Patterns of Change on Earth

Patterns and Cycles
Many events on Earth occur in cycles. A cycle is a series of events that occur over and over again. You’ve learned about life cycles, which are the events that occur in an organism’s life. The steps of a cycle always occur in the same order. You can be sure that a caterpillar will always hatch from an egg laid by an adult butterfly. Since the steps of a cycle always occur in the same order, you can predict the next step in a cycle and when it will occur in the future. As you read, you will learn about cycles caused by Earth’s movement in space.

The Sun in the Sky
One of the most obvious cycles on Earth occurs every day. You are so used to it that you probably don’t even notice it. Every day, the sun rises in the east, is high in the sky at midday, and sets in the west in the evening. This pattern is so regular that we can predict the exact time that the sun will rise and set at any place on Earth.

The cycle of day and night is caused by the spinning of Earth on its axis, which is called rotation. Earth rotates once every 24 hours. It is daytime for the half of Earth that faces the sun. It is nighttime for the other half of Earth, which is facing away from the sun. Earth is constantly spinning, so the parts of Earth experiencing day and night are constantly changing.

People used to think that the sun traveled around Earth every day. That explained why the sun seemed to move across the sky. We now know that it is Earth’s rotation that causes the sun to seem to move. The sun is not actually moving across the sky. If you stand in place and spin in a circle, you will see objects appear to move around you. The same thing happens each day with the sun and the stars in the sky.

Shadows
On a warm summer day, you can cool off by sitting in the shade. You might find shade beneath a tree, under an umbrella, or next to a building. When you sit in a shaded area, you are actually sitting in a shadow. Shadows form because light does not shine through most objects. A shadow is the unlit area behind an object.
The size of a shadow depends on the angle of the light that is hitting it. When the sun is low in the sky in the morning, shadows are long. You are only a few feet tall, but your shadow is several feet long at sunrise! As the day progresses and the sun’s position changes, your shadow gets shorter. By midday, the sun is directly overhead. Your shadow is small and just under your body. In the afternoon, your shadow starts to grow longer again. However, it is pointing in the opposite direction as your morning shadow. At sunset, your shadow is long once again. This pattern repeats every day.

In the past, people used shadows to tell time. A sundial is a clock that tells time based on shadows. It is not accurate. You can make your own sundial and investigate shadows. Put a stake in the ground through a sheet of paper. Throughout the day, trace the shadow of the stake and label it with the time of day.

Each season has its own characteristics. Winter is cold. The days are short and the nights are long. The sun does not rise very high in the sky. Summer is the opposite. The days are longer than the nights, and the sun is high in the sky. On one day in spring and one day in fall, the amount of daytime and the amount of nighttime are equal. There is 12 hours of each. These days are called the spring equinox and the fall equinox.

Living things respond to changes in the seasons. The leaves of many trees change colors and drop in fall. Some animals hibernate through winter. In spring, bare trees grow new leaves and flowers blossom. Many animals raise their young in spring and summer.

The seasons occur because Earth’s axis is tilted. The part of Earth tilted toward the sun has summer. This half of Earth receives more direct sunlight, which causes it to be warmer. The days are longer during summer, too. In the image below, it is summer in the northern half of Earth. Notice the sun’s rays hitting that part of Earth directly. It is winter in the southern half of Earth. The sun’s rays are not very direct.

Seasons

You are probably familiar with the pattern of the seasons. For example, you know that the Fourth of July occurs in summer every year. Most places on Earth experience four seasons—winter, spring, summer, and fall (or autumn). The seasons always occur in this order.
Seasons in the Northern Hemisphere

Seasons change as Earth orbits, or travels in a path around, the sun. It takes Earth one year to complete one orbit around the sun. The parts of Earth that have summer on one side of the sun have winter on the other side, 6 months later.

The Moon’s Patterns

When you look at the night sky and observe the moon, you can see another cycle. The moon looks different at different times. Sometimes it is a bright circle, and sometimes you can see just a small sliver shining. The different shapes the moon appears to have are called moon phases.

When the moon looks like a large circle in the sky, it is called a full moon. A full moon occurs once every 29½ days. Many calendars mark when a full moon occurs. If you are outside during a full moon, it provides light for you to see. Nights with a full moon are not very dark.

The moon does not give off its own light. You see the moon because it reflects light from the sun. The sun gives off its own light. Light travels from the sun to the moon and bounces off. Some of that light is reflected toward Earth.

Like Earth, half of the moon is lit by the sun at any time. However, you can’t always see the part of the moon that is lit. That’s because the moon revolves around Earth. It takes just less than one month for the moon to orbit Earth one time.
The moon’s phase is constantly changing. A full moon occurs when Earth is between the moon and the sun. You can see the entire lighted part of the moon. Each night over the next two weeks, you can see less and less of the lit half of the moon. A new moon occurs when the moon is between the sun and Earth. The entire lit side of the moon is facing away from Earth and you cannot see the moon in the sky. Nights when there is a new moon are very dark. Then, over the next two weeks, the moon slowly returns to being full. This pattern, which is shown on the right half of the page, repeats every 29½ days.

You can investigate the moon’s phases yourself. Keep a calendar like the one shown below. On the calendar, draw the phase that you see each night. In one month, you will see all of the moon’s phases. Label each of the phases and look for the pattern.
Tides

Tides are another phenomenon on Earth that occurs in a pattern that can be predicted. Tides are the rising and falling of sea levels every day. Most places near the ocean experience two high tides and two low tides every 24 hours.

Tides are caused by the gravitational pull of the moon and the sun. You know gravity as the force that holds you on Earth. A gravitational force exists between any two objects. The size of the force depends on the sizes of the objects and the distance between them. Although the sun is larger, the moon affects tides more because it is much closer to Earth.

As the moon orbits Earth, it exerts a gravitational pull on the entire Earth. Because the moon's pull is stronger on the side of Earth that faces the moon, the ocean on this side of Earth bulges slightly. At the same time, another bulge forms on the side of Earth opposite the moon. This bulge forms because the solid Earth is pulled more strongly toward the moon than the ocean water on this side of Earth is. Halfway between the two bulges, the water level is lower.

A high tide occurs when Earth’s rotation causes the coastline to move toward a bulge of water. A low tide occurs when a location on Earth rotates away from the bulge. The times at which the high and low tides occur are influenced by the locations of the sun and the moon. Spring tides occur at new moon and full moon when the sun, the moon, and Earth are in line. This forms higher-than-normal high tides and lower-than-normal low tides. Neap tides occur at first quarter and last quarter, when the sun, Earth, and the moon are at right angles. This forms high tides and low tides that are not very different.

This device uses energy in the moving water of the tides as an alternative energy source. At high tide, a pool of water is filled. At low tide, the water is released from the pool through a turbine. The spinning turbine is used to generate electricity. The repeating pattern of the tides makes this possible.
Modeling Changes

You can model many of the phenomena that occur as a result of movement of Earth, the sun, and the moon in the solar system.

**Procedure:**

1. Mark your location on a globe by using a tack.
2. Place a lamp or other bright light source in the center of the classroom. This represents the sun.
3. Rotate the globe on its axis through one complete rotation. Observe the patterns of light and shadow on Earth. Especially look at the shadows around the tack. Think about the length of time this represents.
4. Carrying the globe, walk counterclockwise one revolution around the light source. Be sure to keep the globe tilted the same direction. Think about the length of time this represents.
5. Go ¼ of a revolution in your orbit, and stop. Rotate Earth. Determine which part, if any, is receiving direct sunlight. Determine how the length of the day compares on each part of Earth.
6. Continue in the path, and stop at ½ of a revolution. Rotate Earth. Repeat the observations.
7. Continue in the path, and stop at ¾ of a revolution. Rotate Earth. Repeat the observations.
8. Continue in the path, and stop at one full revolution. Rotate Earth. Repeat the observations.
9. Use the globe, the lamp, and other objects to model another phenomenon, such as moon phases or the tides.

**Discussion Questions:**

1. Which parts of the Earth’s orbit correspond to the different seasons? How do you know?
2. How are the seasons different in the Southern Hemisphere?
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1. The moon’s phases on the labels below are in order. Shade in the moon to match how each phase appears from Earth.

- 1. new moon
- 2. waxing crescent
- 3. first-quarter moon
- 4. waxing gibbous
- 5. full moon
- 6. waning gibbous
- 7. third-quarter moon
- 8. waning crescent

2. Describe how the shadow of a flagpole changes throughout the day.

3. In Texas, how do the amount of daylight and the sun’s position in the sky change with each season?
TEKS Assessment 4.8C

Fill in the letter of the best choice.

1. Look at the drawing Susan made below.

Which of the following would be the next view of the moon in this sequence?

A.  
B.  
C.  
D.  

2. How many days of the year have an equal amount of day and night?
   A. Zero  
   B. One  
   C. Two  
   D. Four

3. Which of these is the main cause of Earth’s seasons?
   A. Earth’s revolution and tilted axis  
   B. Earth’s rotation and tilted axis  
   C. The distance between Earth and the sun  
   D. The pull of gravity between Earth and the moon

4. Why do shadows made by the sun move over the course of a day?
   A. Because the weather changes  
   B. Because someone moves the objects  
   C. Because the sun appears to move across the sky each day  
   D. Because Earth revolves, causing the sun’s light to strike Earth differently at different times

5. When is a shadow formed?
   A. When there is no source of light  
   B. When the path of light is blocked by an object  
   C. When an object falls to the floor  
   D. When the sun shines

6. Which is not caused by the position of Earth and the moon?
   A. Moon’s phase  
   B. Time of a high tide  
   C. Time of a low tide  
   D. Start of a season