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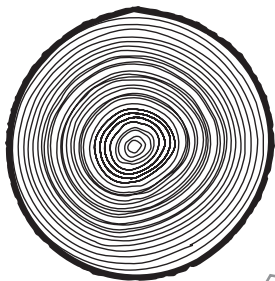
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If you look closely, you can find many patterns in the world around you. There are patterns in living things and other aspects of nature. There are also patterns in structures and systems that are human-made. Some of these patterns are part of the way something looks. Other patterns exist in the way something functions over time.

Physical Patterns

Some patterns in natural and human-made systems are physical. **Physical patterns** have an object or design that repeats. As a tree grows, it produces a new layer of wood each year. These layers form recognizable rings in the cross section of tree trunks and branches. The rings form the pattern.

There are also physical patterns in the arrangement of veins in plant leaves. Veins are tube-like structures that carry fluids throughout a leaf. In some leaves, veins grow in a pattern of parallel lines. In other leaves, veins grow in a net-like pattern of branching lines.



Some physical patterns in nature result from the way plants grow.

Some physical patterns in nature exist on a much smaller scale. Atoms and **ions** are the smallest parts of matter. They can bond together in patterns that form solids called **crystals**. A crystal of salt is made up of alternating ions of sodium and chloride. These ions pack tightly together in a repeating order. This arrangement creates crystals of salt with a cubic shape. Table salt is made up of many of these cube-shaped crystals.

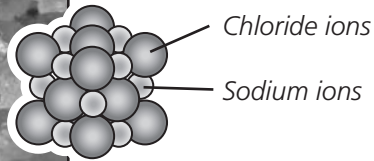
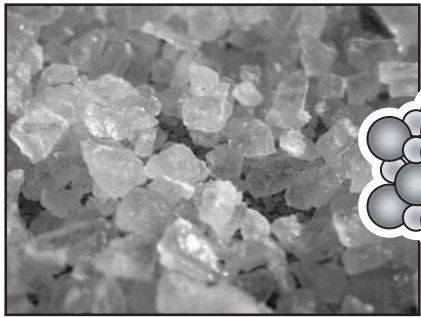
A **physical pattern** has objects or shapes that repeat in a certain way.

When trees grow a new layer of wood each year, they form a pattern of growth rings in their trunks. Scientists can count the number of tree rings in this pattern to determine the age of trees. They can also analyze the size of the rings to determine the weather conditions in certain past years.

You can learn more about atoms in Unit 3, Lesson 2.

An **ion** is an atom that has gained or lost electrons. Gaining electrons gives the particle a negative charge. Losing electrons gives the particle a positive charge.

A **crystal** is a solid substance with a regular, repeating arrangement of atoms or ions.



The pattern of sodium and chloride ions repeats in salt crystals.

Many human-made structures also have physical patterns. Some bridges, for example, have a repeating arrangement of crossbeams. When these beams form a triangular shape, they are called **trusses**. Trusses provide support. A pattern of trusses on a bridge distributes the weight of the vehicles that travel over it.

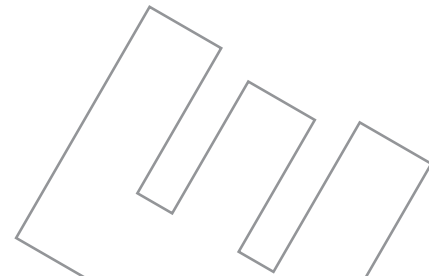


The trusses in this bridge are a human-made physical pattern.

Which of these best explains how trusses can form a pattern?

- A They vary in size.
- B They are made of steel.
- C They support heavy loads.
- D They repeat within a structure.

Trusses can vary in size, can be made of steel, and can support heavy loads. However, these characteristics do not mean that trusses form a pattern. Therefore, choices A, B, and C are incorrect. Trusses form a pattern when they repeat within a structure. The correct choice is D.



A **truss** is a structural frame made of straight beams in the shape of a triangle.

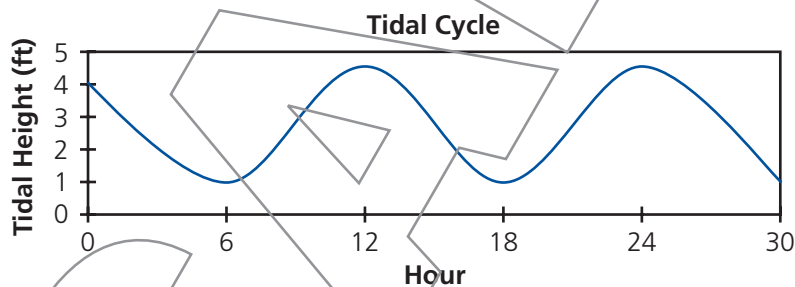
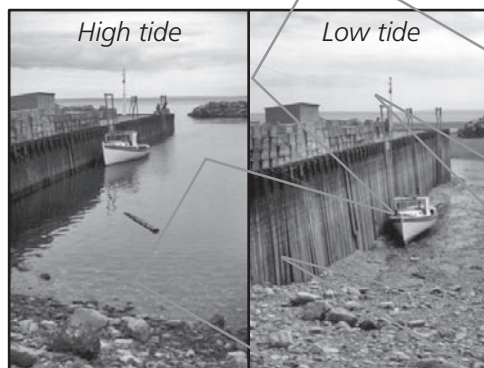
A repeating arrangement of trusses is commonly used in construction to support heavy weights. People often use a pattern of trusses to support the roofs of houses and other buildings.

Temporal Patterns

Some patterns in natural and human-made processes are temporal. **Temporal patterns** repeat over a certain period of time. They are also called periodic patterns. Some temporal patterns repeat several times a day. Other temporal patterns repeat once a day, month, or year. Some patterns take many years to complete. Seasons are a temporal pattern that repeats annually. Winter is followed by spring, summer, and fall. The seasons repeat in this order every year.

The seasons also have a pattern of weather. In Pennsylvania, winters are generally cold and summers are generally hot. Many birds in Pennsylvania have behaviors that follow the seasons. They fly south when the weather turns cool and return north when the weather warms.

The change in ocean tides is a daily temporal pattern. Each day, oceans tides cause water to creep up and down the shoreline, becoming shallower and deeper in a cycle. When the tide comes in, water covers more of the shore or becomes deeper. The water reaches its deepest point at high tide. Then the tide begins to recede. Over several more hours, the water level falls. The water is at its shallowest point at low tide. Then the tide begins to come in again, and the cycle repeats. There is at least one tidal cycle each day.



Some temporal patterns are regulated. This means that they repeat based on certain conditions. Thermostats are human-made devices that regulate the temperature in a room. The way thermostats function creates a pattern that repeats over time.

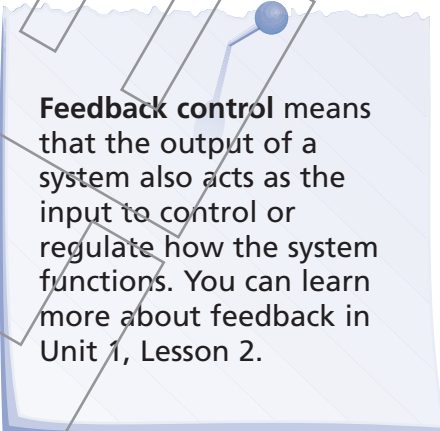
A **temporal pattern** is an event or process that repeats on a regular basis. The word *temporal* comes from the Latin word *tempus*, which means "time."

Animals that move long distances when the seasons change *migrate*. Some whales swim from Antarctic to Australian waters in the winter. They return to Antarctic waters when the weather warms. The whales repeat this migration pattern every year.

The peaks in the graph represent high tides and the valleys represent low tides. High tides and low tides repeat over time on a regular basis. In this case, one tidal cycle repeats about every 12 hours.

People set thermostats to the temperature they want a house or a room to be. This temperature is called the *set point*. Thermostats have sensors that detect the actual temperature in a room. If the temperature drops below the set point, the thermostat switches on a heating system. The heat causes the temperature in the room to rise. Once the temperature reaches the set point, the thermostat switches the heating system off. This pattern repeats each time the temperature drops below the set point.

In this way, thermostats are **feedback-controlled** systems. Heat is the output of the system. Output also helps determine when heat is no longer needed. Many systems in the human body are regulated in a similar way. The products of some chemical reactions control whether the reaction will continue. For example, the chemical insulin breaks down sugar in the blood. When there is too much sugar in the blood, the body produces more insulin. When the level of sugar decreases, the body stops releasing insulin into the blood.



Feedback control means that the output of a system also acts as the input to control or regulate how the system functions. You can learn more about feedback in Unit 1, Lesson 2.

Because patterns repeat, scientists can use them to make predictions. A scientist records the phase of the moon every week for seven weeks.

MOON PHASES

Week	Moon Phase
1	last quarter
2	new
3	first quarter
4	full
5	last quarter
6	new
7	first quarter

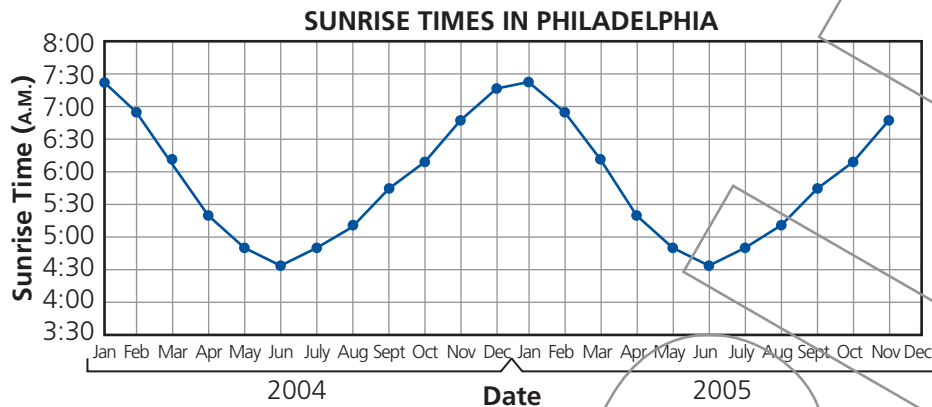
- A Based on these data, what phase do you predict the scientist will observe in week 10?**
- B Explain why this pattern is both physical and temporal.**

Based on the pattern, the scientist will observe a new moon in week 10. A first quarter moon is followed by a full moon, a last quarter moon, and a new moon. The scientist would observe a full moon in week 8, a last quarter moon in week 9, and a new moon in week 10. The pattern is physical because the shapes or phases repeat in order. It is temporal because the phases repeat monthly, or over time.

It's Your Turn

Please read each question carefully. To answer each multiple-choice question, circle the correct response.

Use the graph below to answer question 1.



1 Based on the graph, which of these statements correctly describes the pattern in sunrise times?

- A** It is an hourly periodic pattern.
- B** It is a daily periodic pattern.
- C** It is a monthly periodic pattern.
- D** It is an annual periodic pattern.

2 Which of these is an example of a physical pattern in nature?

- A** A tree loses leaves in the fall and grows new leaves in the spring.
- B** A roof is supported by a repeating framework of wooden trusses.
- C** A computer automatically saves information every five minutes.
- D** A bee builds a honeycomb made of recurring hexagonal cells.

3 How would opening a window in a room on a winter day most likely change the pattern of thermostat cycles in the room?

- A** It would make the cycles more frequent.
- B** It would make the cycles unregulated.
- C** It would make the cycles controlled.
- D** It would make the cycles less efficient.