3.1   Graphing Relationships
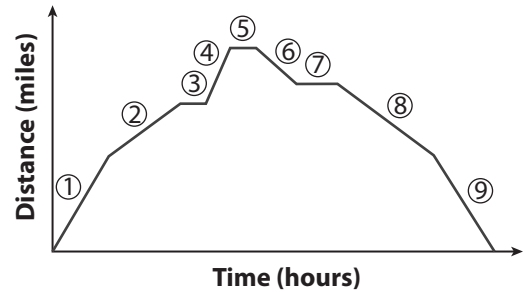
Essential Question: How can you describe a relationship given a graph and sketch a graph given a description?

🧭 Explore   Interpreting Graphs

The distance a delivery van is from the warehouse varies throughout the day. The graph shows the distance from the warehouse for a day from 8:00 am to 5:00 pm.

(A)   Segment 1 shows that the delivery van moved away from the warehouse. What does segment 2 show?

_____

_____

(B)   Based on the time frame, what change in the distance from the warehouse is represented by segment 6?

_____

_____

(C)   Which line segments show intervals where the distance did not change?

_____

(D)   What is a possible explanation for these segments?

_____

_____

Reflect

1.   **Discussion** Explain how the slope of each segment of the graph is related to whether the delivery truck is not moving, is moving away from, or is moving toward the warehouse.

_____

_____

_____

_____

⏱ Explain 1 Relating Graphs to Situations

Graphs can often be drawn to represent real life situations. These graphs are not always easily derived from equations, but rather represent certain situations. For example, these graphs may include the amount of rain over a certain period of time, or the height of a bouncing ball over a certain period of time.

Example 1 **Three hoses fill three different water barrels. A green hose fills a water barrel at a constant rate. A black hose is slowly opened when filling the barrel. A blue hose is completely open at the beginning and then slowly closed. The three graphs of the situations are shown.**
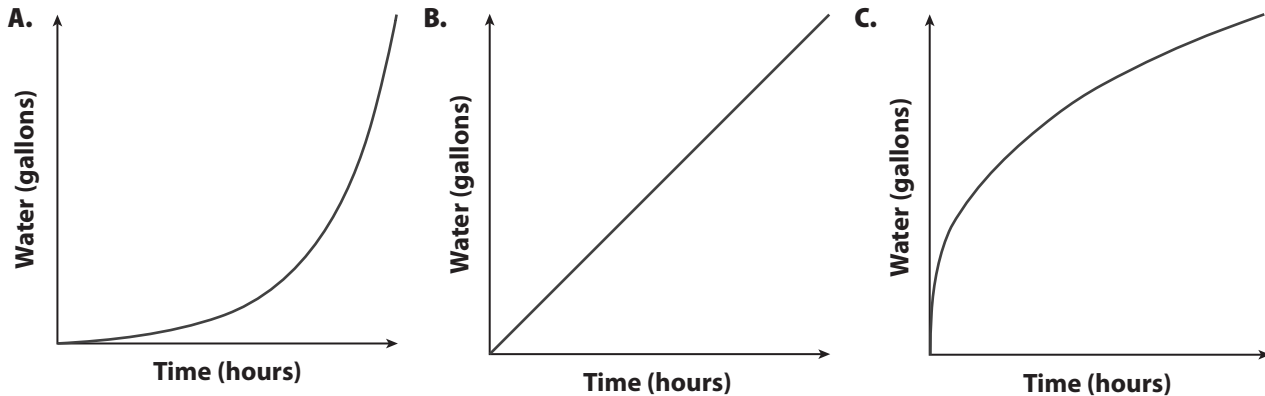
Ⓐ Which graph best represents the amount of water in the barrel filled by the green hose?

Since the flow of the water is constant, the amount of water in the barrel should be a steady increase. Thus, graph B best represents the situation.

Ⓑ Describe the water level represented by each graph. Then determine which graph represents each situation.

Describe the water level for graph A.

_____

Describe the water level for graph C.

_____

Graph A represents the _____ hose and graph C represents the _____ hose.

Reflect

2. Could a graph of the amount of water in a water barrel slant downward from left to right? Explain.

_____

You and a friend are playing catch. You throw three different balls to your friend. You throw the first ball in an arc and your friend catches it. You throw the second ball in an arc, but this time the ball gets stuck in a tree. You throw the third ball directly at your friend, but it lands in front of your friend, and rolls the rest of the way on the ground. The three graphs of these situations are shown.

A.

Height (ft) — Time (seconds)

B.

Height (ft) — Time (seconds)

C.

Height (ft) — Time (seconds)
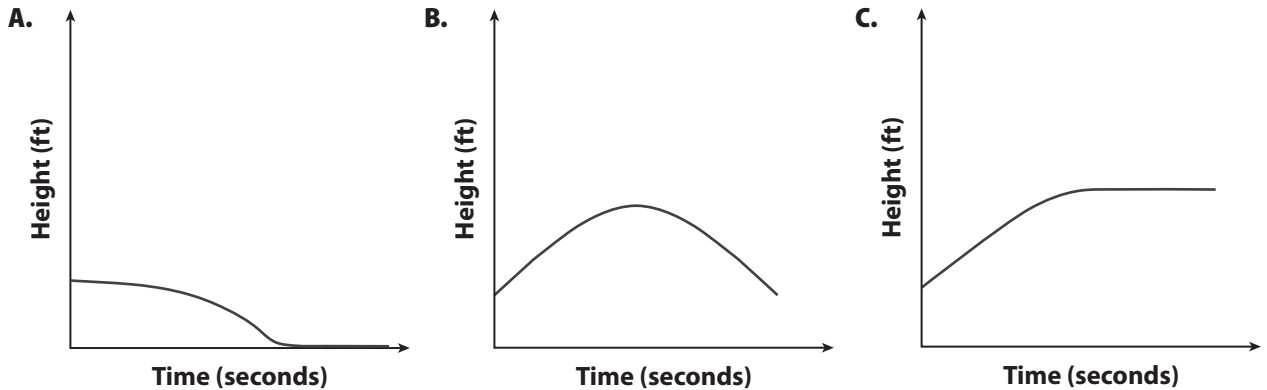
3. Which graph represents the situation where the ball gets stuck in the tree?

_____

4. Describe the height of the ball represented by the other two graphs.

_____

_____

_____

🔧 Explain 2   Sketching Graphs for Situations

Some graphs that represent real-world situations are drawn without any interruptions. In other words, they are *continuous graphs*. A **continuous graph** is a graph that is made up of connected lines or curves. Other types of graphs are not continuous. They are made up of distinct, unconnected points. These graphs are called **discrete graphs**.
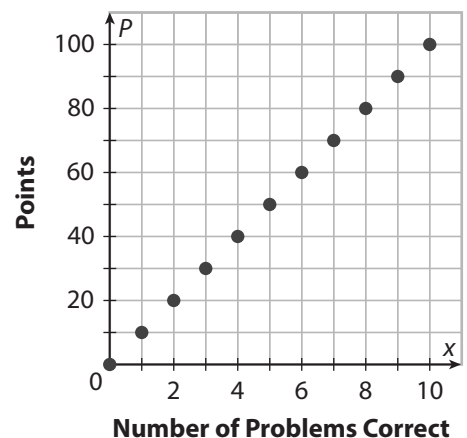
Example 2   **Sketch a graph of the situation, tell whether the graph is continuous or discrete, and determine the domain and range.**

(A)   A student is taking a test. There are 10 problems on the test. For each problem the student answers correctly, the student received 10 points.

The graph is made up of multiple unconnected points, so the graph is discrete.

The student can get anywhere from 0 to 10 questions right, so the domain is the whole numbers from 0 to 10.

If the student gets 0 problems correct, the student gets 0 points. If the student gets 10 problems correct, the student gets 100 points. So the range is whole number multiples of 10 from 0 to 100.

Number of Problems Correct

(B) A bathtub is being filled with water. After 10 minutes, there are 75 quarts of water in the tub. Then someone accidentally pulls the drain plug while the water is still running, and the tub begins to empty. The tub loses 15 quarts in 5 minutes, and then someone plugs the drain and the tub fills for 6 more minutes, gaining another 45 quarts of water. After a 15-minute bath, the person gets out and pulls the drain plug. It takes 11 minutes for the tub to drain.
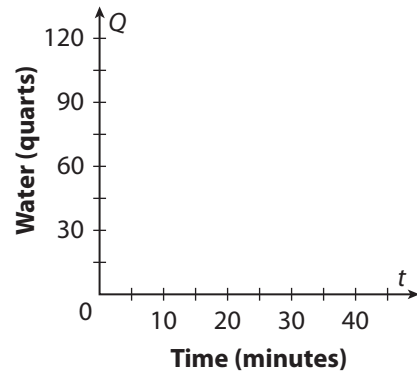

The graph is a _____ graph.

The domain is _____ .

The range is _____ .

Your Turn

Sketch a graph of the situation, tell whether the graph is continuous or discrete, and determine the domain and range.

5. At the start of a snowstorm, it snowed two inches an hour for two hours, then slowed to one inch an hour for an additional hour before stopping. Three hours after the snow stopped, it began to melt at one-half an inch an hour for two hours.

_____

_____

_____
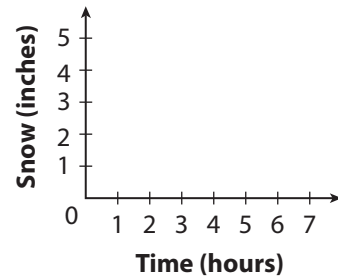
6. A local salesman is going door to door trying to sell vacuums. For every vacuum he sells, he makes $20. He can sell a maximum of 10 vacuums a day.

_____

_____

_____
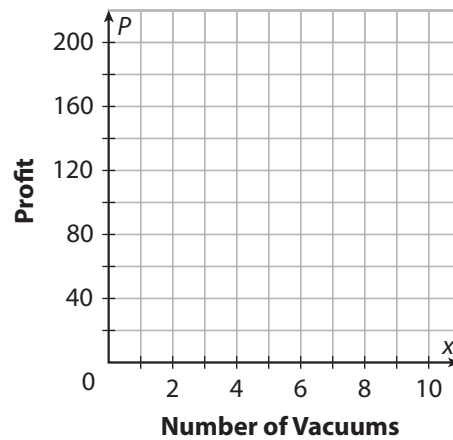
7. When interpreting graphs of real world situations, what can the slope of each part tell you about the situation?

_____

_____

8. **Discussion** What is the best way to sketch the graph of a situation?

_____

_____

9. **Essential Question Check-In** How can you tell when to use a discrete graph as opposed to using a continuous graph? Give an example of each.
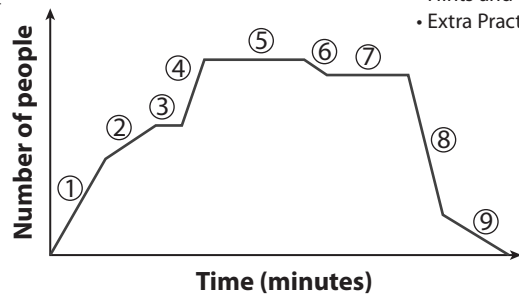
_____

_____

_____

_____

_____

⊛ Evaluate: Homework and Practice

- Online Homework
- Hints and Help
- Extra Practice

The graph shows the attendance at a hockey game, and the rate at which the fans enter and exit the arena.

1. Compare segments 1 and 2. What do they represent?

2. What does segment 8 represent in terms of the game?

3. What is the significance of segments 5 and 7?

4. What does segment 6 mean?

Use Graphs A–D for Exercises 5–8. Janelle alternates between running and walking. She begins by walking for a short period, and then runs for the same amount of time. She takes a break before beginning to walk again. Consider the graphs shown.

A.

B.

C.

D.
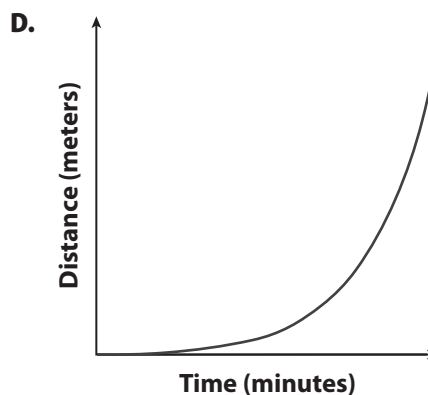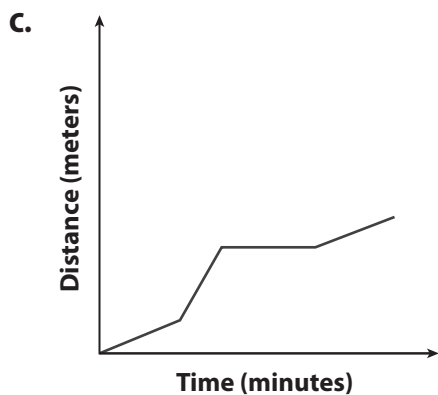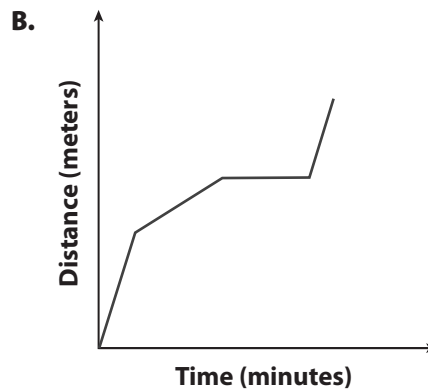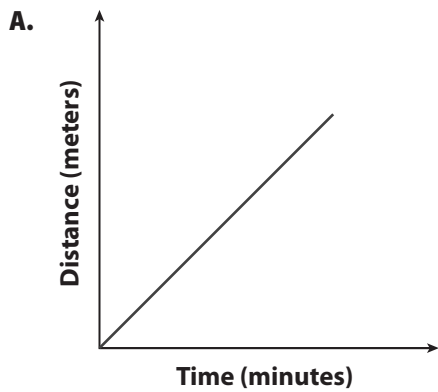
5. Which graph best represents the given situation?

6. Describe the other three graphs.

7. What if Janelle began by running, then slowed to a walk, stopped, and then began running again. Which graph would represent this situation?

8. What are possible situations for graphs A and D?

Use Graphs A–D for Exercises 9–11. **During the winter, the amount of water that flows down a river remains at a low constant. In the spring, when the snow melts, the flow of water increases drastically, until it decreases to a steady rate in the summer. The flow then slowly decreases through the fall into the winter. Consider the graphs shown.**
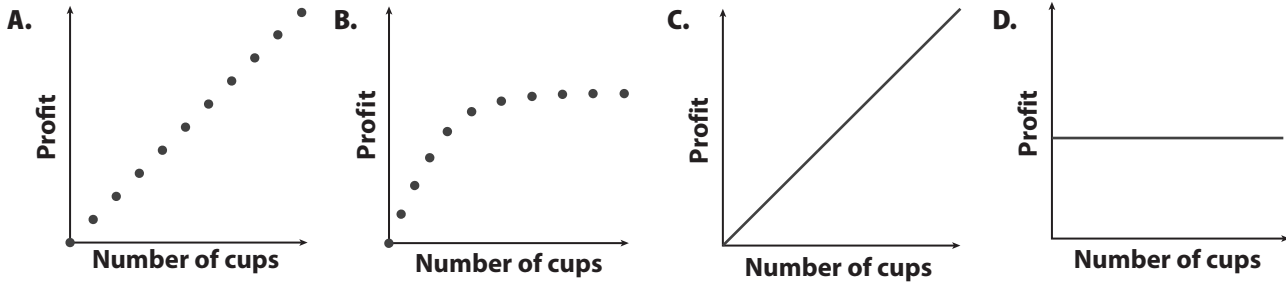
A.

B.

C.

D.
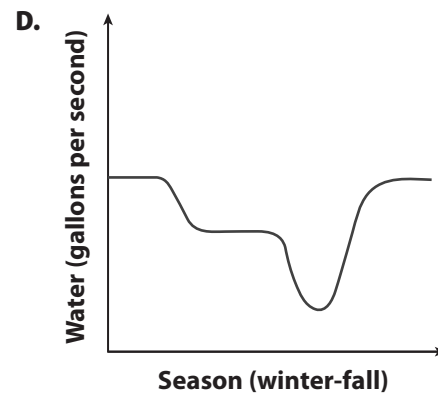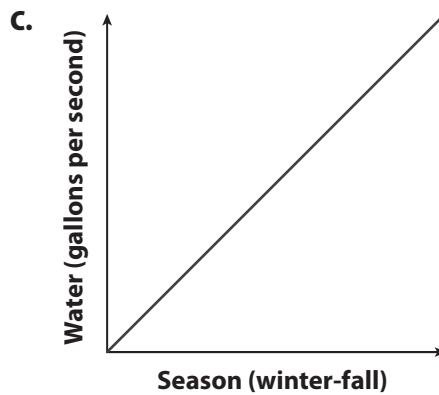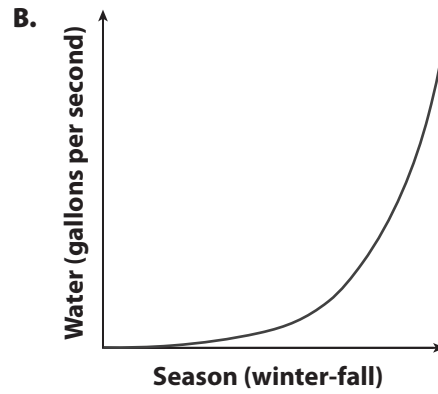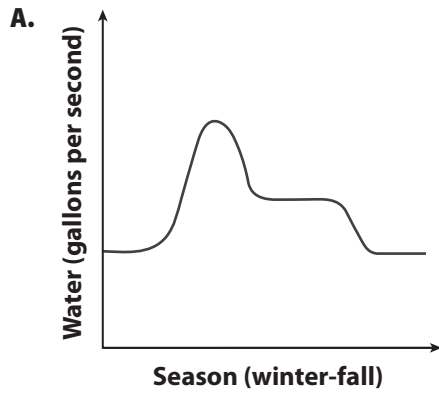
9. Which graph best represents the given situation?

10. Describe the other three graphs.

11. What are possible situations for graphs B, C, and D?

**Two children are selling lemonade. They are charging \$1 for a cup.
They only sell 10 cups. Consider the graphs shown.**

A.

Profit

Number of cups

B.

Profit

Number of cups

C.

Profit

Number of cups

D.

Profit

Number of cups

12. Which graph best represents the given situation?

13. What situations could the other graphs represent?

14. Is the graph that represents the given situation discrete or continuous?

**A plane takes off and climbs steadily for 15 minutes until it
reaches 30,000 feet. It travels at that altitude for 2 hours until
it begins to descend to land, which it takes 15 minutes at a
constant rate.**

15. Sketch a graph of the situation.

Height (feet)

30,000

1   2

Time (hours)
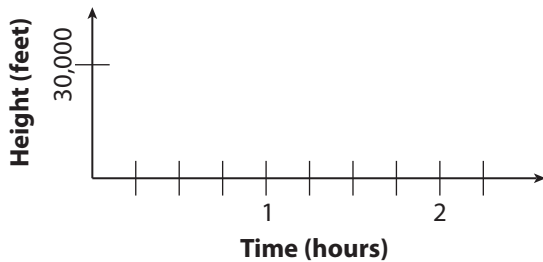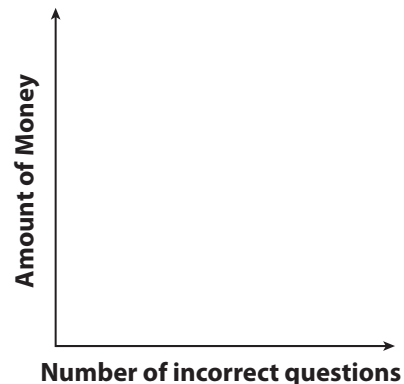
16. Is the graph discrete or continuous?

17. Determine the domain and range.

**A contestant on a game show is given \$100 and is asked five
questions. The contestant loses \$20 for every wrong answer.**

18. Sketch a graph of the situation.

19. Is the graph discrete or continuous?

20. Determine the domain and range.

Amount of Money

Number of incorrect questions

You decide to hike up a mountain. You climb steadily for 2 hours, then take a 30 minute break for lunch. Then you continue to climb, faster than before. When you make it to the summit, you enjoy the view for an hour. Finally, you decide to climb down the mountain, but stop halfway down for a short break. Then you continue down at a slower pace than before.

21. Sketch a graph of the situation.

**22.** Is the graph discrete or continuous?
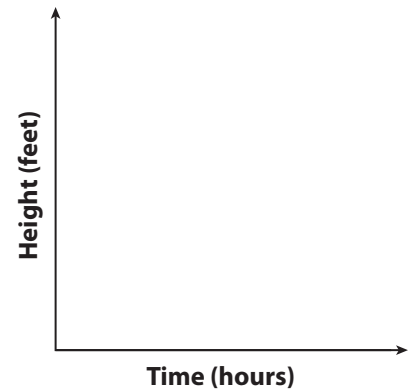
H.O.T. Focus on Higher Order Thinking

**23. Analyze Relationships** Write a possible situation for the graph shown.
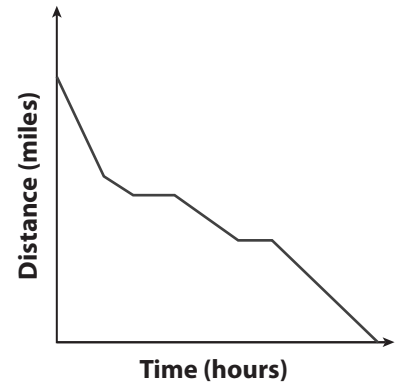
24. Represent Real-World Problems Scientists are conducting an experiment on a bacteria colony that causes its population to fluctuate. The population of a bacteria colony is shown in the graph.

   a. What happened to the bacteria colony before time t?

   b. Suppose at time t, a second colony of bacteria is added to the first. Draw a new graph to show how this action might affect the population after time t.

   c. Suppose at some point after time t, scientists add a substance to the colony that destroys some of the bacteria. Describe how your graph from part b might change.
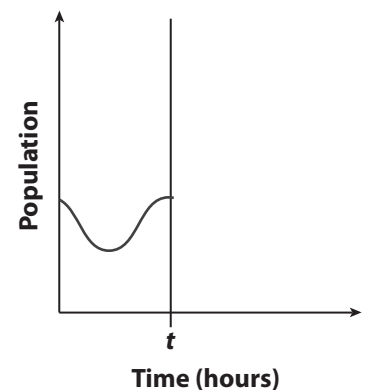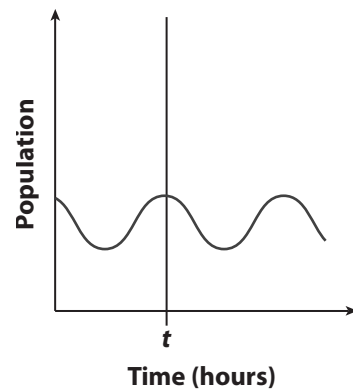
25. Explain the Error A student is told to draw a graph of the situation which represents the height of a skydiver with respect to time. He drew the following graph. Explain the student's error and draw the correct graph.
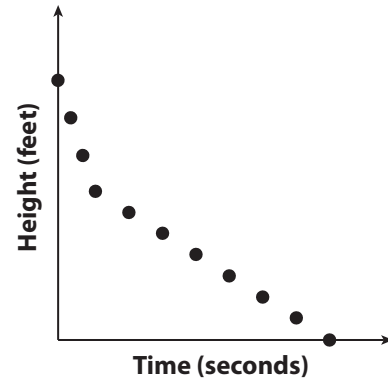
Lesson Performance Task

A digital rain gauge has an outdoor sensor that collects rainfall and transmits data to an indoor display. Assume you produced a graph of all the data collected by the rain gauge over a 24-hour period.

  a. Would that graph be a discrete graph or a continuous graph? Explain your reasoning.

  b. Describe the general shape of the graph assuming it rained at a rate of 0.1 inch per hour for the entire 24-hour period.

  c. Describe the general shape of the graph assuming it rained 0.1 inch per hour for 6 hours, stopped raining for 6 hours, and then rained 0.2 inch for 12 hours.