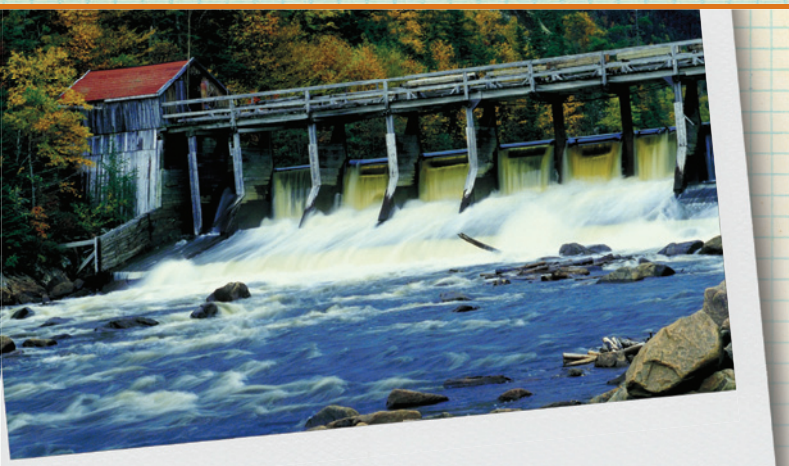
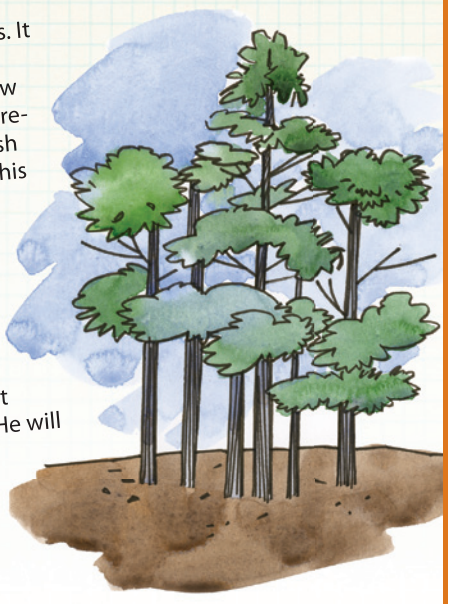


3

Natural Resources

For many years man tried to prevent all forest fires. It seemed such a waste to allow one of our natural resources, forests, to burn. But researchers are now finding that fire can be beneficial to a forest. Fire returns nutrients to the soil. It clears out underbrush and opens areas of sunlight on the forest floor. This allows smaller plants to get the sunlight they need to grow. Some trees even need the heat of a fire to open their seeds. Forest fires can be tragic events, but these fires also remind us that God is wise and merciful. God uses natural disasters to renew and sustain the world He has made. Someday the entire earth will be burned with a fire (2 Peter 3:10). But just as God uses a forest fire to restore a forest, so He will use this great fire to renew the earth. All who are trusting in Jesus will live forever in that new earth—a place where nature will be restored, and sin will be completely gone.



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TEACHER HELPS

Chapter preview
Other preview and prereading activities may include using a K-W-L chart, a probe, or an anticipation guide.

Chapter photo
The photo is of a hydroelectric dam.

Student Text diagrams
Diagrams from the Student Text are included on the Teacher's Toolkit CD.

SCIENCE BACKGROUND

Beneficial fires
A 1988 fire consumed 38 percent of Yellowstone National Park. Naturalists thought the devastation was so severe that the park would take decades to recover. However, they now believe that the fire may have been beneficial. The research that resulted from the fire caused park and forestry personnel to reevaluate their policies on natural fires.

Objectives
- Explain how God's wisdom and mercy are demonstrated in natural disasters
- Preview the chaper content

Introduction

In the days before modern firefighting equipment was available, a forest fire generally had to burn itself out. Man did not have the means to control or even contain a forest fire. However, as man's technology improves and his efforts to manage fires become more effective, man sometimes must choose whether to fight a fire or let it burn out on its own.

Teach for Understanding

Provide time for the student to complete Looking Ahead, Activity Manual page 41. For part B, encourage the student to think of things he would like to learn about the water cycle and conservation. He should write his answers in question form, such as, "What resources should we conserve?"

Provide the answers for part A and allow the student to check his work. After the chapter is finished, you may choose to have him look back at this page and check his understanding of the items he missed.

As time allows, discuss student questions from part B about chemical weathering and erosion. You may choose to provide trade books or other resources to help answer questions that are beyond the scope of this chapter.

Allow the student to leaf through the chapter, looking at the headings, pictures, captions, charts, etc., and discuss the things he thinks he will be learning about.

What is the chapter title? Natural Resources

What are some natural resources that you already know about? Answers will vary.

What natural resources are pictured on the page? trees, water

Activity Manual

Preview, page 41
The Looking Ahead page is intended to assess the student's prior knowledge before beginning the chapter.

Lesson 31

Student Text page 52–55
Activity Manual page 42

Objectives

- Differentiate between renewable and nonrenewable resources
- Explain how fossil fuels are formed
- Identify the sources and uses of petroleum, natural gas, and coal
- Describe the benefits and problems related to the use of nuclear energy

Materials

- 25 checkers
- clock with a second hand

Vocabulary

natural resource
renewable resource
nonrenewable resource
fossil fuel
petroleum
crude oil
refinery
petrochemical
natural gas
coal
uranium

Introduction

Hide the checkers around the room. Allow one person 20 seconds to find as many as he can. Record how many he found. Allow a second and then a third person to each search for 20 seconds, and record the number of checkers each person finds.

Who found the most checkers? Why was it easier for the first person to find checkers?

Why is it getting more and more difficult to find new supplies of energy resources? because there are fewer places to look

Teach for Understanding

Purpose for reading

What is a nonrenewable energy resource?

What are some advantages of using fossil fuels?

Discussion

What are natural resources? materials on Earth that God has made available for our use

What is the difference between a renewable resource and a nonrenewable resource? Nature can replace renewable resources easily. Nonrenewable resources cannot be replaced easily by nature.

What are fossil fuels formed from? remains of plants and animals that are buried quickly

Why are these resources called fossil fuels? They are formed in much the same way as fossils are formed—from the remains of plants and animals that were buried quickly.

Why do geologists always search for more sources of petroleum? Petroleum is a nonrenewable source of energy.

Where is the largest known oil field in the United States? Prudhoe Bay Field in Alaska

From the fresh water that plants need to grow to hidden veins of gold and silver, God has provided everything we need to live on Earth. We call the materials on Earth that are available for our use **natural resources**. Some of these resources we use for producing energy. Other resources we use to provide food and other products.

God has called humans to study the earth and use it to meet their needs. Since we live in a fallen world, it is difficult to use natural resources without damaging or changing nature. This fact should motivate us to study God's world so we can determine better and safer ways to make use of natural resources.

Energy Resources

Earth contains both nonrenewable and renewable resources. **Renewable resources** can be replaced by natural means in a relatively short amount of time. **Nonrenewable resources** cannot be replaced easily. Some of our energy resources are considered nonrenewable. We are gradually using up the earth's supply. However, no one knows how many of these energy resources lie beneath the earth's surface.

Fossil Fuels

Petroleum, natural gas, and coal are all **fossil fuels**. Fossil fuels are formed when the remains of plants and animals are buried quickly. These fossil fuels provide most of the energy we use.

Petroleum

Petroleum (puh TRO lee um) means "liquid rock." Petroleum is the liquid form of fossil fuel. We use petroleum products for transportation and to heat our homes. In some areas, power plants use petroleum to produce electricity. Because petroleum is a nonrenewable resource, geologists constantly search for new oil fields. One of the biggest oil finds in the United States was Alaska's Prudhoe Bay Field. It is the largest known oil field in the United States.

oil drilling rig

Wells are built to retrieve the petroleum, or **crude oil**. Different types of drilling machines are used, depending on the location of the oil site. During the oil boom in Texas in the early 1900s, drilling units dotted the landscape. But many other oil fields are located under oceans and seas. Special drilling units, or drill ships, are used to retrieve the oil from these fields.

Oil wells pump up crude oil, but the crude oil has to be refined before it can be used. Pipelines and oceangoing tankers transport the crude oil to refineries. A **refinery** is a factory that separates crude oil into different products. The Alaskan Pipeline, completed in 1977, is 1290 km (800 mi) long. It transports Alaskan oil from Prudhoe Bay in northern Alaska to

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SCIENCE BACKGROUND

Noahic Flood
Some scientists believe that fossil fuels were formed as a result of the Noahic Flood.

Exhaustible and nonexhaustible
Some people use the terms *exhaustible* and *nonexhaustible* resources instead of *renewable* and *nonrenewable* resources. An exhaustible resource is one that is renewable if used properly, such as soil or forest land. A nonexhaustible resource is one such as the wind or solar energy, which cannot be exhausted no matter how much of it is used.

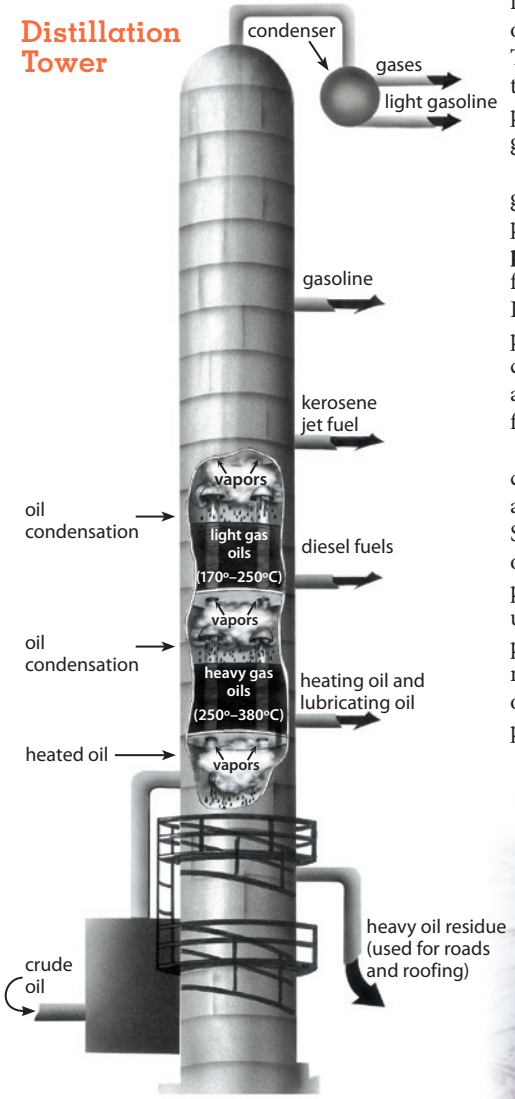
Refinery temperatures
The temperatures used in refining fuels may vary depending on the grade of fuel being processed. These values are not exact and may vary from one source to another.

SCIENCE MISCONCEPTIONS

Crude or refined
Crude oil is not the same oil that is put into automobiles or on door hinges. Crude oil is refined and eventually made into oil, gasoline, and kerosene.

Often people associate high fuel prices with a shortage of crude oil. But high prices may be a result of a shortage of processed fuel.

the port city of Valdez. Ships at Valdez transport the oil to refineries in the lower forty-eight states.



In its original form, crude oil is not a very useful product. However, by refining it we can get many different fuels and products. Heating the crude oil causes it to separate and vaporize. The vapors are collected, and when they condense they form many of the products we associate with petroleum—gasoline, kerosene, diesel, and others.

Most of us recognize that gasoline and heating oil are crude oil products. But we may not realize that **petrochemicals**, chemicals produced from oil, are used in many other ways. People use petrochemicals for making plastics, paint, fabrics, make-up, and cologne. Some petrochemicals are even added to certain foods to help keep them from spoiling.

The use of crude oil products can cause pollution. Spills sometimes occur at oil wells and during transportation. Ships that run aground, hit other ships, or catch fire may cause spills as well. Air pollution from using petroleum products is also a problem. Some cities have poor air quality because of the waste materials thousands of cars and dozens of factories produce as they burn petroleum products for energy.

Discussion

What is another name for petroleum? crude oil

What happens to crude oil after it is pumped up from the earth? It is sent to refineries.

What does a refinery do to the crude oil? separates it into different products

Why is it necessary to refine crude oil? Crude oil is not a very useful product in its original form. Refining produces many different fuels and products.

What are petrochemicals? chemicals produced by oil

What are some uses for petrochemicals? making plastics, paint, fabrics, make-up, cologne

What are some problems that can occur by using oil? oil spills, air pollution

Discuss the *Distillation Tower*.

Does diesel fuel or heating oil vaporize at a higher temperature? heating oil

What is the residue from the refinery used for? roads and roofing

Do you think gasoline vaporizes at a higher or lower temperature than jet fuel? lower **Why?** By looking at the placement of temperatures on the tower, we see that the higher the fuel is on the tower, the lower the temperature needed for the fuel to vaporize.

ART

Petroleum collage

Direct the student to make a collage showing the uses of petroleum. Provide materials for the student to make the collage, and make resource books available to him. If printed pictures are not available, the student may draw illustrations. He should label each petroleum product pictured.

Discussion

Where is natural gas often found? near deposits of oil

How do we get most of the natural gas we use? offshore drilling

What is an advantage of natural gas over oil? Natural gas burns cleaner because it does not contain sulfur.

What is coal? plant material that was buried quickly and fossilized under great pressure

What biblical event can you think of that would have buried plants quickly? the Noahic Flood

How much of our energy needs are supplied by coal? about 25 percent

What are the three grades (types) of coal? anthracite, bituminous, lignite

If anthracite is the cleanest coal to burn, why is it not used more often? It is not common, and it is more expensive.

Which grade of coal is used most often? bituminous coal **Why?** because it is plentiful and fairly inexpensive

Where is lignite formed? in bogs

What has to happen to lignite before it can be used? It has to be dried.

What problems result from coal burning? Burning coal produces soot and sulfur gases that pollute the air.

What condition do many scientists think is caused by an excess of sulfur gases in the atmosphere? acid rain (see Chapter 2)

Are pollution problems solvable? Accept any answer, but point out that some progress has already been made; however, most solutions are very expensive.

Energy resources are a gift from God. What are some ways that we can use energy resources to glorify God? Answers will vary.

Discuss *Science & History*.

How did the miners get trapped underground? They drilled too close to an abandoned mine shaft. Water from the shaft poured in and trapped them in a small space underground.

How long did it take to rescue them? It took 150 workers 77 hours to rescue 9 miners.

Natural gas

Natural gas, a fossil fuel found in a gaseous state, is often found close to deposits of oil. About one-fifth of the world's natural gas comes from offshore drilling. When natural gas was first discovered, no one had a use for it. It was burned off as a waste product. Now natural gas is used to produce heat and light. It is much cleaner to burn than oil because it does not contain sulfur.

Coal

Coal was formed from plant material that was quickly buried and fossilized under great pressure. Coal provides just under 25 percent of our energy needs. Most of the coal mined today is used to generate electricity.


anthracite

Coal comes in several grades. The best and cleanest grade is *anthracite* (AN thruh SITE) coal. Anthracite burns without smoke and produces almost no pollutants. However, it is not common and is quite expensive.

The next grade is *bituminous* (bih TOO muh nus) coal. It is the most common type of coal. Bituminous coal is soft and contains sulfur. Large amounts of ash are produced when bituminous coal is burned. Although bituminous coal causes pollution, it is used often because it is plentiful and fairly inexpensive.


bituminous

Another grade of coal is made of partially decayed plant material. *Lignite* (LIG NITE) is brown and often has pieces of wood in it. It is formed in bogs and must be dried out before it can be burned.


lignite

Burning coal for fuel produces soot and sulfur gases. Most of the soot can be cleaned from the air. Some sulfur can be removed after coal is crushed, but other forms of sulfur are much harder and more expensive to remove. However, since petroleum is more difficult to find, coal is an important energy source.

SCIENCE & HISTORY

Coal mining has always been a dangerous job. Even with today's technology, it continues to carry heavy risks. On July 24, 2002, in Somerset, Pennsylvania, nine miners were trapped after drilling too close to an abandoned mine shaft. Water from the old shaft poured in, trapping the men in a four-foot-high passageway 240 feet underground. Rescuing the miners seemed impossible.

Rescuers drilled shafts from the surface in an attempt to get the miners out. Work slowed when one of the 1,500-pound drill bits broke in a shaft. To keep the miners from freezing, rescuers piped hot air down to them. It took 150 rescue workers 77 hours to successfully rescue the miners.

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SCIENCE BACKGROUND

Coal

Burning coal provides over 50 percent of the electricity generated in America. Coal is also useful in steel production. As cited in the text, coal provides just under 25 percent of all energy needs, including electricity.

Sulfur dioxide

Burning coal, especially bituminous coal, releases sulfur dioxide into the atmosphere. Sulfur gases are pollutants that can cause respiratory and other health problems. Sulfur dioxide is also a main component of acid rain.

Natural gas

Natural gas is the cleanest fossil fuel. Because it does not have an odor, color, or taste, natural gas is a popular source of fuel for homes. Many homes use gas-powered stoves, furnaces, and water heaters.

But natural gas can be deadly. It is poisonous if inhaled by living creatures. Gas companies add a rotten egg fragrance to the gas. If the gas leaks, the rotten egg smell should alert people to the danger. A natural gas detector is also a good safeguard against poisoning. As well as being poisonous, natural gas is highly flammable. In the case of a natural gas leak, even a small spark or flame can cause a violent explosion.

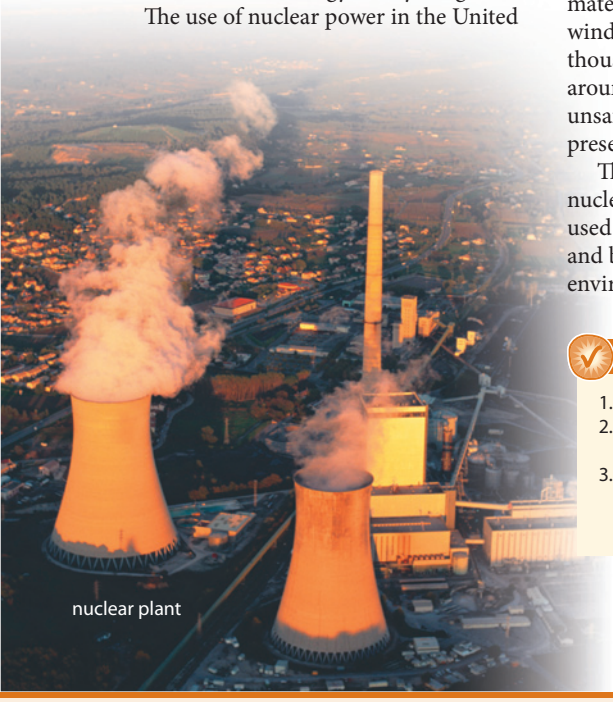
Nuclear Energy

Nuclear energy does not use a fossil fuel. However, it does depend on a nonrenewable resource. Most nuclear energy depends on the mineral **uranium** (yoo RAY nee um). Uranium is used in nuclear reactors to produce electricity and to power some ships and submarines. In a nuclear reactor the uranium atoms are split, producing energy that heats water and turns it into steam. The steam is then used to produce electricity.

About 8 percent of the energy produced in the United States is nuclear. A nuclear energy plant is both efficient and clean. It does not pollute the air with gases or soot. However, uncontrolled nuclear energy is very dangerous. The use of nuclear power in the United States has declined because some people fear what might happen if an accident were to occur at one of the nuclear plants. They point to a reactor accident in 1979 at Three Mile Island in Pennsylvania. Because the reactor had enough backup protection, very little radiation escaped the plant. But the accident did serve as a warning that nuclear plants must be well maintained by alert and highly trained personnel.

People living in Ukraine were not so fortunate. In 1986, in the small town of Chernobyl (chur NO bul), one of three nuclear reactors underwent a core meltdown. The nuclear reaction became so hot that it caused an explosion that blew the top off the structure intended to contain it. Radioactive material reached the atmosphere, and winds carried radioactive pollution for thousands of miles. Some of the soil around Chernobyl is still considered unsafe for farming because of the presence of radioactive particles.

The storage of used radioactive nuclear fuel is another problem. The used fuel needs special containment and burial to keep it from harming the environment.



nuclear plant

QUICK CHECK

1. What are natural resources?
2. Why are petroleum, gas, and coal called fossil fuels?
3. Why is nuclear energy a nonrenewable source of energy?

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Discussion

Why is nuclear energy considered a nonrenewable resource? It depends on a nonrenewable resource.

What does most nuclear energy depend on? uranium

Why is uranium not a fossil fuel? Uranium is a mineral. It was never plant or animal material.

What are some uses of nuclear energy? Possible answers: to produce electricity and to power some ships or submarines

What are some benefits of nuclear energy? Possible answer: It is efficient and clean.

Why has the use of nuclear power declined? because of the fear of accidents and the difficulty in disposing of the waste material

Why was the accident at Chernobyl so much more harmful than the accident at Three Mile Island? At Three Mile Island, backup protection contained the radiation, but the explosion at Chernobyl destroyed the building meant to contain it.

Do you think it is wise to give up on nuclear power plants because of these accidents? Why? Answers will vary.

What are some precautions that could help prevent future accidents? Possible answers: well-built plants, proper waste disposal, well-trained workers

Answers

1. the materials on Earth that are available for our use
2. Petroleum, natural gas, and coal are called fossil fuels because they are formed when the remains of plants and animals are buried quickly.
3. It depends on uranium, a nonrenewable mineral.

Activity Manual

Expansion, page 42

The student will practice reading bar graphs to learn about energy sources used around the world. You may want to compare the United States oil consumption and production with the countries listed on the first graph. In 2009 the United States produced 6,736,000 barrels per day and consumed 19,418,697 barrels per day.

BIBLE

Flood evidence

Coal deposits demonstrate evidence of a worldwide flood as described in the Bible. Coal often contains plant fossils such as leaves and stems. Sometimes whole tree trunks are found in deposits of coal. Often the tree trunks are standing, going through several strata layers. These trees, as well as other fossils, indicate that they were buried quickly and that the strata formed rapidly.

GEOGRAPHY

Chernobyl effects

Use maps and other resources to look at the areas affected by the Chernobyl disaster. Encourage the student to research the range of effects the disaster had on the region.

Lesson 32

Student Text pages 56–57
Activity Manual pages 43–44

Objectives
- Explain the different methods of cleaning up an oil spill
- Predict the best method for removing the oil
- Use a model to demonstrate the different methods of cleanup
- Compare the methods used in this activity with the methods used in a real oil spill

Materials
- See Student Text page

Introduction

Name some characteristics of oil. Possible answers: does not mix with water; burns; floats; slimy or slippery; unusual smell; is used to get heat or energy

Some properties of oil may be useful when trying to clean up a spill, while other properties make the job more difficult. Today we are going to try to clean up an oil spill.

Teach for Understanding

Purpose for reading
The student should read all the pages before beginning the activtiy.

Discussion
Why should oil spills be cleaned up quickly? They can cause great harm to wildlife and the environment.

What is an oil slick? a thick layer of spilled oil on the surface of the water

What are some ways of cleaning up after an oil spill? Possible answers: containing and removing, using chemicals that break up the oil, burning, washing, vaccuming

Accidents do happen. God wants us to be honest and faithful workers who take responsibility for our actions. [BATs: 2c Faithfulness; 2e Work; 4c Honesty]

God commands us to love and care for others. How can cleaning up an oil spill demonstrate that love and care? Possible answers: Removing the oil creates a healthier environment and can reduce property damage.

ACTIVITY

Clean Up the Spill

Process skills
- Hypothesizing
- Predicting
- Making a model
- Observing
- Inferring

Oil is a very important resource. We use oil for many things. But sometimes oil spills occur while oil is being transported by ship, by pipes, or by oil wells. Oil spills can cause great harm to wildlife and the environment, so people try to clean them up quickly.

Because oil floats on salt water and usually floats on fresh water, an oil spill can be easy to locate. The spilled oil spreads out rapidly, forming a thick layer called an *oil slick* on the surface of the water.

There are several ways to handle oil spills. Sometimes it is better to leave the oil alone and let it break down naturally. This is true when there is little risk to human or animal life.

Another way to handle an oil spill is to contain and remove the oil. A *boom*, or flotation foam, is used to gather the oil into a contained area. Then a *skimmer* or *sorbant* can remove the spill. A skimmer either sucks the oil off the water like a huge vacuum cleaner or adheres to the oil and lifts it off the water. A sorbant is a material that absorbs the oil like a sponge. This method is used mainly for small spills or for the later stages of cleanup of a larger spill.

Chemical agents are sometimes used to disperse and break down the oil, but they can be harmful to underwater animals. Other methods of removing the oil include burning it, washing it off beaches with hoses, vacuuming the oil, and removing sand and gravel that have been contaminated with oil.

In this activity you will test several methods of cleaning up a model oil spill.

Materials
baking pan
cooking oil
water
waste pan for oil
paper towels
spoon
10–15 cotton balls
liquid dish soap
medicine dropper
Activity Manual

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TEACHER HELPS

Modeling
The materials used in this activity model methods used to clean up real oil spills.

boom: rolled paper towel

skimmer: medicine dropper or spoon

sorbant: cotton balls or bits of paper towels

chemical agent: dish soap

Set up
Cover your work surface with a towel, disposable plastic tablecloth, or newspaper to make clean up easier.

SCIENCE BACKGROUND

Cleaning up oil spills
The methods used to clean up oil depend on the type of oil, how much is spilled, the location of the spill, what human and animal life is affected, and the weather conditions. While containing the oil with booms and then removing it to reuse it is the best way to clean up a spill, it is also the most expensive. People who cause oil spills are fined severely. People who clean up the spills practice by performing drills. Those who transport the oil must also have a plan in case a spill should occur. If a response is quick, there will be fewer complications and often an easier cleanup process.

Problem

What is the most effective method of removing an oil spill?

Procedure

1. Examine the different materials you will use to clean up the spill. Rank the materials in order from 1 to 5, 1 being the material that you think will work best for removing the oil from the water. List the materials in that order in your Activity Manual.
2. Write a hypothesis stating which material and method you think would be best for cleaning up your oil spill. The materials listed represent materials actually used for cleaning up an oil spill.
3. Add water to the pan until it is half full.
4. Add 100 mL of cooking oil to simulate an oil spill.
5. Use the material you ranked as number one to try to clean up the oil from the water. Record the results in your Activity Manual.
6. Use the materials and methods you ranked from 2 to 5 and compare those with the method you had predicted would work best. Record your observations.

Conclusions

- Which method and materials were most effective?
- Which method and materials were least effective?
- Which method took the most time?

Follow-up

- Try other methods to clean up the oil.
- Research to find out if different types of oil require different methods of cleanup.

SCIENCE PROCESS SKILLS

Making a model

What are the advantages of making and using models? Possible answers: A model can help us see and handle things that are otherwise too large or too small to see and handle easily. A model allows us to try new procedures on a different scale.

Do you think scientists used models to try methods of cleaning up oil? probably

Computer simulations are a type of model.

HISTORY

Deepwater Horizon oil spill

On April 20, 2010, an explosion occurred in the Gulf of Mexico on the Deepwater Horizon oil drilling rig. An estimated 4.9 million barrels of crude oil flowed into the gulf before the well was capped that July. Some oil was still found seeping from the well as late as spring of 2012. The oil quickly spread across the surface of the water and eventually onto the shores of several states. The spill significantly affected fishing, tourism, and related industries.

People tried many traditional methods of cleanup such as skimmer ships, containment booms, sand-filled barricades along shorelines, and chemicals. A competition was announced to inspire creative solutions to cleaning up what had become the largest accidental oil spill in history. The competition included more than thirty teams. During the contest, large amounts of oil were successfully removed from the Gulf.

Procedure

Remind the student to take the time to examine his materials and predict which he thinks will work best. He should list the materials and write his hypothesis before setting up his oil spill.

Guide the student as he sets up his oil spill pan and begins testing his hypothesis. If his results do not support his hypothesis, direct him to try the materials he ranked second. Provide time for him to use each of the materials and observe the results. Remind him to record his observations for each material before testing the next one.

Conclusions

Provide time for the student to evaluate his hypothesis and answer the questions in his Activity Manual. Discuss the student's answers as time allows.

How is this model similar to a real oil spill? Possible answers: The oil floats on water. The oil responds to chemical agents.

How is it not like a real oil spill? Possible answers: The type and thickness of the oil is different. Real oil spills are much larger. No weather conditions are involved.

Use the questions in the Science Process Skills to discuss modeling.

Activity Manual

Activity, pages 43–44

Assessment

Rubrics

Select the prepared rubric, or design a rubric to include your chosen criteria.

Lesson 33

Student Text pages 58–61
Activity Manual pages 45–46

Objectives

- Describe some renewable energy resources
- Compare and contrast renewable sources of energy

Vocabulary

reservoir
hydroelectric energy
geothermal energy
wind energy
solar energy

Introduction

What are some types of nonrenewable energy? Possible answers: petroleum, natural gas, coal, nuclear energy

There are also other sources of energy.

Have you seen solar panels on a house or another building?

Do you have a calculator or toy that is powered by a solar cell?

Have you visited a mill that uses a water wheel or seen a field of windmills?

All of these energy resources share a common characteristic—they are renewable.

Teach for Understanding

Purpose for reading

What are some renewable energy resources?

Why are these resources not used by everyone?

Discussion

What are some advantages of using renewable energy resources? They are clean and fairly efficient.

What is the biggest disadvantage of renewable energy resources? Many are expensive.

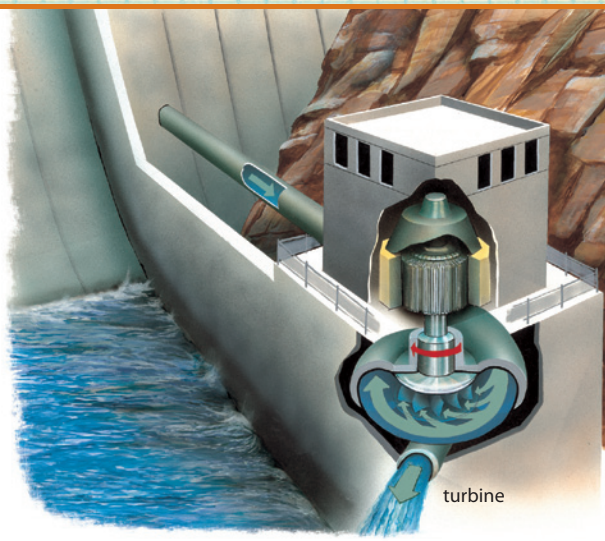
Renewable Energy

Oil, coal, natural gas, and uranium are all examples of nonrenewable sources of energy. There are also renewable sources of energy that can be replaced by natural means. Most are clean, and some are fairly efficient. Unfortunately, many of them are still too expensive to be used on a large scale.

Hydroelectric energy

Water power is the most common form of renewable energy. Even before it was used to produce electricity, rushing water powered wheels for mills that ground grain. Today about 7 percent of the electrical energy needs of the United States is met by using hydroelectric power. By building dams across rivers to form **reservoirs**, or holding areas, behind the dams, engineers can control the flow of water. **Hydroelectric energy** is produced as water flows from the reservoirs and turns turbines. The turning of the turbines generates electricity.

Hydroelectric energy is a great renewable energy resource. In addition to energy production, reservoirs are often designed as recreational lakes. The reservoirs may also provide water for irrigation. However, hydroelectric power has potential difficulties. In order to create a reservoir, large areas of land must be flooded. Also, producing enough water to keep a reservoir filled requires a relatively large river. Additionally, engineers must consider the downstream impact of building a dam across a river.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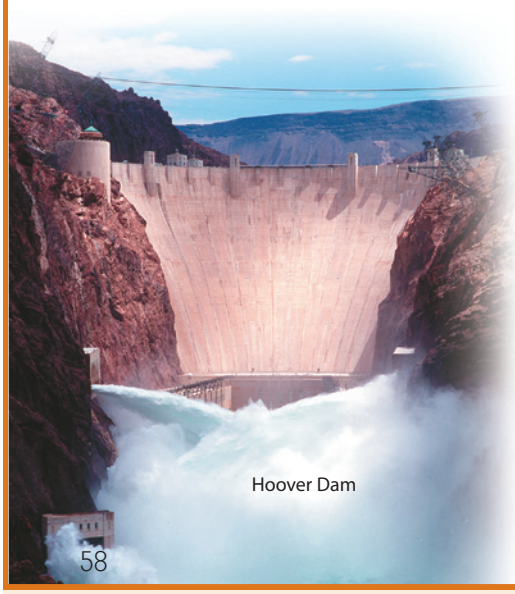

Hoover Dam

58

SCIENCE BACKGROUND

Hoover Dam
The 726.4-foot-tall Hoover Dam is a concrete arch dam located on the Colorado River. The Hoover power plant located at the base of the dam houses seventeen turbines, or water wheels. This power plant produces an average of four billion kilowatts of electricity per year. A kilowatt is 1,000 watts of electricity.

America's first hydropower plant
The first American hydropower plant was at Niagara Falls. It is still a source of power today. In 1881 the first station generated electricity for nearby mills and villages. By 1896 the electricity was being transmitted 26 miles to Buffalo, New York.

Geothermal energy
The geothermal energy descibed in the Student Text is used for large scale energy needs and requires great amounts of underground heat. There are also small heat pump systems installed in some homes that are called geothermal systems. These pump water through the ground around the building to heat and cool homes. No electricity is generated.

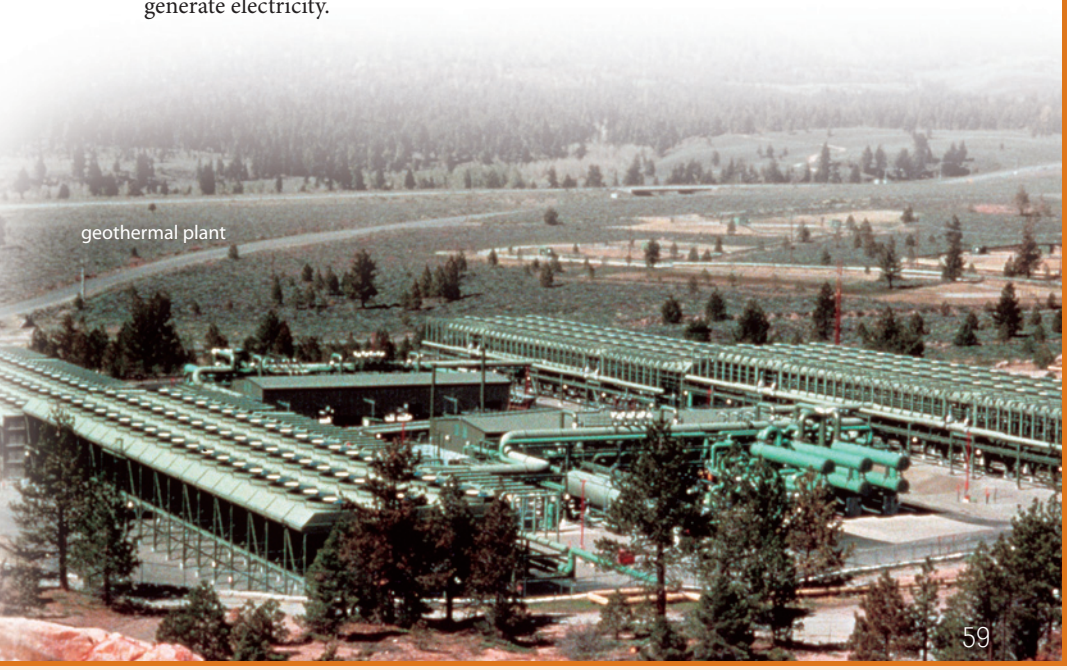
Geothermal energy

To produce energy from fossil fuels, the fuel must be used up or consumed. The consumption of this fuel heats water and produces steam that turns a turbine. In contrast, **geothermal energy** uses heat from the earth to produce steam. There is no consumption of the heat source. This allows geothermal energy to be renewable.

One method of using geothermal energy is to use the steam or hot water that already comes out of the ground. Another method is to drill into a place in the earth where very hot water or steam is under pressure. Releasing the pressure causes the super-hot water to change into steam. The steam is then channeled to turn turbines and to generate electricity.

Water heated by geothermal energy can also be channeled through pipes. These hot-water pipes heat many things, such as schools, swimming pools, and greenhouses.

Geothermal plants are fairly inexpensive to build and operate. This type of heat produces no air pollution or radioactive hazards. But this resource is not perfect. Water deep in the earth carries many pollutants. When the water becomes steam, those pollutants remain behind. They must be properly disposed of to avoid contaminating streams and rivers. Also, only certain areas where there is magma close to the earth's surface are suitable for using geothermal energy.



geothermal plant

DIRECT A DEMONSTRATION

Demonstrate different energy sources

Materials: pinwheel, electric fan or hairdryer, container of water, goggles, and a source of steam, such as a teakettle on a hot plate

Blow on the pinwheel, or hold it in front of the fan or hair dryer to make it turn.

What is the source of energy? wind

Pour water down the edge of the pinwheel to make it turn.

What is the source of energy? moving water

Place the pinwheel in the path of the steam to make it turn. (Use goggles or safety glasses while using the hot plate.)

What is the source of energy? steam

HISTORY

Water wheels

Mabry Mill, located in Virginia, and Newlin Grist Mills, located in Pennsylvania, have two of the oldest water wheels in America. They have been preserved for future generations. At designated times, tourists and visitors can view demonstrations of the grist mills and other Early American crafts.

GEOGRAPHY

Geothermal energy locations

Point out Iceland on a world map. Iceland has over 250 hot springs, which is more than any other country in the world. This form of geothermal energy is used to heat homes and greenhouses.

Discussion

What is the most common form of renewable energy? water power

What are reservoirs? holding areas for water

How does a hydroelectric dam make electricity? Water flows through the dam and turns a turbine that generates electricity.

What are some advantages of hydroelectric power? Possible answers: It is a renewable resource; reservoirs can be used for recreation and irrigation.

What are some difficulties of hydroelectric power? Possible answers: A large area of land must be flooded to form the reservoir. It requires a large river. It may create problems downstream from the dam.

What are some possible problems that may occur downstream from a dam? Possible answers: less water in the river than before the dam; risk of flooding if the dam breaks; affects the ecosystems along the river and reservoir

What does geothermal energy use to produce steam? heat from the earth

Why is geothermal energy renewable but energy from fossil fuels nonrenewable? Geothermal energy does not require consumption of a heat source. To produce energy from fossil fuels, the fuel is used up (consumed).

How does geothermal energy produce electricity? Hot water or steam from underground sources is used to turn turbines and produce electricity.

What is another way geothermal energy is used? It can be piped to heat structures.

What are some advantages of geothermal energy? Possible answers: It is renewable. It is relatively inexpensive. It does not produce air pollution or radioactive waste.

What problems does geothermal energy have? Possible answers: pollutants from the earth; available only in certain areas

Is geothermal energy available in all parts of the world? no **Why?** Geothermal energy is available only where heat sources, such as magma, are close to the earth's surface.

What earth feature is associated with magma? volcano

Discussion

What is a wind farm? an area containing many windmills that turn wind into electrical energy

What is wind energy? energy produced by air movements (wind)

What are some advantages of wind energy? It is nonpolluting and requires little maintenance.

What are some difficulties with wind energy? Possible answers: It requires a steady wind. The windmills take up a lot of space. There must be a way to store the energy. Some people object to the sight and sound of the machines.

How does the sun indirectly provide energy for us? We eventually eat plants that have used the sun for photosynthesis and eat food from animals that have eaten plants. The food provides energy to power and heat our bodies.

What term do we use to describe the sun's energy? solar energy

How do solar panels provide energy to heat a house? They contain tubes of water heated by the sun and stored for use in the house.

How warm does water heated by solar panels usually get? about 74 C° (165° F) **What can be used to increase the water temperature even higher?** special reflectors

How do some scientists think a solar field could provide energy? Large mirrors would reflect sunlight to heat water, which would produce steam that turns a turbine.

What is another way the sun's energy can produce electricity? through photovoltaic cells

What happens when sunlight hits panels of photovoltaic cells? A chemical reaction produces an electric current.

Wind energy

Since the 1960s, a new type of farm, called a *wind farm*, has appeared. A wind farm is not covered with waving wheat but rather with giant windmills. Like water wheels, windmills have long been used to turn wheels to grind grain. But these new windmills use **wind energy**, or air movements, to generate electrical energy. The windmills often have blades that are over 30 m (100 ft) long. They take up much space, but they do not cause air or water pollution. Windmills operate with very little maintenance.

However, these windmills require steady wind. There are not many places on Earth where wind blows constantly. Also, scientists are still working to solve the problem of efficiently storing electrical energy produced by the windmills. And some people who live nearby object to the sight and sound of these massive machines.

Solar energy

Every day the sun provides energy for us indirectly, as plants use it to produce food through photosynthesis. Through the food chain we use that energy to power and heat our bodies. However, we can also use the sun's energy, or **solar energy**, to power and heat other things.

One way of using the sun's energy is to directly raise the temperature of water and air. In a house with solar collectors, sunlight raises the temperature of water. Solar panels contain tubes of water that are heated by the sun and carried to a storage tank to be used in the house. Water heated in this way can reach temperatures of around 74°C (165°F).

With special reflectors, water temperatures may be raised to 288°C (550°F). This is another way of using solar energy. These high temperatures produce the steam needed to turn a turbine. Some scientists believe that all of the electricity

wind farm

HISTORY

Windmills

Windmills seem to have originated in Persia. The oldest ones are in Afghanistan. Historians think either conquerors or crusaders brought information about windmills to Europe. From Europe, this invention spread to the rest of the known world.

GEOGRAPHY

Wind farm locations

Due to Ukraine's windy terrain, wind is one of this nation's most promising natural resources. In the United States, the Midwest and Great Plains are ideal locations for wind farms. Many Midwest and western states have existing wind farms and are in the process of building more. Wind farms are not limited to land. Some countries. such as the United Kingdom, Denmark, Belgium, the Netherlands, Germany, and China have offshore wind farms. Point out some of these areas on a world map.

needs of the United States can be met with one giant solar collection area about 280 sq km (174 sq mi), called a *solar field*. Large mirrors would reflect sunlight to a tower where water would turn to steam.

The sun's energy can produce electricity more directly through *photovoltaic cells*. When light strikes panels made of these cells, a chemical reaction produces an electric current.

The biggest problems with solar energy are the expense of the solar collection cells and the large amount of land area required. Also, these systems have to store electricity since they cannot work after sunset.

FANTASTIC FACTS

Solar cells are an essential part of the space program. They were used to power the moon buggy that transported astronauts on the moon during the 1970s. But what about using solar cells on the moon to produce electricity on Earth? Some physicists think that we should consider putting a huge solar cell grid on the moon. As the grid collects solar energy, the energy would be converted to microwave energy and beamed to receivers on Earth that would convert it to electrical energy. Moon rocks collected during lunar missions show that the moon has the basic materials for producing solar cells. Perhaps one day the moon may be the means of supplying our energy needs.

QUICK CHECK

1. What is a renewable resource?
2. Compare the advantages and disadvantages of the different types of renewable energy.

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SCIENTIST

Charles Fritz

Charles Fritz invented the first solar cell in the 1880s. Other inventors improved this invention by making it more efficient and practical. The first solar panel was built in 1954 as a joint effort by Gerald Pearson, Calvin Fuller, and Darrel Chapin. A solar panel is a battery powered by the sun.

TECHNOLOGY

Use of solar cells

In addition to producing electricity at power plants, solar cells have powered vehicles, calculators, toys, emergency phones, roadside message boards, traffic lights, and satellites. Solar cells have also been used to cook food.

Discussion

What is an advantage of solar energy? There are no pollutants.

What are some disadvantages of solar energy? Possible answers: expense; amount of land required; having a way to store electricity

Discuss *Fantastic Facts*.

At what unusual place do some scientists think they could put a solar grid? the moon

How might the moon be used to produce electricity on Earth? A solar grid on the moon would collect solar energy and send it to Earth to be converted to electricity.

Answers

1. a resource that can be replaced by natural means
2. **Hydroelectricity**—Advantage: Reservoirs provide water for recreation and irrigation.
   Disadvantage: Reservoirs require a large river and require the flooding of large land areas.
   Wind—Advantages: no pollutants; requires little maintenance
   Disadvantages: require steady wind; need to store energy; takes up a lot of space; sometimes considered noisy or unsightly
   Geothermal—Advantages: Power plants are inexpensive to build and produce no air pollutants or radioactive hazards.
   Disadvantages: Power plants must be close to areas where hot magma is close to the surface; water pollutants must be disposed of.
   Solar—Advantages: provides heat and electricity; no pollutants
   Disadvantages: expensive; problem of storing energy; requires a large amount of land

Activity Manual

Review, pages 45–46

These pages review Lessons 31 and 33.

Assessment

Quiz 3-A

The quiz may be given any time after completion of this lesson.

Lesson 34

Student Text pages 62–65
Activity Manual pages 47–48

Objectives

- Name and identify the uses of several metals
- Recognize soil as a natural resource
- Identify several ways to conserve soil
- Defend the idea that people can change nature to meet their needs

Materials

- Bible
- samples of metals, such as aluminum (cans or foil), lead (curtain weights or fishing sinkers), iron, and copper (pieces of wire or pipe)
- hammer
- magnet

Vocabulary

mineral	malleable
vein	fallow
ore	ground cover
smelting	contour plowing

Introduction

Lead a discussion concerning the properties of metals. Suggested metals include aluminum, lead, iron, gold, silver, copper, nickel, bronze, and brass.

Identify some physical characteristics of each metal and test each sample with your hands and the hammer to see if it can be easily dented, scratched, or bent. Use the magnet to see if the metal is attracted to it.

Is the metal heavy or lightweight?

Does it look tarnished or rusted?

Does it dent or bend easily?

Is it magnetic?

Each metal has properties that make it useful.

Teach for Understanding

Purpose for reading

What is smelting?

What are some ways to conserve soil?

Discussion

What are two characteristics of minerals? Possible answers: They occur naturally in the earth. They are solid substances. They have never been organic substances.

How are veins of minerals formed? Material containing minerals melts. The minerals have different properties, so they separate into layers. As they cool, they form concentrated areas of the minerals.

Other Resources

Minerals

Though some minerals are very abundant, most scientists consider minerals nonrenewable natural resources. A **mineral** is a solid substance found naturally in the earth's surface. It never has been a living organism. Minerals include such common substances as salt, sand, and iron, and such rare substances as gold and diamonds.

Concentrated areas of specific minerals are called **veins**. Veins of minerals are often found near volcanic areas. The intense heat from the volcano causes the materials containing minerals to melt. The different properties and densities of these melted minerals cause many of them to settle into layers as they cool.

Veins often contain **ores**, materials with usable amounts of metal in them. Sometimes a process called **smelting** is used to separate metal in the ore from the other materials. The ore is crushed and heated until it is a liquid. The *dross*, or nonmetal part, floats to the top, where it can be removed easily. The remaining material has a much higher concentration of the metal. Often this process is repeated several times. Each time the resulting product is purer than the time before. God uses the process of refining, or purifying, metal to illustrate what God does in the life of a believer (Job 23:10). His ultimate goal is to make us like His Son (Rom. 8:29).


smelting

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Precious metals

Some metals are called precious metals because of their rarity. When the wise men went to worship Jesus, they took Him gifts that were of great value. Only the best that they had would be right for the King of kings. One of the gifts that they offered was gold (Matt. 2:11). Throughout the ages, a man's wealth has often been judged by the amount of gold he possesses.


gold

Gold is a soft and shapeable, or **malleable**, metal. People used to test gold coins by biting them. If a person's teeth dented the coins, the coins were real gold. Though gold is often used for jewelry, it must be mixed with other metals, such as copper or nickel, to strengthen it. Gold is also used in dentistry, glassmaking, and for some special wiring and electronic connections.


tarnished silverware

Silver is another metal used mainly for money and jewelry. Also a malleable substance, silver is often mixed with other metals. Silver is easy to scratch, and it tarnishes, or turns black. Silver may be found around your house in forms such as electrical parts, ink, glass, mirrors, or medicines. Silver is even necessary for making and processing photographic film.


copper

Other metals

The red-orange metal called *copper* is also used for money. If you have an old penny, then you have copper. One of copper's greatest values, however, is that it is a good conductor of electricity. Copper can be shaped or formed easily, yet it is sturdy and does not rust as iron does. Because of its properties, copper is used frequently around the house in wiring and plumbing. Bronze and brass are made from mixing copper with other materials.


hot roll of steel

Iron is a very plentiful and useful metal. Because iron is strong and durable, it has been used to make tools and weapons throughout history. Iron is used for many household items, such as pans, paint, and appliances. It is also used in the form of steel for constructing buildings. You can find things that contain iron by using a magnet. If the magnet is attracted to an item, the item probably contains iron.


aluminum cans

You have probably seen aluminum foil used to wrap up leftovers before they are stored in the refrigerator. *Aluminum* is very practical because it is strong and lightweight. The transportation industry uses it to make cars and airplanes. Aluminum is the most abundant metal in the earth's crust. Even though this resource is plentiful, we can help preserve it. Recycling things like soda cans is a way to use our resources wisely.

aluminum foil

Discussion

Why are minerals usually found near volcanic areas? Answers will vary but might include that intense heat helps melt the materials containing minerals.

What are ores? materials with usable amounts of metal in them

Describe the process of smelting. Ore is crushed and heated until it is a liquid. The nonmetal part, or dross, floats to the top so it can be removed. The remaining metal is purer.

Read Job 23:10 and Romans 8:29.

How is the process of smelting similar to how God works in the life of a Christian to cause him to be more Christlike? Just as metal is put to the test of fire so it will be purer, a Christian may be taken through hard times of testing to help purify his life.

Why do we call something a precious metal? because it is rare

Why did biting a gold coin help test whether the coin was real or not? Because gold is soft, the coin would dent or move. If it had been made of something else, it would have probably been too hard to dent.

Why do gold and silver have to be mixed with other metals for most purposes? They are too soft by themselves.

What are some uses for silver? Possible answers: money, electrical parts, ink, glass, mirrors, medicines, and for developing photographs

What is a red-orange metal? copper

Why is copper such an important metal? It is a good conductor of electricity.

Why has iron been used to make tools and weapons? It is strong and durable.

What is a way of finding out if something has iron in it? See if a magnet is attracted to it.

What is the most abundant metal on Earth? aluminum

Why is aluminum such a practical metal? It is strong and lightweight.

Why would these properties make aluminum a good choice for cars and airplanes? Because aluminum is lightweight, less fuel is required to move things made of aluminum.

Discussion

Why is soil considered a natural resource? Possible answers: God gave it for our use. It is something we can use to meet needs.

Why were many early settlers in America not careful with the soil? They thought there would always be plenty of fertile land for their use.

Farming is one change that man has made to nature. Name some other kinds of changes man has made to nature. Possible answers: clearing land, fertilizing, planting, building houses and cities, paving roads

Share and discuss the information in the Bible link about mother nature and complete a Venn diagram to contrast it with man's dominion over the earth.

Do the Direction Activity on page 73 as time allows.

What are some ways that farmers can help their land be more fertile? Possible answers: let fields lie fallow, rotate crops, plant ground cover crops, add fertilizer, use contour plowing

What did farmers in the Middle Ages learn about planting crops? The soil wore out as a result of planting the same crops in the same fields year after year.

What does it mean to leave a field fallow and what is the benefit? let the field rest and not plant in it; the rest allows natural processes to replace nutrients

What are some substances that farmers can use to replenish nutrients in the soil? Possible answers: compost, manure, mineral and chemical fertilizers

Why might a farmer plant soybeans in a field? Soybeans are a crop that helps return nutrients to the soil.

What events in the 1930s caused scientists and farmers to work together to stop erosion? dust storms

Discuss *Science & the Bible*.

Why do you think God has given man the example to rest one day each week? Possible answers: to worship; because our bodies need rest to be healthy

According to the law given Moses, what was supposed to happen during the seventh year? Nothing was to be planted or harvested, in order to give the fields a year of rest.

What land-use principle was a result of the Sabbath year? allowing the land to lie fallow

Was land conservation the main reason God established the Sabbath year? no **What was the reason?** God intended it as a time to remind the Israelites of Him.

Soil

Another important natural resource is soil. America is a land blessed with much fertile soil. Many early settlers thought that no matter how they treated the soil, there would always be enough land to provide their needed timber, food, and fiber products. When fields no longer produced good crops, new fields were cleared and the old fields were abandoned. Today Americans are much wiser in their treatment of this important natural resource.

Conservation

Fortunately, soil is a renewable resource. Even old fields can be brought back to fertility if they are properly cared for. There are several methods farmers can use to keep soil fertile and productive.

As early as the Middle Ages, farmers learned to rotate crops in their fields to help maintain soil fertility. The farmers might plant corn one year and beans the next year. They discovered that if they planted the same crop year after year, the soil wore out and became unproductive. They also let fields lie **fallow**, or resting, for a season or year. This period of rest let natural processes replace the nutrients that had been used up. Many farmers today do the same. They rotate crops and, when possible, leave fields unplanted so the soil can be replenished.

One way of replenishing the lost nutrients of the soil is by adding fertilizer. The use of compost or manure adds organic material that breaks down and releases nutrients into the soil. The addition of minerals and chemical fertilizers also produces more fertile ground. Many farmers plant crops that help enrich the soil. Soybeans are good for this, since they return needed nutrients to the soil as they grow.

During the dust storms of the 1930s, scientists and farmers worked together to stop the wearing away of the soil. They discovered that fields with vegetation had less erosion from the devastating winds than barren fields. Unused fields were planted with

SCIENCE & THE BIBLE

When God finished His creation, He rested on the seventh day. He established the seventh day as a day of rest and worship. When God gave the Law to Moses, He established a seventh year of rest (Lev. 25:4). In that year, nothing was to be planted or harvested. Though the purpose of the Sabbath year was to remind the Israelites of God, it also established a sound principle for using the land efficiently.

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SCIENCE BACKGROUND

Soybeans

Soybeans have a practical purpose other than just enriching the soil. Soybeans provide oil and protein and are an important food source for man and animals. The sprouts are rich in vitamin C. Soybean oil is in margarine, shortening, mayonnaise, salad oil, plastics, paint, and glue. Some of the many uses for soybeans include soy flour, soy grits, soymilk, imitation ham, hot dogs, hamburgers, soy sauce, tofu, and animal food.

SCIENCE MISCONCEPTIONS

Organic

The term *organic* can mean "containing carbon," since all living things contain carbon. This does not mean that all carbon was once part of living organisms. In the Student Text, *organic* is used only to refer to living or dead organisms.

BIBLE

Mother nature

Some people think that man should not change nature. They believe that man, like whales and buffalo, is part of nature, so they should leave nature as they found it. But the Bible teaches that people are special. We are made in God's image and are to have dominion, or rule, over the earth (Gen. 1:26–28). The earth is not our mother. The earth is a world of resources that God invites us to use in order to meet our needs and the needs of others.

a **ground cover**, a low-growing crop, such as clover. Instead of plowing immediately after a harvest, farmers began leaving the old stalks in the fields until the next spring planting. The stalks helped protect the soil and slow the evaporation of water from the ground. Today farmers use many of these same methods to protect their fields when they are not in use.

Contour plowing is a method used by farmers to help keep water


contour plowing

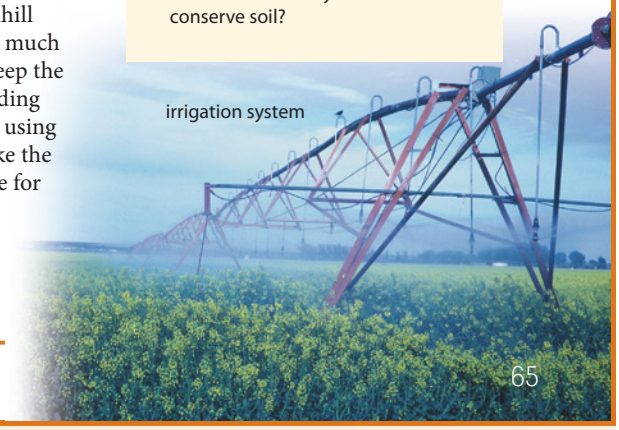
from washing soil away. Farmers plow furrows horizontally around a hill instead of up and down it. The furrows slow the flow of rainwater downhill so that it does not carry away as much topsoil. The furrows also help keep the water on the fields longer, providing more moisture for the crops. By using these methods, farmers can make the land more profitable and useable for future planting.

Modern farms

Farmers closely monitor the conditions of their fields in order to ensure the best use of their land. In many parts of the world, small family farms are still the most common kind of agriculture. Because the fields are small, a single field can be irrigated and fertilized the same way. But on large industrial farms, like many in the United States, the needs of the soil in different areas of one field may vary. To help meet these needs, many large farming operations turn to technology to improve the use of their soil. A farmer may use satellites to provide information about the conditions of the soil. That information and a Global Positioning System (GPS) are then used to provide the right amounts of fertilizers and irrigation to the areas in need.

QUICK CHECK

1. What are the characteristics of a mineral?
2. How is dross removed from metal ores?
3. List several uses for copper and iron.
4. What are some ways to conserve soil?


irrigation system

DIRECT AN ACTIVITY

Man's "rule" over the earth

Guide a discussion about the response Christians should have to the following: "Man is not a king over nature, he is the same as the animals and needs to learn to live with the earth and not try to rule over it." People are made in God's image and they are to rule over the earth (Gen. 1:26–28). We should view resources as gifts from God that we should use to meet the needs of others. We should work hard not to abuse the earth, but we should not be afraid to use it.

TECHNOLOGY

GPS

The Global Positioning System is really a network of satellites that orbit the earth and relay information to receivers on Earth. It can tell you the exact latitude, longitude, and altitude of the location of a receiver.

A farmer's use of the GPS and satellites is called precision farming. Information from satellites helps a farmer pinpoint the location of soil samples and crop yield. With this data, a farmer can make intricate grids and determine which parts of his field need more fertilizer and which parts of his field are producing as desired. By mounting a GPS receiver on a tractor, a farmer can plow or harvest a field more efficiently. The GPS helps the farmer navigate through the field without missing spots or overlapping rows.

Discussion

What did farmers and scientists discover about barren fields? Barren fields have greater erosion.

Why would keeping topsoil from eroding be important to a farmer? Answers will vary but should include that most growing occurs in the topsoil.

How did farmers adjust their farming methods to prevent barren fields? Possible answers: They planted ground covers in unused fields. They left old stalks in the fields until the next planting.

What is a ground cover? a low-growing crop

In addition to decreasing erosion, how did leaving stalks in a field help the land? The stalks slowed evaporation of water from the ground.

What is contour plowing? plowing horizontal furrows around a hill

What is a benefit of contour plowing? The horizontal furrows slow the downhill flow of water, reducing erosion and keeping water on the fields longer.

What modern technology is sometimes used on large farms? satellites and the Global Positioning System (GPS)

How does the Global Positioning System (GPS) help farmers? It allows farmers to irrigate and fertilize only the areas of the field that need it rather than the whole field.

Answers

1. A mineral is a solid substance found naturally in the earth's surface. It has never been a living organism.
2. The ore is crushed and heated until it is a liquid. The dross floats to the top of the liquid and is removed.
3. Possible answers: copper—money, electrical parts, plumbing
   iron—tools, weapons, pans, paint, appliances, steel
4. let fields lie fallow, rotate crops, add fertilizer, plant ground cover crops, use contour plowing

Activity Manual

Expansion, page 47

The student will read a map about the location of mineral resources.

Review, page 48

This page reviews Lesson 34.

Assessment

Quiz 3-B

The quiz may be given any time after completion of this lesson.

Objectives
- Make models of soil without erosion prevention and soil with erosion prevention
- Infer how certain materials prevent soil erosion

Materials
- See Student Text page
- bucket or large containers to dispose of used soil and water

Introduction

What are some methods farmers use to conserve soil? Possible answers: let fields lie fallow, rotate crops, fertilize, plant ground cover crops, use contour plowing

Which methods may help prevent soil erosion? plant ground cover, contour plowing

In this activity you may try some of these methods to help prevent soil erosion.

Teach for Understanding

Purpose for reading
The student should read all the pages before beginning the activity.

Procedure
Discuss ideas about how the student might prepare the pan with erosion protection. Provide time for him to write or draw his plan as his hypothesis.

How might you simulate planting a cover crop? by placing planting material in soil

How might you arrange items in the soil to simulate contour plowing? Possible answers: make horizontal furrows; place objects in horizontal rows

Guide the student in cutting and preparing the pans. Help him measure and set up the angle for each pan. Remind him that the pan with erosion protection should match the plan he explained for his hypothesis.

After his pans collect the run off, help as needed with the filtering and measuring mass.

ACTIVITY

Erosion Prevention

Process skills
- Making a Model
- Observing
- Inferring
- Recording data

You have been given the challenge of helping Farmer Brown figure out a way to prevent erosion on his farm. His land is situated on a hill with a 20° angle, and every year he loses valuable soil from rain runoff. He has hired you to be his land engineer. Using the materials below, find a solution to Farmer Brown's problem.

Problem
How can you reduce the amount of erosion on a 20° slope?

Procedure

1. In your Activity Manual, write or draw your plan for helping Farmer Brown reduce erosion.
2. Prepare the foil baking pans by cutting them at the corners of one of the smaller ends. Fold the cut piece down to be even with the bottom of each pan so it will not interfere with the erosion. (Safety tip: The cut edges of the pan may be sharp.)
3. Place 500 mL of potting soil at the uncut end of each baking pan. One pan will have erosion protection that you add to it, and the other pan will not have erosion protection.
4. Place the open end of each pan into a larger pan or container. These containers will catch the runoff.
5. Put each baking pan at a 20° incline with the soil at the top. Books or any slanted surface can be used to make the incline.
6. In the pan that will have erosion protection, add the grass tufts, sticks, leaves, pebbles, and any other materials you want to use to slow down the erosion of the soil. This pan should look like the plan you stated in your hypothesis. List the materials you used for erosion prevention in the materials list.
7. Use the watering can to slowly sprinkle 250 mL of water onto the soil with the erosion protection. Be sure to sprinkle the water over all areas of the soil. Allow the eroded material to run into the runoff container.

Materials
2 foil baking pans (9″ × 13″)
scissors
potting soil
containers for runoff
protractor
water
watering can
balance
grass tufts
sticks
leaves
pebbles
cheesecloth
4 clear plastic cups, 12 oz
Activity Manual

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TEACHER HELPS

Filter ideas
Nylon hose could be substituted for the cheesecloth filter. Coffee filters and paper towels do not work well as filters for this activity.

Alternate materials
Instead of a plastic cup, a coffee filter could be used to measure the mass of the eroded material. A large salt shaker could also be used instead of a watering can.

Measuring the slope
Rest one end of the pan on several books. Place the flat side of the protractor on the table. Align the center point of the protractor with the point with which the pan touches the table. Measure the angle formed between the pan and the table. Adjust the books as needed to get the correct angle.

8. Place a double layer of cheesecloth over a plastic cup to act as a filter. Pour the contents of the container through the filter to remove the water. Put the eroded material in a clean plastic cup and use the balance to measure its mass. Record your measurements.
9. Repeat steps 7 and 8 for the pan without erosion protection. Compare the results from the two containers.

Conclusions

- What prevented the soil in one pan from eroding as much as the soil in the other pan?
- How might your observations help Farmer Brown?

Follow-up

- Try using a different method to prevent erosion.
- Plant some grass seed in the soil. After it has sprouted, try the experiment again.
- Try other methods of pouring the water.

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SCIENCE PROCESS SKILLS

Inferring
Inferring involves interpreting observations and drawing conclusions based on previous knowledge and experience.

What could you infer about soil conservation from this activity? Possible answer: Erosion protection slows erosion.

How might the results affect how you set up other related experiments? Answers will vary, but elicit that knowledge gained from one experiment can influence later experiments.

Conclusions

How did the items you placed in the soil slow the amount of erosion? Answers will vary.

How do you think your results will help a farmer with fields on hillsides? Answers will vary.

What could you have done differently to the soil to help prevent erosion? Answers will vary.

In what ways is this experiment limited in modeling what would happen in Farmer Brown's fields? Answers will vary.

Provide time for the student to evaluate his hypothesis and answer the questions in his Activity Manual.

Use the questions in the Science Process Skills to dicuss inferring.

Activity Manual

Activity, pages 49–50

Assessment

Rubrics
Select the prepared rubric, or design a rubric to include your chosen criteria.

Lesson
36–37

Student Text pages 68–73
Activity Manual pages 51–52

Objectives

- Identify water as a natural resource
- Explain how the ocean is the source of most fresh water
- Identify locations of fresh water
- Describe the different kinds of ice
- Explain what it means to reuse, reduce, or recycle something

Materials

- container
- water
- world map
- salt
- dark plastic bag

Vocabulary

hydrosphere
water cycle
phytoplankton
ground water
aquifer
humidity
ice sheet
ice shelf
iceberg
sea ice
reduce
reuse
recycle

Introduction

Lessons 36–38 cover six Student Text pages. Divide the material into two lessons as best fits your schedule.

What are some things we use to produce energy? Possible answers: water, coal, oil, natural gas, wind, nuclear power, the sun

What are some things we produce from these resources? Possible answers: electricity, gas, heat, plastics

Teach for Understanding

Purpose for reading

What is the hydrosphere?

Why are oceans salty?

Discussion

What is the hydrosphere? all of the water on, above, and within the earth

What is the path that water takes as it travels between land and sky called? the water cycle

How does the water cycle benefit the earth? God designed it to continually replenish the earth and its living things with fresh water.

Discuss the chart *Earth's Water* and the *Water Cycle* diagram.

What percentage of water is in the oceans? 97.2%

Which has a greater percentage of Earth's water—freshwater lakes or inland seas and salt lakes? freshwater lakes

Water

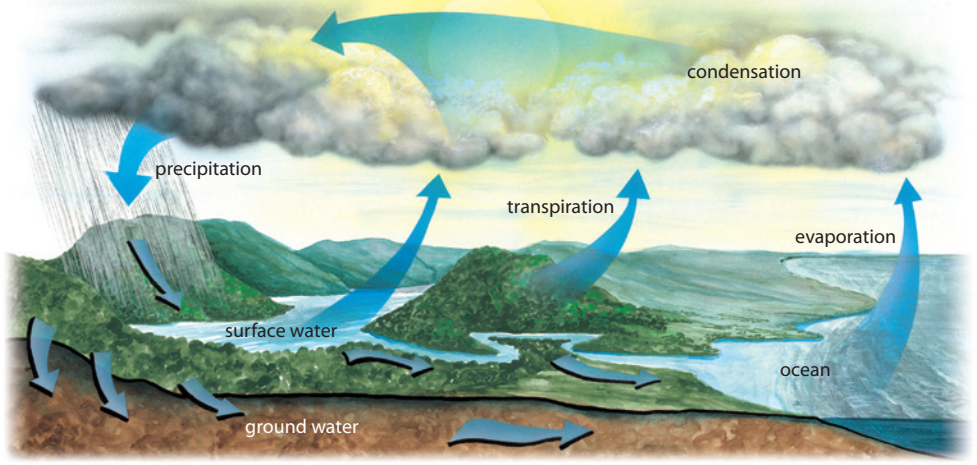
Water is one of Earth's most valuable renewable resources. Three-fourths of the earth's surface is covered by water. Earth is the only planet known to have water in its liquid form. Water is one way God provides for the needs of His creation. All of Earth's water found in lakes, oceans, streams, rivers, soil, underground, and in the air is referred to as the **hydrosphere**. This chart shows where most of our water resources are located. Without the hydrosphere, living things could not survive.

We can see how water is replaced and reused by looking at the path it takes as it travels from land to sky and back to land. This path is called a **water cycle**. God created this process to continually replenish the earth and its living things with fresh water (Job 36:27–28).

Earth's Water

Water source	% of total water
Oceans	97.2%
All icecaps and glaciers	2.0%
Ground water	0.62%
Freshwater lakes	0.009%
Inland seas, salt lakes	0.008%
Atmosphere	0.001%
All rivers	0.0001%

Water Cycle



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TEACHER HELPS

Water cycle
The water cycle has been covered in previous grades, so little emphasis is put on it in this chapter. However, you may want to spend some additional time reviewing the diagram and discussing the water cycle with them.

SCIENCE BACKGROUND

Transpiration
This is the part of the water cycle in which water is released by plants as they carry on photosynthesis.

Phytoplankton
These photosynthetic organisms live near the surface of the ocean because they need sunlight. Phytoplankton are members of the kingdom Protista.

Photosynthesis
Plants use a process called photosynthesis to convert the energy in sunlight into a useable source of energy, sugar.

Ocean currents and weather
Water warms and cools more slowly than land. An ocean current can carry warm or cool water from one area of the ocean to another.

The Gulf Stream carries warm water from the Caribbean to the coasts of Europe. The warm air over the ocean then flows toward the cool air over the land, causing breezes and winds. These warm winds affect the weather and climate of Europe. Other ocean currents have similar effects on landmasses around the world.

Oceans

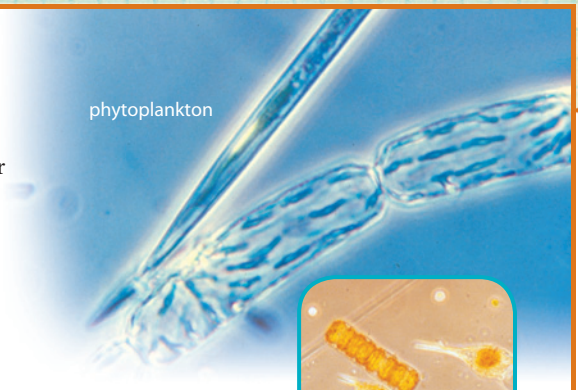
Oceans contain most of Earth's water. Though we cannot drink their salty water, the oceans are a key factor in providing fresh water for us. Through the water cycle, ocean water evaporates, condenses, and returns to Earth as fresh water. The dissolved minerals and salts that are left behind cause the oceans to be *saline*, or salty.

Many parts of the world do not have enough fresh water. In the past, people in these places depended on deep wells. Now desalination (dee SAL uh NA shun) facilities are able to remove the salts and other minerals from ocean water in order to help produce fresh water. Some countries and areas depend heavily on this process for water.

TRY IT YOURSELF

You can demonstrate one way that desalination works. Stir a teaspoon of salt into a half cup of water. Place the cup in a dark plastic bag and set it in the sun for 1 to 2 days. The water in the cup will evaporate, leaving the salt behind. The water that evaporates and condenses on the plastic bag will be fresh.

Oceans also play a key role in the carbon dioxide-oxygen cycle. **Phytoplankton** (FYE toh PLANK ton), small plantlike organisms that make up the first link in the ocean's food chain, are the chief contributors to this cycle.



Millions of these tiny ocean organisms can fit in a single teaspoon of water. They are not plants, but God created these tiny phytoplankton to do something that plants can also do. They carry on photosynthesis, a process by which plants and these organisms take in carbon dioxide and give off oxygen. Human beings need this oxygen to live. Since there are so many of these organisms, scientists estimate that phytoplankton carry out over 50 percent of the exchange of oxygen and carbon dioxide on Earth.

Oceans also influence the climates around the world. The air above ocean currents produces winds that warm or cool the land nearby. Instead of being completely frigid, northern Europe has a moderate climate because of the Atlantic Ocean's warm Gulf Stream. Even normal winds from the ocean can greatly affect the climate of a particular place.

Discussion

Describe the path of a drop of water through the water cycle. Answers will vary but should follow the diagram on page 68.

What makes oceans saline? As water evaporates, dissolved minerals and salts remain behind.

What would happen if only fresh water sources were part of the water cycle? Accept any answer, but elicit that there would not be enough water for our needs.

Is there enough fresh water in all areas of the world? no **How do people in areas without abundant fresh water meet their needs?** Possible answers: deep wells, desalination facilities that can remove salts and other minerals from ocean water to produce fresh water

Provide time for the student to set up the water for the *Try It Yourself*. Allow the student to observe the results at a later date. See Teacher Helps for suggestions.

What is the carbon dioxide-oxygen cycle? the exchange of oxygen and carbon dioxide that happens during photosynthesis

What kind of organisms do you already know about that make food through the process of photosynthesis? plants

How are oceans important to the carbon dioxide-oxygen cycle? Phytoplankton in the ocean carry on photosynthesis, taking in carbon dioxide and giving off oxygen.

What are phytoplankton? small plantlike organisms that live in the ocean

How does the ocean affect climates? The air above ocean currents produces wind that warms or cools the land.

What ocean current affects the climate of the eastern United States and northern Europe? the Gulf Stream

Though man is just starting to appreciate the value of the oceans, God planned them for our use from the very beginning (Gen. 1:9).

TEACHER HELPS

Try It Yourself
You could provide time for the student to do this activity during the teaching of the lesson. You could also assign it to be done after the lesson or just encourage the student to do it on his own. If assigned, follow up with discussion about what the student observed.

BIBLE

God's provision
God the Father has provided for man's physical well-being by supplying shelter, food, and water. He has provided for man's spiritual well-being through Christ's death on the cross. [Bible Promises: E. Christ as Sacrifice; I. God as Father]

GEOGRAPHY

Fresh water resources
It is estimated that one-fifth of the world's population does not have a steady source of fresh water. These countries are located mainly in the Middle East and Africa. Saudi Arabia uses desalination to provide about 70 percent of its drinking water. Israel has more than 30 desalination facilities that provide about 40 percent of Israel's water needs.

Use a world map to show the location of Saudi Arabia.

Why might Saudi Arabia be a country that could need and use desalination facilities? Accept any answer, but elicit that Saudi Arabia is mostly desert, but it has much coastland.

Discussion

Is most of the water on Earth fresh water or salt water? salt water

What is true of most of Earth's fresh water? It is frozen.

Where does most of the fresh water we use come from? surface waters, such as rivers, streams, and lakes

Where is the majority of liquid fresh water? underground

What do we call this water? ground water

What are aquifers? layers of sand, gravel, or bedrock that hold or move ground water

How is ground water commonly retrieved? through a deep well in an aquifer

What is drawdown? dropping of the underground water level due to water use

If drawdown has occurred during the day, why would the water level rise during the night? Possible answer: Water use is less at night than during the day.

What might cause water use to be restricted? drought or poor water management

Discuss the aquifer diagram.

This illustration shows that ground water can flow in several different layers, or aquifers.

What helps purify ground water? soil and organisms in the soil

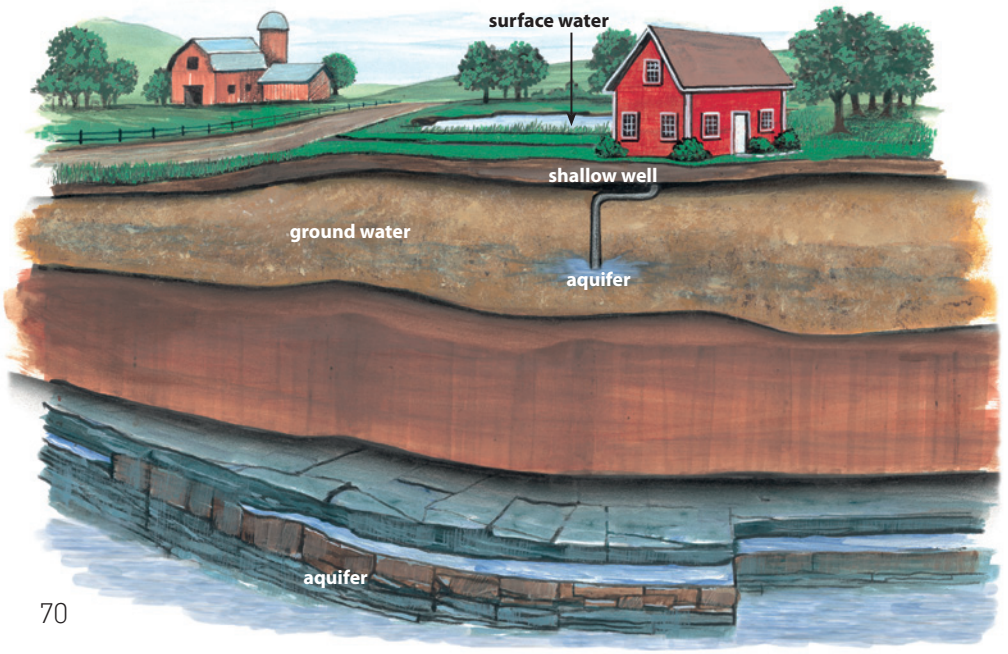
What can happen if chemical contaminants get into the soil? Ground water can become contaminated.

Fresh water

Only a small part of Earth's water is fresh water, and most of that water is frozen. Most of the fresh water that we use comes from rivers, streams, and lakes. But these surface waters only contain a small part of Earth's fresh water. The majority of liquid fresh water is underground. When rain falls, some of the rainwater flows into the soil and is stored beneath the surface of the earth. This water is called **ground water**. Layers of sand, gravel, or bedrock that hold and move ground water are called **aquifers** (AHK wuh furz). Aquifers have enough air space to absorb and hold water.

The most common way to retrieve ground water is through a deep well in the aquifer. During the day, when a lot of water is drawn from the well, the water level may fall. This is called *drawdown*. At night or at times when little water is taken from the well, the slowly flowing ground water refills the well. Sometimes, due to drought or poor water management, the water remains low. When this occurs, water use may be restricted to help ensure adequate water in the aquifer.

Keeping our water resources pure is very important. You might think that water becomes dirty as it flows slowly through the soil and rock of the earth. On the contrary, soil and the organisms living in it purify ground water by filtering out many organic contaminants. But if chemical pollution gets into the soil, it can contaminate the water. Though it takes a lot of money and time to do so, chemically polluted



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SCIENCE BACKGROUND

Drilling wells

In Bible times, men dug wells by hand. Today drilling is a common way to find water. A giant drill is able to dig quickly and efficiently deep into the earth. Some drill rigs can drill a hole about 305 m (1000 ft) deep.

BIBLE

Wells in the Bible

Genesis 16 contains the first Bible reference to a well. The Lord provided this well or fountain of water to sustain Hagar. Hagar named the well Beerlahairoi, a name that reminded her that God lives and would always see her.

FANTASTIC FACTS

The Florida Aquifer System

Perhaps you imagine an aquifer as a small area of contained underground water. While some aquifers do supply water for only a small area, other aquifers and aquifer systems cover thousands of kilometers. A huge aquifer system lies under about 260,000 sq km of the southeastern United States. It is not actually one aquifer but many aquifers that sometimes lie in layers under the surface. The deepest aquifers may reach to a depth of almost a kilometer. Florida's aquifers are among the most productive in the world. They provide more than 30 billion liters (8 billion gallons) of water every day.

water must be pumped out of the ground and clean water pumped in. In some places, such as near landfills, people monitor ground water for contamination.

Atmosphere

A small amount of Earth's water is held as water vapor in the atmosphere. Water becomes part of the atmosphere through evaporation. On some days we can feel the moisture in the air, and we say the day is humid. **Humidity** is the term we use to refer to water vapor in the air. When water vapor condenses, it falls to the earth and provides the water we need.

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TECHNOLOGY

Cleaning water

Cleaning water involves removing sediment, parasites, viruses, bacteria, and certain chemicals, such as lead and poisons, from the water. One of the oldest ways to purify water is to boil it. Today water treatment plants use distillation, filters, chlorine, and ultraviolet light to purify water.

Distillation involves boiling water and capturing the steam. The steam is free of unwanted minerals, sediment, and chemicals.

Some water filters remove dirt particles, and other filters absorb pollutants. Carbon filters are very popular because they can absorb some pollutants and remove the bad taste from water. Adding some chlorine to water can kill many but not all pathogens.

Exposing water to ultraviolet light is a way to clean water without using chemicals or heat. The light prevents most pathogens, such as parasites, viruses, and bacteria, from causing harm by destroying the pathogens' ability to reproduce.

Discussion

Can chemically polluted water be purified in the ground? no **What must be done to clean the water?** The water must be pumped out of the ground, and then clean water must be pumped back into the ground.

What locations would require close monitoring for possible ground water contamination? Possible answers: the ground near landfills, factories, or power plants

What are some ways that man can protect fresh water? Possible answers: keep it free from contaminants; not use up water faster than it can be replaced

In what state of matter is water in the atmosphere? gas (vapor)

How does water become part of the atmosphere? through evaporation

What name is given to the moisture in the air? humidity

What are some examples of contamination in the atmosphere? Possible answers: acid rain, smog, vog

Discuss *Fantastic Facts*.

How large is the aquifer in the southeastern United States? about 260,000 sq km

What states are part of this aquifer? Alabama, Florida, Georgia, Mississippi, and South Carolina

How deep is the deepest aquifer in this region? almost one kilometer

How much water does Florida's aquifer provide? 30 billion liters per day

What impact might Florida's growing population and the state's closeness to the ocean have on the fresh water supply? Possible answers: A greater population means possible overtaxing of aquifers as fresh water is depleted and increased chances of aquifers becoming polluted. Also, if too much fresh water is removed, salt water may invade the aquifer. (This is called encroachment.)

Discussion

Where is seventy percent of Earth's fresh water located? in Antarctica's ice sheet

How are glaciers and ice sheets similar? Layers of unmelted snow form them, and they move slowly.

What distinguishes a glacier from an ice sheet? Glaciers tend to be in mountains, whereas ice sheets are on relatively level land.

How thick is the ice sheet covering Antartica? almost 5 km

What is an ice sheet called when it reaches the ocean and floats? an ice shelf

How do you think the thickness of an ice shelf compares to that of an ice sheet? Elicit that an ice shelf would probably be thinner than an ice sheet but thicker than sea ice.

What is the most famous ice shelf in Antarctica? Ross Ice Shelf

Use a world map to point out the Ross Ice Shelf. You may want to also point out a familiar state or country the size of France to give the student a comparison of the size of this very large ice shelf.

What do we call pieces of ice that break off and float independently in the ocean? icebergs

What is sea ice? frozen ocean water

Ice sheets and ice shelves are also frozen water. How is sea ice different? Ice sheets and ice shelves form from frozen fresh water. Sea ice is made from frozen salt water.

What important geographical point is not actually on land? the North Pole

On what is the North Pole located? on packed sea ice in the Arctic Ocean

What are other differences between sea ice and an ice sheet? Possible answers: Sea ice is relatively thin and has no land under it. An ice sheet is very thick and covers land.

Which do you think an ice breaker ship can move through more easily—an ice shelf or sea ice? Why? sea ice is usually thinner than an ice shelf.

Arctic Ocean and North Pole

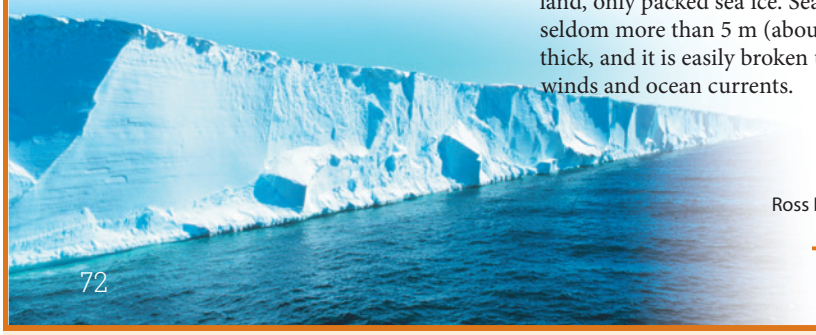
Antarctica and South Pole

Frozen water

Seventy percent of the world's fresh water is in Antarctica, Earth's southernmost continent. This huge expanse of ice is called an **ice sheet**, and it is essentially a glacier on relatively level land. Like a glacier, an ice sheet forms when layers of snow build up. Since the weather is too cold for the snow to melt, the snow becomes deeper and deeper. The ice sheet covering Antarctica is 4776 m (15,670 ft) deep—almost 5 km (3 mi)!

Like a glacier, an ice sheet moves slowly. When an ice sheet reaches the ocean, it continues to float out over the water. This floating ice is called an **ice shelf**. The most famous of Antarctica's ice shelves is the Ross Ice Shelf. When pieces of glaciers, ice sheets, or ice shelves break off into the ocean and float independently, they are called **icebergs**.

Another kind of ice does not come from fresh water. **Sea ice** forms when ocean water freezes. At the poles, sea ice completely covers the ocean in the coldest winter months. The geographic North Pole is located in the middle of the Arctic Ocean, where there is no land, only packed sea ice. Sea ice is seldom more than 5 m (about 15 ft) thick, and it is easily broken up by winds and ocean currents.



Ross Ice Shelf

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SCIENCE BACKGROUND

Ross Ice Shelf

This ice shelf, found in Antarctica, is famous because it is one of the largest ice shelves. It is 180–910 m (600–3,000 ft) thick. The tallest points are 60 m (200 ft) above the water. This ice shelf stretches about 965 km (600 mi) long and 804 km (500 mi) wide.

WRITING

North Pole expeditions

Both Frederick Cook and Commander Robert Peary claim to have been the first to reach the North Pole. Direct the student to research and write a paragraph about the North Pole expedition of one of the men. Tell the student to take a position presenting evidence either for or against his person reaching the North Pole first.

Preserving Our Resources

There are things that you can do today to help conserve the resources that God has given us to use. Some of the solutions are simple. First, **reduce** the amount of resources you use. This can be as easy as turning off the lights when you leave a room or turning off the water when you are not using it.

Another thing you could do to help is to **reuse** materials that would sometimes get thrown away. Find new ways to use containers. Use newspaper to wrap things for moving or to put under a messy project. There are many things that you can reuse if you put some thought behind it.

A very important way to conserve these resources is through **recycling**. Take plastics, paper, aluminum, and glass to recycling centers. They will take these resources and remake them into other products. Our landfills will last longer, and we will get the benefit of recycled products.

The most important reason of all to take the best care we can of our world is that the earth was created by God as man's home. We are to be good stewards of all that God has provided for us. Adam had the duty of taking care of Eden (Gen. 2:15). It is right and proper that we work to keep our earth beautiful and not squander the resources given to us.

QUICK CHECK

1. Diagram the path water takes through the water cycle.
2. Name at least three ways that the oceans provide resources for us.
3. What is the difference between sea ice and ice sheets?
4. How can we preserve our resources?

TEACHER HELPS

The 3 Rs

An easy way to remember ways to conserve our resources is to remember the 3 Rs: reduce, reuse, and recycle.

Recycling policies

Review recycling policies for your school and community. Identify the locations of recycling centers and the types of items collected for recycling.

DIRECT AN ACTIVITY

Reusing items

Materials: cylindrical containers (such as those from oatmeal, powdered drink mixes, or potato chips), cardboard tubes, old calendar pictures, etc.

Provide a variety of materials that are often discarded. Ask the student to think of ways each item could be reused instead of discarded. If needed, provide a few ideas to direct his thinking. Encourage him to be both creative and practical.

As time permits, allow him to make a poster or some other form of presentation that would encourage others to reuse items when possible.

Suggested ideas:

Cylindrical containers can be reused to store pencils, markers, rulers, etc.

Cardboard tubes from gift-wrapping can be reused to store rolled-up posters, maps, and artwork.

Interesting or unusual pictures or art from package labels, advertisements, and magazines can be reused as writing prompts.

Discussion

What three things can you do to help preserve Earth's resources? reduce what you use, reuse what you can, and recycle

Reduce means "to make smaller." What are some specific things you do or can do to reduce your use of resources? Answers will vary.

Look around the room. What do you see being reused differently than what was intended originally? Answers will vary.

What is the most important reason for taking care of the earth? God gave us the earth as our home. It is our privilege and responsibility to care for the earth.

What are the advantages and disadvantages of using renewable resources and nonrenewable resources? Answers will vary but should include ideas such as the availability of resources, the pollution that is a result of the use of certain resources, the expense of the resource, the amount of land required, etc.

Answers

1. Answer should include information from the illustration on Student Text page 68.
2. Oceans influence climates. They are part of the water cycle and the carbon dioxide-oxygen cycle.
3. Possible answer: Sea ice is relatively thin, forms from salt water, and has no land under it. An ice sheet is very thick, forms from fresh water, and covers land.
4. by reducing what we use, reusing the existing resources when possible, and recycling

Activity Manual

Reinforcement, page 51

Review, page 52

This page reviews Lessons 36 and 37.

Assessment

Quiz 3-C

The quiz may be given any time after completion of this lesson.

Objectives

- Compare the differences between water accessibility in Bible times and water accessibility now
- Identify several ways to conserve water
- Recognize Christ as the Living Water

Materials

- *Water in Israel* (IA), both pages for each student

Vocabulary

cistern

Introduction

The student should complete Activity Manual page 53 before the lesson. Discuss the answers from the chart.

How many gallons of water does your family use?

What total did you get for washing clothes?

What total did you get for taking a shower?

What would cause the water usage of one family to be different from that of another family? Possible answers: the number of people in the family; priorities of water usage

What are some other things that you use water for? Possible answers: washing the car, watering the lawn, cooking

Purpose for reading

How has the use of water changed since Bible times?

Discussion

How did the people in Bible times protect their wells? They used large stones to keep out dirt and debris.

What often happened to water wells during times of war? Enemies filled the wells with dirt and stones.

How can we help protect our water supply today and keep it safe for use? We can help keep trash, chemicals, and other items out of the water systems.

What are some ways you can help conserve water? Possible answers: turn off water while brushing teeth; wash full loads of laundry

Water in Israel

Name _____

Because some of the country of Israel is hot and dry, water is an especially important resource. The country's usable water, from both rivers and aquifers, is already being used to its limit. As the country's population grows, the stress on its water system grows as well. Consequently, Israel has a number of desalination plants to help supplement its fresh water supply.

Conflicts Over Water

Israel shares many water sources with its neighboring countries—Syria, Lebanon, and Jordan—as well as with its own Palestinian occupied areas. Conflicts sometimes develop over how much water each area is allotted. But disputes over water in the Middle East are not new. As far back as Abraham's time, wells were often a source of conflict. Digging wells in Bible times was an important but difficult task. Wells were considered the property of the person who dug them, and usually they were passed on as an inheritance just as land was. To take over a well that someone else had dug was considered stealing. In Genesis 21 Abraham reproves the leader of the Philistines, Abimelech, because Abimelech's servants had violently taken over a well that Abraham's servants had dug. Abraham and Abimelech made a covenant to establish Abraham's ownership of the well. Abraham called the place of the well Beersheba.

After Abraham died, the Philistines filled the wells that he had dug with dirt. When Abraham's son Isaac opened each of the wells and found water, the herdsmen of the area fought to gain control of the wells. Isaac moved on to another well that was fought over also. Finally he came to Beersheba. At Beersheba, Isaac's servants again dug a well and found water. Abimelech recognized that Isaac was blessed by God and reestablished a covenant with Isaac as he had with Abraham.

modern Middle East

TEACHER HELPS

Direct the student to complete Activity Manual page 53 the night before the lesson. Parents may help the student with the chart. There are no right or wrong answers.

Sources of Water

Wells were the cleanest sources of water in ancient Israel. They usually had a spring or some source of water flowing into them. A short wall of limestone or stone often surrounded wells. The wall helped protect people and animals from falling into a well. Often the wells would have a stone cover that would have to be removed to draw water from the well. Because the wells were often used for watering flocks, they usually had a trough of wood or stone nearby into which water could be poured to allow the flocks to drink.

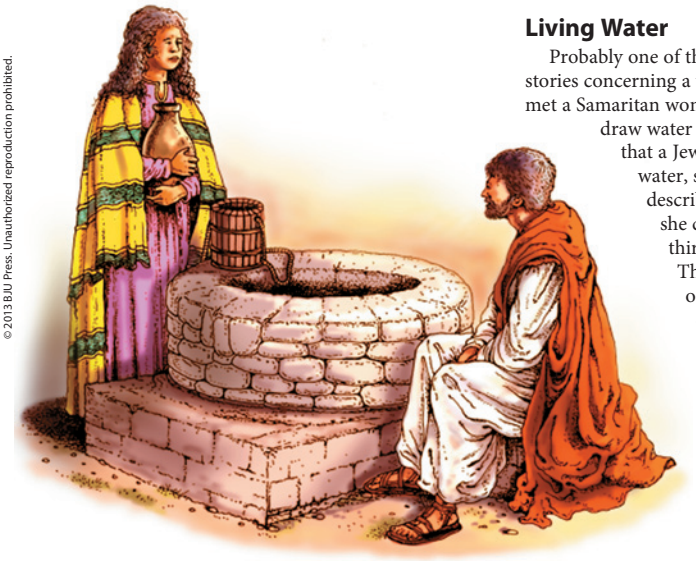
Usually the women in a household were responsible for drawing water for the family. Typically, women would draw water early in the day and toward evening. Water was drawn by dropping a vase or waterskin attached to a rope into the well. Some wells were dug into the limestone and had steps descending into them.

A large stone protected the well from dirt and smaller stones.

Another source of water in ancient Israel was cisterns. Cisterns were holes carved into rock that served as a storage place for water. They were often lined with a special type of plaster or clay to prevent leaking. Cisterns did not have a natural source of water like a well. Instead, water was directed to flow into them and fill them. The water that ran off rooftops during the rainy months was usually directed into a cistern. The stored water could then be used during the dry months.

Living Water

Probably one of the most well-known Bible stories concerning a well is found in John 4. Jesus met a Samaritan woman at the well. He asked her to draw water for him to drink. Surprised that a Jew would ask a Samaritan for water, she questioned Jesus. He described for her living water that she could obtain. She would never thirst again. What was this water? The gift of salvation that God offers to all men. No conservation is needed for the living water. It is freely available in abundance for all those who seek for Christ.



MATH

To determine the weight of a gallon of water, weigh a student on a bathroom scale. Record his weight. Weigh the student again while he is holding a gallon of water. Record the weight. Allow a student to calculate the difference to find the weight of the water.

How much does the gallon of water weigh? A gallon of water weighs approximately 8.33 lb.

If you carried only two gallons of water at a time, how many trips would you need to make to carry the water your household uses in a day?

How much would all the water that your household uses weigh?

Discussion

Which person in the family went to the well during Bible times? the woman in the household

How many times did she go to the well each day? two

What method did she use to draw water? She tied a rope around a pitcher, drew the water out, and carried the water on her shoulders.

What is a cistern? a hole carved in rock used to store water

How was a cistern important to the people? It provided water during the dry months or any time it was needed.

Refer to Activity Manual page 53.

Look at the number of gallons of water your family used. Do you think you could carry that much water to your home each day? no

What things would you not use as much water for if you had to carry water from a well each day? Answers will vary.

Read John 4:4–26.

What was the Samaritan woman doing at the well? drawing water for her household

What did Jesus ask her to do? give Him a drink of water

What is the difference between the water in the well and the water that Jesus was offering the woman? Lead the students to understand that the water from the well was physical water that would quench her thirst temporarily. The water that Jesus was offering would quench her spiritual thirst for truth and give her eternal life.

Activity Manual

Exploration, pages 53–54

Lesson 39

Student Text pages 74–75
Activity Manual page 55

Objectives
- Identify examples of technology
- Explain what an autonomous underwater vehicle is
- Identify uses for AUVs
- Describe how the *Seaglider* functions

Vocabulary
technology
autonomous underwater vehicle

Materials
- 5 meters of rope or yarn
- a book
- *Bathyscaphe* (IA), for display

Introduction
Tie the rope to the book and place the book on the floor. Holding the end of the rope, drag the book as you walk between desks until the rope tangles.

What problem did the book have when following my lead? Possible answer: the book could not move once the rope became tangled.

Even if there were no obstacles, could I easily change the direction of the book? no

Some underwater vehicles are attached, or tethered, to a survey ship similar to the way this book is attached to me. A vehicle that is tethered is limited in its ability to move. Today's lesson discusses underwater vehicles that are not attached to ships.

Teach for Understanding
Purpose for reading
What is technology?

What are some ways AUVs are used?

Discussion
What is technology? taking what God has created and designed and using it to do work and meet the needs of people; the tools invented, developed, and used to solve problems and get things done

What are some examples of technology? Possible answers: computer, cell phone, fishing pole, rake

What job did God give to people? to maximize the usefulness of the earth to the glory of God and for the benefit of mankind

What was the first tool used to explore deep in the ocean? a bathysphere

Display and discuss the bathysphere photo.

What animal has helped people explore the ocean? dolphins

What are some disadvantages to using dolphins? Possible answers: they get tired and hungry; might be uncooperative; cannot go everywhere in the ocean

TECHNOLOGY

Autonomous Underwater Vehicles

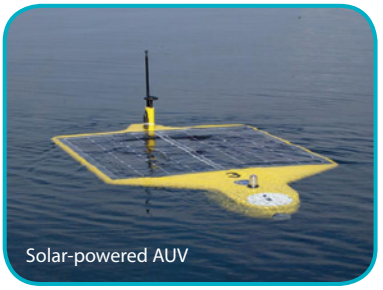
What do you think of when you hear the word *technology*? Do you think of cell phones, computers, or television? These are examples of technology, but technology has been around since God created man. Technology is taking what God has created and designed and using it to do work and meet the needs of people. It is the tools that we invent, develop, and use in order to solve problems or get things done. Even a rake and a fishing pole are examples of technology.

Adam and Eve must have used technology to take care of the garden God planted and charged Adam to cultivate and keep. God gave Adam and all people after him the job to maximize the usefulness of the earth to the glory of God and for the benefit of mankind. Man is sinful, and technology is sometimes used in sinful ways. However, a Christian should seek to use technology in ways that glorify God and benefit others.

Water is one of our most important natural resources, and most of the earth's water is in the ocean. For many years man has sought to learn about what is in and under the ocean water. In the 1930s, William Beebe and Otis Barton were the first to explore deep in the sea using their bathysphere, a circular watertight structure attached to a barge. Since then, scientists have used many other means to explore underwater.

Scientists have used dolphins to recover equipment and locate mines in the sea. However, dolphins have some disadvantages. They get tired and hungry and they cannot go everywhere. What if there were a dolphin that did not get tired, hungry, or uncooperative? Scientists have made artificial dolphins called AUVs, or *autonomous underwater vehicles*. An AUV has no pilot and controls itself.

AUVs are robots that can record information from the ocean. There are many kinds of AUVs. Some have propellers and others do not. Many are long and streamlined like torpedoes. They run on battery power, but scientists are also developing and testing a solar-powered AUV.


Solar-powered AUV

AUVs are not built for speed, but they are built for endurance. They go on missions that can last for months, slowly collecting information as they move through the ocean depths. When underwater, they are not tethered or attached to a ship, so they can go places that surface ships and manned submarines cannot go, such as in caves

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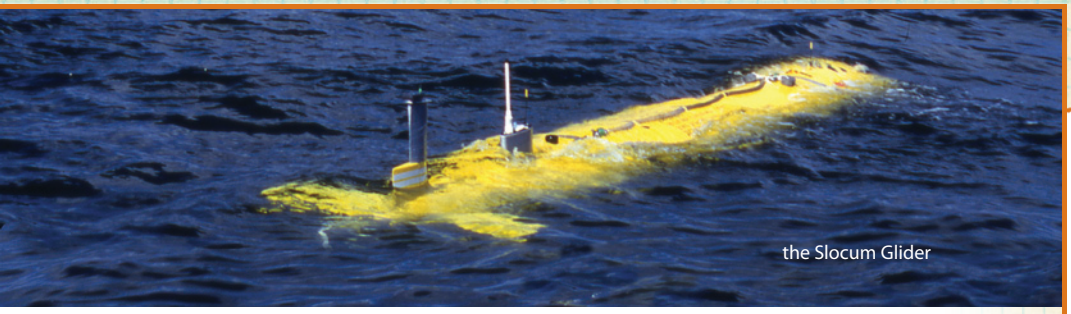
SCIENCE BACKGROUND

Acoustic signals
Because radio waves do not transmit well through water, sound waves are used even though they are not as fast. Data is compressed so that the AUV can transmit more data at one time. You may want to refer to Lesson 34 for further information about a GPS navigation system.

Underwater observatories
Scientists are also building unmanned underwater observatories. In 2006, the Monterey Accelerated Research System (MARS) was set up as the first US deep sea observatory off the California coast. Its purpose is to monitor the ocean continually the way weather stations monitor conditions on land. The electricity is sent down to the ocean floor by a long cable which also carries the data signals from the cameras and instruments. Extension cables connect electricity and data paths to other scientific instruments on the ocean floor.

Scientists have continued to develop and improve other observatories such as the NEPTUNE system in Canada. Some of these observatories may be able to send out fleets of AUVs on missions in the future.

Autonomous systems
Other robotic vehicles have been developed. Some of the uses include helping farmers plant and harvest crops, the military detect mines, and NASA explore space.



the Slocum Glider

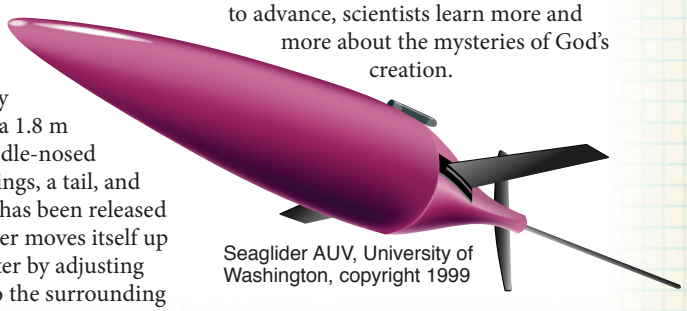
and around underwater volcanoes.

AUVs are able to operate by themselves because lists of instructions, or mission scripts, are programmed into them. Sometimes an AUV receives additional instructions from a ship by acoustic signals, which travel through the water. This can only happen when the ship is near the AUV's location.

AUVs can be programmed to map the ocean floor, locate mines in a harbor, check undersea oil lines, and explore shipwrecks. Some can take water samples, detect volcanic activity, or take pictures of the changes on the ocean floor. Some AUVs can also travel under the ice in polar regions. The only other sea vehicle that can go there is a nuclear submarine. AUVs are much less expensive and easier to work with than ships and submarines.

The *Seaglider* is a type of AUV developed by scientists at the University of Washington. It is a 1.8 m (about 6 ft) long needle-nosed vehicle with fixed wings, a tail, and an antenna. Once it has been released into the sea, the glider moves itself up and down in the water by adjusting its density relative to the surrounding water, using oil it moves in and out of a reservoir. The battery pack that powers it also serves as its "steering wheel." The pack shifts forward and back to pitch the glider's nose up or down and from side to side to turn the glider left or right. When the *Seaglider* comes to the surface, it raises its trailing antenna into the air. This antenna determines its location using GPS (Global Positioning System), uploads data, and downloads any new instructions. All of this AUV's sensing instruments and moving equipment are housed in its torpedo-like body. Scientists continue experimenting with other designs and alternative ways for AUVs to propel themselves.

Autonomous underwater vehicles are just one means of discovering much more about what lies in and under the oceans. As technology continues to advance, scientists learn more and more about the mysteries of God's creation.



Seaglider AUV, University of Washington, copyright 1999

ART

AUV design

Direct the student to design his own AUV. He should list the types of information it will gather and draw a diagram of his vehicle. He should then label any features that help it perform its tasks.

Discussion

What are autonomous underwater vehicles? robots that can record information from the ocean

What does *autonomous* mean? independent, self-contained

An AUV is not tethered to a ship when it is underwater. How is this an advantage? It can go places that other vehicles cannot go

How do AUVs operate? Lists of instructions are programmed into them. Occasionally they receive additional instructions from a ship or through GPS.

What are acoustic signals? sound waves

What are some things that AUVs can do? Possible answers: map the ocean floor; locate mines; check undersea oil lines; explore; take water samples; detect volcanic activity; take pictures; travel under ice

What advantages does an AUV have over a nuclear submarine? It is less expensive and easier to work with.

Who developed the *Seaglider*? scientists at the University of Washington

How does the *Seaglider* move? It can move up and down in the water by moving oil in and out of a reservoir. Its battery pack shifts to help the glider move up or down and left or right.

What does *reservoir* mean? a supply or source of something, often water

Why does the *Seaglider* raise its antenna in the air when it surfaces? to determine its location, upload data, and download new instructions

Why do you think *Seaglider* must come near the surface to use GPS satellites? Possible answer: GPS signals do not travel through water.

What does technology help scientists to do? to learn more about God's creation

Activity Manual

Technology, page 55

Student Text page 76
Activity Manual page 56

Objectives
- Recall concepts and terms from Chapter 3
- Apply knowledge to everyday situations

Introduction
Material for the Chapter 3 test will be taken from Student Text page 76 and Activity Manual pages 45–46, 48, 52, and 56. You may review any or all of the material during this lesson. Questions similar to Solve the Problem or the ones in Thinking It Through, Activity Manual page 56, may appear on the test.

You may choose to review Chapter 3 by playing "Mining for Gold" or a game from the Game Bank on the Teacher's Toolkit CD.

Teach for Understanding
Diving Deep into Science
Information on this page reflects the concepts the student should know for the test.

Solve the Problem
In order to solve the problem, the student must apply material he has learned. The student should attempt the problem independently. The answer for this Solve the Problem is based on the material on Student Text page 70. Answers will vary and may be discussed.

Activity Manual
Review, page 56
These pages require written responses to application questions.

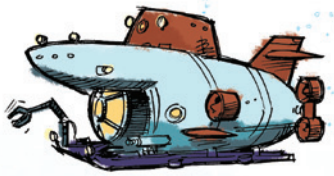
Lesson 41
Objective
- Demonstrate knowledge of concepts taught in Chapter 3

Assessment
Tests, Chapter 3

DIVING DEEP INTO SCIENCE

Words to Know
natural resources
petroleum
crude oil
refinery
petrochemicals
natural gas
coal
nuclear energy
uranium
hydroelectric energy
reservoir
geothermal energy
wind energy
solar energy
mineral
vein
ore
smelting
malleable
hydrosphere
phytoplankton
ground water
aquifer
humidity
reduce
reuse
recycle

Key Ideas
Renewable and nonrenewable resources
Sources and uses of fossil fuels
Advantages and disadvantages of each energy source
Metals and their uses
Conservation of soil and water
Water cycle
Importance of the ocean
Differences between kinds of ice



Solve the Problem
Ian's family owns a large farm that depends on an aquifer under their land for their water supply. All of their water needs, including the well water for their household, comes from the aquifer. Last year Ian's father planted a new field. He irrigates and fertilizes it on a regular basis. Ian's mother, however, has started to notice that the water pressure at the house is low. What might be happening to the water supply, and what could be done to solve the problem?

Possible answers: The aquifer may not be adequate to supply both the well and the irrigation needs. Precision farming (using GPS) could help with irrigation needs. Also, adjusting the times water is used to minimize drawdown may help.

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Review Game
Mining for Gold
Divide the class into two teams. Have available a set number of tokens or gold candy pieces. The goal is to "find" the most gold. Each time a team answers a question correctly, they have "found" some gold and receive a token. The game continues until the vein has yielded all of its resources (all the tokens are given out). The team with the most tokens wins.

Variation: The class could see how much of a vein could be mined before it comes up empty (how many tokens in a row they can collect before someone answers a question incorrectly).