Objective 4

The student will demonstrate an understanding of the earth sciences.

You should be able to show your understanding of Earth's physical features, how they are shaped, and why they change.

All right, but what's a physical feature?

I'm glad you asked! Earth's physical features include the many *landforms* found on our planet's surface. These can include:

- mountains
- valleys
- rivers
- canyons
- islands
- beaches
- volcanoes
- oceans
- glaciers

I never thought of a beach as a physical feature. While I was at the beach in Galveston, I built a sand castle. Several hours later, it washed away. What happened?

You're talking about the tides. Tides are the regular rise and fall of the ocean's surface each day. You built your sand castle during a low tide. After you built it, the sea level rose. Your sand castle washed away during a high tide.

But what causes tides?

Tides are caused mainly by the moon's gravity pulling on Earth. Ocean water is pulled toward those areas of Earth closest to the moon.

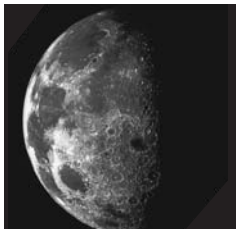
As long as we're talking about the moon, can you explain what makes the moon glow?

Of course. The moon, like Earth, doesn't produce any light of its own. Moonlight is actually light from the sun that is reflected by the moon's surface back to Earth. At any given time half the moon's surface is lit up by the sun. However, most of the time we can see only part of the surface that the sun shines on.

New moon

First-quarter moon

Full moon



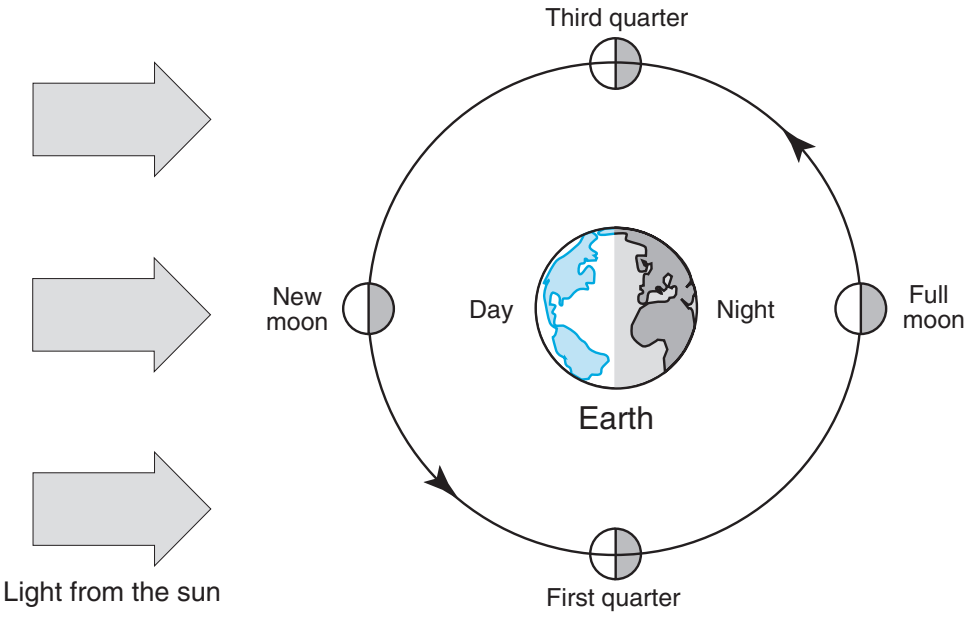
Third-quarter moon

Is this why the moon looks different at different times of the month?

Exactly! You're talking about moon phases. It takes the moon about 29.5 days to go through a complete cycle of its phases as it revolves around Earth. Let me explain the phases.

- **New moon:** When the moon's orbit takes it directly between the sun and Earth, the side of the moon facing Earth is dark, and the side facing the sun is lit up. We can't see the moon during the new-moon phase.
- **First-quarter moon:** As the moon continues to revolve around Earth, the moon's surface becomes visible as a thin crescent. Each night more of the moon's surface is visible to a person on Earth. After the moon moves a quarter of its orbit around Earth, we see half of the lighted half of the moon, or about one-quarter of the moon's surface. A first-quarter moon looks like the right half of a circle.
- **Full moon:** After the first-quarter phase, the surface of the moon that can be seen from Earth continues to increase in size. When the moon reaches the opposite side of Earth from the sun, the entire side of the moon facing Earth reflects sunlight back to Earth. The full moon appears as a complete circle.
- **Third-quarter moon:** After a full moon less and less of the moon's surface is visible each night. After the moon has completed three-quarters of its orbit around Earth, we again see half the lighted half of the moon. A third-quarter moon looks like the left half of a circle. After the third-quarter phase, the surface of the moon that can be seen from Earth continues to decrease in size until the next new moon.

Moon Phases



I heard that there isn't any wind on the moon. It was really windy in Galveston. Where does the wind on Earth come from?

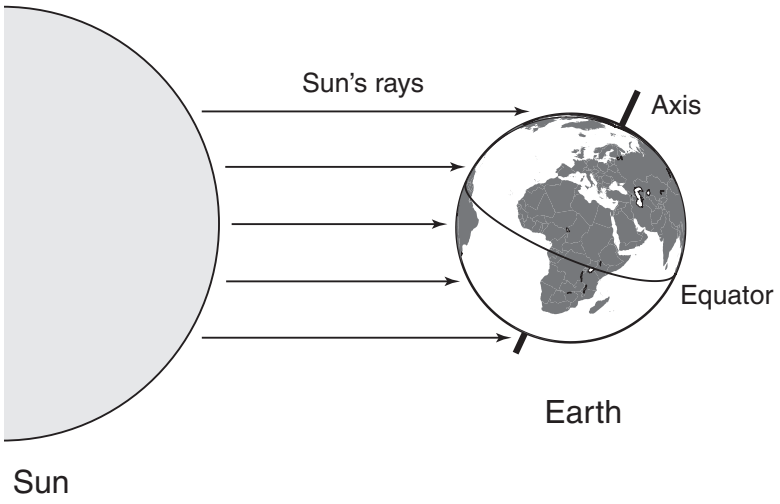
That's an excellent question. You're right, there isn't any wind on the moon because there isn't an atmosphere on the moon. Wind is simply air moving across Earth's surface. There are a number of things that cause wind, but the main one is the uneven heating of Earth's surface.

Remember!

Air is made up of particles of different gases, such as nitrogen, oxygen, and carbon dioxide.

I thought Earth was heated by the sun; how could that be uneven?

Remember Earth is tilted on its axis. The sun's rays strike Earth more directly at the equator than they do at the poles. This causes the air at the equator to warm faster than at other places on Earth.



And this causes wind?

Yes, when air is warmed, the particles gain energy, begin to move faster, and then spread farther apart. This means that warm air is less *dense* than cold air, and the warm air rises. The cold air sinks, replacing the warm air. As the warm air rises, it cools, becomes denser, and then sinks back to Earth's surface, where it warms again. Wind results because this warming and cooling cycle is happening at different rates on Earth.

Remember!

A substance that is less dense will float on a substance that is more dense.

What else does uneven heating affect?

It affects climate. It's always cold at the poles, and it's always warm near the equator. Areas close to the equator are warmer because the rays they get from the sun are more direct. But many things affect climate besides distance from the equator.

Large bodies of water affect climate. Water takes a long time to heat up. It also takes a long time to cool down. But land heats up and cools down very quickly. Winds blowing over water onto nearby land keep the temperature of the land more constant. This air is also more humid because it contains more water vapor.

Remember!

Water in the form of a gas is called water vapor. Humid air contains a lot of water vapor.

Did you know?

Fossils of seashells found in the Texas Hill Country show that the climate in Texas was very different millions of years ago.

O.K. But why do I really need to know this? What good does it do for me to know how things on Earth work?

I love this question! Understanding science and how things work gives you the skills to be a great science detective. If you understand how things work on Earth, you can figure out what things were like on Earth long before you were born. Knowing the past is helpful in predicting the future. This is important because Earth's surface is always changing.

Really? What causes these changes?

Earth's surface can be changed by many things, such as wind, rain, and volcanoes. Some of these can change Earth very slowly, and others change it very quickly. For example, wind and rain can wear down a mountain over millions of years. A volcano can change an area within a few hours or a few days. When the Mount St. Helens volcano erupted, it blew away the side of the mountain.

Let me give you an example of how water can change Earth's surface over a long time. A river might run over a flat plain. Over time the water will pick up some of the soil and carry it with the water. The process of moving soil from one place to another is called *erosion*. The force of the water will also wear down large rocks into smaller rocks. The process of breaking rock into soil, sand, and other tiny pieces is called *weathering*. Further downstream the river water will drop some of the soil and rock material at a new location. The areas where this happens are often very sandy or muddy. The process of dropping, or depositing, sediment at a new location is called *deposition*.

Before **After**

Courtesy of USGS, David A. Johnston, Cascade Volcano Observatory, Vancouver, Washington

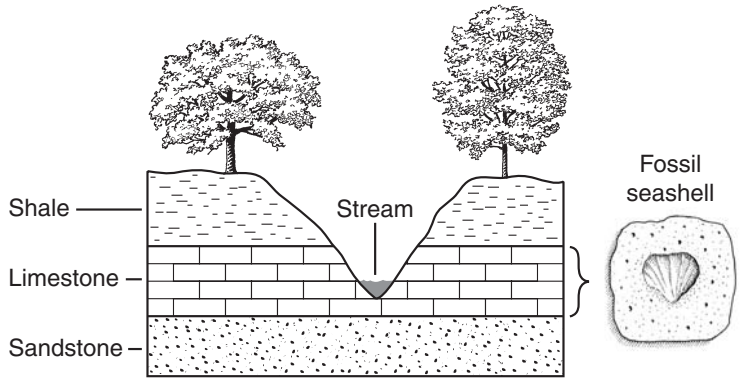
On May 18, 1980, Mount St. Helens exploded. Almost one cubic kilometer of rock and volcanic ash was thrown into the air.

Remember!

A fossil is the remains or trace of a living organism from the past. A shell impression pressed into rock is one example of a fossil.

How else can scientists learn about the past?

Let me give you another example. We can learn more about Earth's past by studying rocks. Look at the picture on the next page. It shows a valley and several layers of sedimentary rock.



Scientists know that the sandstone is older than the limestone and that the limestone is older than the shale.

How do they know this?

It's like making a peanut butter and jelly sandwich. First you lay a piece of bread on a table. This is the first layer. Next you spread on the jelly. This is the second layer. You can add more items to your sandwich. Each item you add is a layer. It works the same way with layers of sedimentary rock. The layer at the bottom is the oldest layer. This layer was formed first. Over time other layers are deposited onto the first layer. The youngest layer is usually at the top.

Remember!

- Weathering means breaking down rocks.
- Erosion means carrying sediments to another location.

What else can scientists learn from the rock layers?

Well, scientists discovered that fossils of animals found in limestone rock layers are much like the animals that live in the ocean today. For this reason, scientists think that a shallow sea once covered this area. Fossils can also be used to match rock layers from different areas and to understand past changes in climate.

Scientists also think that the stream eroded the shale and limestone to form the valley. Scientists know that the valley and stream are younger than the rock layers.

Is this because the valley is on top of the shale?

Not exactly. Let's go back to the sandwich example. You have to finish making a sandwich before you can cut it into pieces to eat. Right? The valley cuts through the shale and limestone layers, kind of like a knife cutting through a sandwich. The valley must be younger because it cuts across the rock layers, which were there first.

By making careful observations and studying clues like fossils, scientists can figure out what happened on Earth a long time ago.

Objective 4

My teacher said that sand is a natural resource that is used to make glass. Are natural resources the materials in nature that people use to make the things they need?

I think you understand natural resources! Did you know that there are three kinds of natural resources?

- **Renewable resources** are those that can be replaced in a short amount of time. Animals, plants, and freshwater are examples of renewable resources. Animals can give birth to new animals. New plants can grow from seeds. Rain brings freshwater to lakes and rivers.
- **Nonrenewable resources** are those that cannot be replaced in a short amount of time. Oil, natural gas, and coal are examples of nonrenewable resources. It took millions of years for fossil fuels to form. People will use them up before they can be replaced by nature.
- **Inexhaustible resources** are those that people cannot use up. Energy from sunlight is an example of an inexhaustible resource.

Renewable Resources	Nonrenewable Resources	Inexhaustible Resources
Plants	Oil	Wind
Animals	Natural Gas	Sunlight
Water	Coal	Ocean tides
Oxygen	Minerals	
Soil		

I don't use very many resources, so I don't worry about them.

Really? I think you'd be surprised at how many resources you use each day. Every time you eat, you are using plants, animals, or both. Many homes are built with wood. Wood comes from trees. Do you know where the paper that this is written on came from? How about your pencil? That's right. Trees again!

But I'm using a pen, not a pencil. It's made of plastic!

Plastics are made from oil, a nonrenewable resource. Even some clothes are made from materials that come from oil. Clothes can also be made of cotton, which is a plant. The lights in your school run on electricity. A power plant supplies the electricity, and it probably uses a fossil fuel to make it. I could go on and on, but I think you get the picture. Every time you use energy, eat something, or buy something, you are using natural resources.