in the new lobsters and snappers. Divers will be used to catch and remove at least fifty percent of the sea urchins. There will not be a total ban on fishing, but fishing boats will only be allowed to fish during one week each month. It is estimated that 50 fishing jobs would be lost. It is expected to take about 10 years for the area to recover to the level that it was in the year 2005. Tourism is expected to remain the same during that time. |

**Constraint:** The solution must cost less than 2 million dollars.
**Criteria: 1.** Best recovery of the biodiversity of the ecosystem.
**2.** Lowest chance of introducing species that may become invasive.
**3.** Smallest number of job losses.
**4.** Shortest time for the ecosystem to recover.

3. Design your own solution. You may change the criteria but make sure that you describe any changes that you make. Explain why your solution is better than the solutions proposed by Seaside City.

| Altering the Water Cycle | |
|---|---|
| **Grade Level Standard(s)** | **6.ESS2.4** Apply scientific principles to design a method to analyze and interpret the impact of humans and other organisms on the hydrologic cycle. |
| **Caregiver Support Option** | Provide support as needed with reading and discussing questions. |
| **Materials Needed** | • writing utensil (pencil, pen, etc.)<br>• water mixed with soil and a small amount of vegetable oil.<br>• plastic liter bottle, cut in half.<br>• clear container<br>• cotton balls<br>• pebbles<br>• napkins<br>• coffee filters<br>• rubber bands<br>• cloth |
| **Essential Question(s)** | How can humans and other organisms impact the hydrologic cycle? |
| **Student Directions** | Directions are provided for you to follow. Answer any questions for which space is not provided on a separate sheet of paper. |

**Altering the Water Cycle**

Earth's water cycle would occur even if there were no life on earth. But humans and other organisms influence the water cycle in many ways. For example, beavers build dams in rivers or streams using trees, sticks, and mud. Water pools behind the dam, forming a pond that the beaver uses as a habitat. This affects the water cycle by changing the natural movement of water.

Humans also build dams-much larger than the ones made by beavers. Manmade dams can turn rivers or streams into huge artificial lakes or reservoirs. Humans also affect the types of matter that are moved by the water cycle. Fertilizers and waste can see into groundwater. Garbage and other pollution may also make their way into streams, rivers, and lakes as runoff.

1. **Brainstorm**

List some other ways that human activity affects the water cycle. Divide your list into positive and negative impacts on the water cycle.

_____
_____
_____
_____
_____
_____

**Constructing a Filtration System**

Humans need water to survive. But as water moves through the water cycle, it can mix with other matter that is not so healthy. Most people get their drinking water from ground water. Groundwater collects underground after seeping through layers of soil and rock. Because of this, it may contain chemicals, minerals, or microorganisms that are unhealthy for humans to consume.

Filtration is one way that humans can purify water to make it safer. A water filter is a mechanism designed to separate water from a mixture. It allows water to flow through it, but it traps other substances. Filters used to purify drinking water usually have more than one layer. Each layer is designed to trap certain types of matter, separating it from water.

Water treatment plant use filtration and other methods to purify groundwater or surface water.

2. **Infer**

   What are some properties of an effective filtration system? How would this compare to a less effective filtration system?

   _____
   _____
   _____
   _____
   _____

**You Try It!**

Now it's your turn to design a water filtration system to remove contaminants from water. Choose the materials you think will best filter the water.

1. **Brainstorm Solutions**

   Which materials would you use to design a multi-layered filter? In what order would you place them? List three possibilities below and explain why they might work.

   a. _____
      _____
      _____
   b. _____
      _____
      _____
   c. _____
      _____
      _____

Materials

- ✓ water mixed with soil and a small amount of vegetable oil.
- ✓ plastic liter bottle, cut in half.
- ✓ clear container
- ✓ cotton balls
- ✓ pebbles
- ✓ napkins
- ✓ coffee filters
- ✓ rubber bands
- ✓ cloth

2. **Select a Solution**
   From your list, select a solution. Then create a diagram in the space below. Be sure to label your materials.

3. **Build a Prototype**
   Turn the top half of the liter bottle upside down. Place the materials for your filter (cotton balls, pebbles, etc.) inside the bottle. As you built your filter, were there any parts of your design that could not be assembled as you predicted? What parts did you have to revise as you were building your prototype?

   _____
   _____
   _____
   _____
   _____

4. **Test and Evaluate**
   Hold your bottle over the clear container. Pour the dirty water through the filter and observe the results. Did your filter remove most of the materials from the water? How can you tell? (Caution do not taste or drink the water.)

   _____
   _____
   _____
   _____

5. **Redesign to Improve**
   How could you adjust your filter to make it work better? Try using different materials or layering them in a different order. Test the filter again and describe your results.

   _____
   _____
   _____
   _____
   _____

6. **Communicate Results**
   Describe the best filter you created and why you decided to construct it that way. Why do you think it worked the best?

   _____
   _____
   _____
   _____
   _____

| Analyzing the Life Cycle of a Paper Cup | |
|---|---|
| **Grade Level Standard(s)** | **6.ESS3.1** Differentiate between renewable and nonrenewable resources by asking questions about their availability and sustainability. |
| **Caregiver Support Option** | Provide support as needed with reading and discussing questions. |
| **Materials Needed** | writing utensils (pencil, paper, etc.) |
| **Essential Question(s)** | How can we evaluate our use of natural resources? |
| **Student Directions** | Directions for you to follow are provided. Answer any questions about which space is not provided on a separate sheet of paper. |

A product's life cycle includes all the phases in its "life," from getting raw materials to disposing of it once it has served its purpose. Most steps in the life cycle of paper products affect the environment in some way.

**Impact of a Paper Cup**

A life cycle analysis of a paper cup shows that making it requires trees, water, ink, and plastic for a waterproofing lining. The process also uses several different kinds of fuel, such as natural gas and diesel truck fuel for energy to make and transport the cups. The whole process releases about 110 grams (about ¼ pound) of carbon dioxide per cup into the atmosphere. This amount is 3 to 4 times the weight of a cup itself. And because of the plastic lining, paper cups are difficult to recycle.

Newspaper awaiting recycling.

1. **Estimate**

   Assume that a recycled paper cup is made up of only paper, and that paper could be recycled 5 times. About how much carbon dioxide would this prevent from being released into the atmosphere?

   If making one cup releases about 110 grams of carbon dioxide, then we would save about 550 grams of carbon dioxide from being released into the atmosphere.

These paper cups probably will not be recycled.

**Recycling Paper Products**

Many paper products are more easily recycled that paper cups are. Over 70% of newspaper is recycled to make various products such as cereal boxes, egg cartons, and tissue paper. Many paper products can be recycled 5 to 7 times, after

which the paper fibers are too short and no longer stick together well enough to make paper. Recycling paper products not only saves trees but also saves a lot of water, electricity, and gas and reduces air pollution.

2. **Infer**

   Most newspaper is recycled. Most paper cups are not. What is the one difference in environmental impact between burial and incineration for used paper products?

   Sample answer: Incineration releases many chemicals into the air. Burial takes up space in a landfill and could pollute the soil and/or groundwater.

The life of a paper product starts with trees. Loggers gut the tree, and a paper mill grinds it into pulp.

Most newspapers are recycled, saving trees and energy used in logging.

The mill mixes the pulp with water and other chemicals to make paper, which is used to make paper products such as paper cups.

Most paper cups end up in a landfill.

These products are used by all of us and then either recycled, incinerated, or buried in a landfill.

**You Try It!**

Now it's your turn to analyze the life cycle of a paper cup. You'll consider things such as the benefits of paper cups and their cost in both money and environmental impact. Then you can suggest some ways to improve the cycle.

1. **Identify Benefits**

   Research the benefits of making and using paper cups. List those benefits below.

   Sample answer: Benefits include convenience and hygiene.

2. **Evaluate Cost of Technology**

A. A paper mill uses about 16,000 gallons of water and about 400 kWh of electricity to produce one ton of paper cups. Using the information shown in the chart to the right, what is the cost of the water and electricity that are used to make one ton of paper cups?
16,000 gallons x $0.0007/gallon = $10
400 kWh x $ 0.072/kWh = $30
$2000 - $10 - $30 = $1960 after selling 1 ton of cups and paying for water and electricity.

- Water costs about $0.0007 per gallon.
- Electricity costs about $ 0.072kWh
- 33,000 cups weigh about a ton.
- One ton of cups sells for $2,000.

B. A modern paper mill costs around $1 billion to build. How many cups would a company need to sell to pay for the cost of the plant, the water, and the electricity?
To pay for the $1 billion plant, you need to sell 33,000 x $1 billion/$1960 = 17 billion cups.

3. **Evaluate Environmental Impact**
Think about possible impacts of the life cycle of a paper cup on the environment. Consider things such as the harvesting of trees, the use of chlorine-based chemicals to bleach the pulp, the energy required by the paper mill, problems associated with disposal of paper cups after their use, etc. Record your thoughts below.
Sample answer: Cutting down tress damages the environment by reducing habitat and biodiversity. It also lets a lot more soil wash into rivers when it rains. Another bad thing is that roads are made into the wilderness to get the trees. The chlorine chemicals cause water pollution, which makes us sicker. The energy used causes more greenhouse gases to be released. Paper mills also make a lot of noise, so I wouldn't want to live nearby.

4. **Propose Improvements**
Think about some improvements to the process of making or disposing of paper cups that might help make the life cycle of paper cups more environmentally friendly. Record your thoughts below.
Sample answer: We can stop using so many paper cups. Scientists can research ways to make cups that let us recycle them more. We could put better pollution control on factory smokestacks and water pipes to keep chemicals from getting into the air and water. We could build factories in a way that prevents erosion of the soil.

5. **Communicate Results**
What is the most important thing you have learned about the life cycle of a paper cup and explain why you think it is important?
Sample answer: I had no idea paper cups had such a big impact on the environment. I will try to use fewer paper cups, and I think I will tell my parents to use reusable cups for their coffee and tea.

| **Alternative Thinking: Different Forms of Energy** | |
|---|---|
| **Grade Level Standard(s)** | **6.ESS3.2** Investigate and compare existing and developing technologies that will utilize renewable and alternate energy sources. |
| **Caregiver Support Option** | Provide support as needed with reading and discussing questions. |
| **Materials Needed** | writing utensil (pencil, pen, etc.) |

| | |
|---|---|
| **Essential Question(s)** | How can we evaluate alternative energy? |
| **Student Directions** | Directions are provided for you to follow. Answer any questions about which space is not provided on a separate sheet of paper. |

**Alternative Thinking: Different Forms of Energy**

Alternative energy is a field that is growing quickly. Many forms of alternative energy rely on renewable resources. Water, geothermal, wind, and solar power are renewable. Unlike fossil fuels, these alternative energy sources do not produce greenhouse gases. Alternative energy can also reduce the need to mine fossil fuels. Mining can often damage ecosystems, so many scientists believe that alternative energies are better for the environment.

**Making the Switch**

Switching to alternative energy sources is not always easy. Sunshine, wind, and flowing water are not plentiful everywhere. Also, switching to alternative energy sources may cost a lot of money up front. Building a dam, erecting wind turbines, or installing solar panels can be very expensive.

1. **Brainstorm**
   What local factors might affect a community's alternative energy choices?
   Sample answer: Possible factors include a community's resources (e.g., sources of water or geothermal energy) and climate (e.g., frequency of sunny or windy days).

The Hoover Dam generates enough hydroelectric power each year to serve 1.3 million people in Nevada, Arizona, and California. It relies on the steady flow of the Colorado River into Leak Mead. This artificial lake was created by building the dam.

**Challenges**

Most alternative energy systems have some drawbacks. Solar panels produce lots of power during the long, sunny days of summer. But on cloudy days, they make much less power. During the winter, there are fewer hours of daylight. Then solar panels make relatively small amounts of power.

Wind turbines make power only when the wind blows. Hydroelectric turbines make power as long as water is flowing, but a drought will decrease water levels and reduce power output. Geothermal energy provides a more reliable source of energy, but it requires drilling into Earth. This can be costly and impractical, especially in densely populated cities and towns.

Solar panels need direct access to sunlight to produce power.

One way engineers can make wind turbines more reliable is to build them taller. At higher altitudes, wind speeds are greater, and winds are not blocked by buildings and trees.

2. **Infer**
   Solar panels are more effective on long, sunny days. What areas of the United States do you think would benefit most from solar power?
   Sample answer: Area in the southern United States might benefit more because they receive sunshine more consistently throughout the year. Because these areas are closer to the equator, the days are not as short during the winter months. Areas that have few cloudy days would benefit the most.

**You Try It!**

Now it's your turn to analyze and compare different forms of renewable energy. You'll consider the benefits of different sources, come up with arguments, and create an energy plea.

1. **Identify Benefits**
   Choose one of the following types of pf renewable energy: hydroelectric, solar, geothermal, or wind power. List the benefits below.
   Sample answers: Benefits for hydroelectric may include: It is renewable and doesn't pollute the environment once a power plant is built; if water is available, it is very reliable.
   Benefits of solar may include; It is easy for many people to install solar panels; in many areas sunlight is nearly always available.

Benefits of geothermal may include: It's renewable; it doesn't rely on weather patterns the way wind and solar do.
Benefits of wind power may include: It does not cause pollution; in windy areas, it is an efficient source of power.

2. **Evaluate Cost of Technology**

   A. Look at the list of cons for renewable energy. How would you address this point in your energy plan?

   Solar: Develop a way to store power from solar panels, such as a battery, so that energy produced on sunny days can be used on cloudy days.
   Wind power: Only build wind farms where there are very steady sources of wind, like on a coast or in a shallow part of the ocean.
   Hydroelectric: Build more efficient plants for processing, and only where there is a steady supply of water.
   Geothermal: Use a renewable source of energy, such as solar power, to provide the electricity to operate pumps.

Cons of Renewable Energy Systems

- Clouds can reduce electricity from solar power plants.
- Days with low winds can reduce electricity from wind farms.
- Periods of drought reduce the energy a hydroelectric plant can produce.
- Geothermal energy still needs electricity to operate heat pumps.

   B. What would be the costs involved in your energy plan? Explain how your plan might save costs in the long run.
   The initial costs would be for building or installing the equipment, such as wind turbines, solar panels, or a geothermal pump. This equipment would last for a long time. Over time, this equipment saves money because it produces power from energy sources that are free. There is no cost for fuel.

| Seaside City | |
|---|---|
| **Grade Level Standard(s)** | **6.ESS3.3** Assess the impacts of human activities on the biosphere including conservation, habitat management, species endangerment, and extinction. |
| **Caregiver Support Option** | Provide support as needed with reading and discussing questions. |
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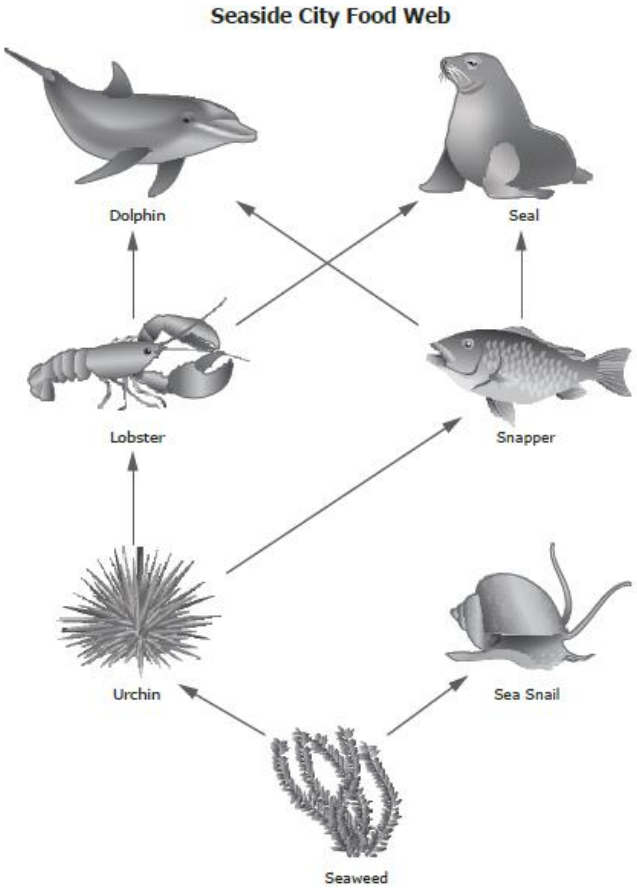
Seaside City has been a popular vacation spot for the past 25 years. Each year more tourists visit, and more people come to live there. A wide range of organisms can be found in the sea near the city. The following food web shows you the feeding relationships between some of these organisms. Seaweed also provides a safe environment for many types of organisms not shown on the food web below.

Visitors love to watch the seals and dolphins. Both tourists and residents enjoy eating lobster or snapper at local restaurants. However, the increasing human population has led to increased demand for lobster and snapper. The table below provides data about the sea near Seaside City. The data indicate that both species have become overfished.




| Year | Number of species in the sea near Seaside City | Number of lobsters per 10 square meters | Number of snappers per 10 square meters | Number of sea urchins per 10 square meters | Percentage of the sea with seaweed |
|---|---|---|---|---|---|
| **1990** | 325 | 5 | 5 | 10 | 50 |
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| **2015** | 285 | 0.5 | 0.5 | 35 | 15 |

1. Construct an explanation about how the overfishing of lobsters and snappers affects the amount of seaweed in the ecosystem. Support your claim with evidence from the table.
   Sample answer: My claim is that the overfishing of lobsters and snappers causes a decrease in the amount of seaweed in the ecosystem. My evidence is that between 1990 and 2015, the number of lobsters decreased from 5 to 0.5 per 10 square meters. The same decrease happened to the snapper. During that same time, the number of sea urchins per 10 square meters increased from 10 to 35. Also, between 1990 and 2015, the percentage of the sea with seaweed decreased from 50% to 15%. The science concept that relates to the evidence and supports the claim is that lobsters and snappers have a predator-prey relationship with sea urchins, so the other decreases when one increases. The sea urchins also have a consumer-producer relationship with seaweed. This concept supports my claim because overfishing reduces the number of lobsters and snappers (the predators). The number of sea urchins (the prey) will rise. If there are more sea urchins, then more seaweed will be eaten.

2. In 2015 the people of Seaside City decided that the changes in this ecosystem were a problem. Two solutions were proposed. A short list of criteria and constraints was also developed by Seaside City. You were selected as one of the team of scientists and engineers to examine the solutions. The solutions, criteria, and constraints are described on the next page.

   Read the proposed solutions and construct an argument that answers the questions, "Which is the best proposed solution, based on the criteria and why?"

| Proposed Solution A |
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| The sea near Seaside City would become a protected area, where no fishing is allowed. The area would extend 5 km (about 3 miles) out to sea and around the city. The cost of creating the protect-ed area would be 1.5 million dollars. Scientists estimate that it will take at least 20 years for the numbers of lobsters and snappers to recover to the 1990 levels. It is estimated that 250 fishing jobs would be lost. However, it is believed that tourism will increase by 20% because of the protected area. As the number of tourists increases, new hotels could be built, creating more jobs. New businesses, such as boat trips for tourists and scuba diving, could also be developed. It is estimated that at least 100 new jobs would be created over the next 5 years. Scientists expect that the number of species in the protected area will take about 30 years to recover to the level that it was in the year 2000. |

| Proposed Solution B |
| --- |
| Five hundred lobsters and one thousand snappers will be brought from other parts of the country. The cost of introducing the species would be $200,000. They will be added to the ocean near Seaside City. They are different, but related, species from the lobsters and snappers that are found near Seaside City. The introduced species are larger and grow more quickly than the existing species. Sales tax will be increased by 1% to cover the cost of bringing in the new lobsters and snappers. Divers will be used to catch and remove at least fifty percent of the sea urchins. There will not be a total ban on fishing, but fishing boats will only be allowed to fish for one week each month. It is estimated that 50 fishing jobs would be lost. It is expected to take about 10 years for the area to recover to the level that it was at in the year 2005. Tourism is expected to remain the same during that time. |

**Constraint:** The solution must cost less than 2 million dollars.
**Criteria: 1.** Best recovery of the biodiversity of the ecosystem.
**2.** Lowest chance of introducing species that may become invasive.
**3. Smallest job loss.**
**4.** Shortest time for the ecosystem to recover.

Sample answer: I believe that proposal A is the best solution. Both proposals fall within the constraint of costing less than $2,000,000. Proposal A meets criteria 1 and 2 better than Proposal B. However, proposal B meets criteria 3 and 4 better than Proposal A. Proposal A creates a protected area where no fishing is allowed. This is an excellent environmental solution and would allow the ecosystem to recover more fully than Proposal B, although it would take about 30 years to do so. Proposal B is a quicker solution as it involves importing 500 lobsters and 1,000 snappers. I think this could be a problem as these organisms are not native to the area and could affect populations of native species. They might even become invasive. It is, therefore, possible that the ecosystem will not recover well and may undergo more changes. This is why I believe Proposal A is better than Proposal B. The biggest problem with Proposal A is that more jobs will be lost than with Proposal B. It is estimated that 250 fishing jobs would be lost, and 100 new jobs created because of increased tourism. This means that there would be a loss of about 150 jobs compared to an estimated job loss of 50 fishing jobs with Proposal B. This could cause increased negative social and economic consequences compared to Proposal B. However, if the ecosystem changed because of the introduction of non-native species under Proposal B, there is a risk that there could be more job losses in the future. Therefore, I believe Proposal A is still the better choice.

3. Design your own solution. You may change the criteria but make sure that you describe any changes that you make. Explain why your solution is better than the solutions proposed by Seaside City.
I think it is essential that the area fully recovers. I don't think it matters if it takes longer to recover, I will remove criterion 4. I also believe that criterion 1 is more important than 3. So, I don't think the best solution has to be the one that has the fewest job losses.

   I would modify Proposal A by making the protected area a little smaller and allowing limited fishing just outside the area. However, I would put limits on the number of fish and lobsters that they can catch. Having a protected area will attract more tourists, and this will create more jobs. Allowing limited fishing will reduce the number of fishing jobs that are lost. By maintaining ecosystem services such as tourism and fishing, this solution is better than Solution A from an economic and social perspective. Solution A is also better than Solution B from an environmental perspective because it does not introduce any non-native species.

| **Altering the Water Cycle** | |
|---|---|
| **Grade Level Standard(s)** | **6.ESS2.4** Apply scientific principles to design a method to analyze and interpret the impact of humans and other organisms on the hydrologic cycle. |
| **Caregiver Support Option** | Provide support as needed with reading and discussing questions. |
| **Materials Needed** | • writing utensil (pencil, pen, etc.)<br>• water mixed with soil and a small amount of vegetable oil<br>• plastic liter bottle, cut in half<br>• clear container<br>• cotton balls<br>• pebbles<br>• napkins<br>• coffee filters<br>• rubber bands<br>• cloth |

| | |
|---|---|
| **Essential Question(s)** | How can humans and other organisms impact the hydrologic cycle? |
| **Student Directions** | Directions are provided for you to follow. Answer any questions about which space is not provided on a separate sheet of paper. |

**Altering the Water Cycle**

Earth's water cycle would occur even if there was no life on earth. But humans and other organisms influence the water cycle in many ways. For example, beavers build dams in rivers or streams using trees, sticks, and mud. Water pools behind the dam, forming a pond that the beaver uses as a habitat. This affects the water cycle by changing the natural movement of water.

Humans also build dams much larger than the ones made by beavers. Manmade dams can turn rivers or streams into huge artificial lakes or reservoirs. Humans also affect the types of matter that are moved by the water cycle. Fertilizers and waste can be seen in groundwater. Garbage and other pollution may also make their way into streams, rivers, and lakes as runoff.

1. **Brainstorm**

List some other ways that human activity affects the water cycle. Divide your list into positive and negative impacts on the water cycle.

Sample answer: Humans can influence Earth's water cycle by tapping groundwater for drinking or irrigation. These are positive influences because they make water available for humans. Humans can also influence the water cycle by draining wetlands or cutting down forests. These are negative impacts because they destroy ecosystems and organisms that contribute to and depend on the water cycle.

**Constructing a Filtration System**

Humans need water to survive. But as water moves through the water cycle, it can mix with other matter that is not so healthy. Most people get their drinking water from ground water. Groundwater collects underground after seeping through layers of soil and rock. Because of this, it may contain chemicals, minerals, or microorganisms that are unhealthy for humans to consume.

Filtration is one way that humans can purify water to make it safer. A water filter is a mechanism designed to separate water from a mixture. It allows water to flow through it, but it traps other substances. Filters used to purify drinking water usually have more than one layer. Each layer is designed to trap certain types of matter, separating it from water.

Water treatment plant use filtration and other methods to purify groundwater or surface water.

2. **Infer**
   What are some properties of an effective filtration system? How would this compare to a less effective filtration system?
   Sample answer: A good filtration system will remove all or most matter from water. A less effective system will only remove some of the contaminants from the water.

**You Try It!**

Now it's your turn to design a water filtration system to remove contaminants from water. Choose the materials you think will best filter the water.

1. **Brainstorm Solutions**
   Which materials would you use to design a multi-layered filter? In what order would you place them? List three possibilities below and explain why they might work.
   Sample answer:
   - Pebbles on top filter out coarse materials that could clog the other filter materials.
   - Napkins to remove finer materials that get through the pebbles.
   - Coffee filters on the bottom to remove very fine material that makes it through the napkins.

Materials
- ✓ water mixed with soil and a small amount of vegetable oil
- ✓ plastic liter bottle, cut in half
- ✓ clear container
- ✓ cotton balls
- ✓ pebbles
- ✓ napkins
- ✓ coffee filters
- ✓ rubber bands
- ✓ cloth

2. **Select a Solution**
   From your list, select a solution. Then create a diagram in the space below. Be sure to label your materials.

   Students should provide a clearly labeled diagram of the bottle filter with multiple layers of filtering material.

3. **Build a Prototype**
   Turn the top half of the liter bottle upside down. Place the materials for your filter (cotton balls, pebbles, etc.) inside the bottle. As you built your filter, were there any parts of your design that could not be assembled as you predicted? What parts did you have to revise as you were building your prototype?
   Students should note any necessary modifications to their design.

4. **Test and Evaluate**
   Hold your bottle over the clear container. Pour the dirty water through the filter and observe the results. Did your filter remove most of the materials from the water? How can you tell? (Caution do not taste or drink the water.)
   Answers may vary, but students should compare observations of the original dirty water to their observations of the filtered water.

5. **Redesign to Improve**
   How could you adjust your filter to make it work better? Try using different materials or layering them in a different order. Test the filter again and describe your results.

Answers may vary, but they should include theories about the order of materials. Maybe the loosest materials, like pebbles, should go on the top, and materials with more straining ability, like cloth, should go near the bottom.

6. **Communicate Results**

   Describe the best filter you created and why you decided to construct it that way. Why do you think it worked the best?

   Based on the filter they constructed, students should be able to explain their process in constructing it and provide support for why it might work well.