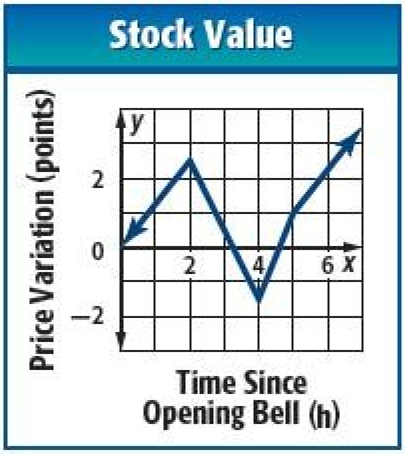
CCSS SENSE-MAKING Identify the function graphed as linear or nonlinear. Then estimate and interpret the intercepts of the graph, any symmetry, where the function is positive, negative, increasing, and decreasing, the *x*-coordinate of any relative extrema, and the end behavior of the graph.

1.



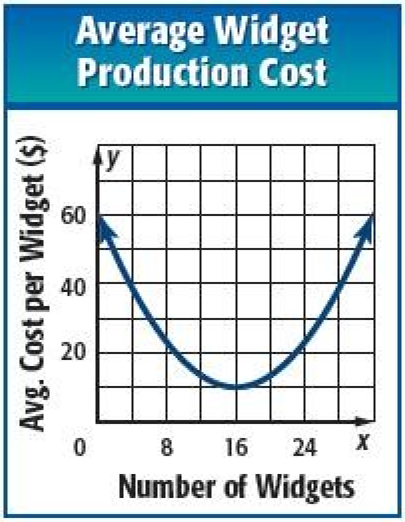
SOLUTION:

Linear or Nonlinear:
The graph is not a line, so the function is nonlinear.
***y*-Intercept:** The *y*-intercept is 0, so there is no change in the stock value at the opening bell.
***x*-Intercepts:** The *x*-intercepts are 0, about 3.2, and about 4.5, so there is no change in the stock value after 0 hours, after about 3.2 hours, and after about 4.5 hours after the opening bell.
Symmetry: The graph has no line symmetry. So the price variations at different times did not go up and down at regular intervals.
Positive/Negative: The function is positive between *x*-values of 0 to about 3.2, and 4.5 and greater. So the stock value was higher than the opening price for the first 3.2 hours and after 4.5 hours. The function is negative between *x*-values of about 3.2 and 4.5. The value was less than the starting value from about 3.2 hours until 4.5 hours after the opening bell.
Increasing/Decreasing: The function increases for *x*-values from 0 to 2, decreases from 2 to 4, and increases for 4 and greater. The stock value starts the day increasing in value for the first 2 hours, then it goes down in value from 2 hours until 4 hours, and after 4 hours it goes up in value for the remainder of the day.
Relative Extrema: There is a relative maximum of about 2.4 at $x = 2$ and a relative minimum of about –1.4 at $x = 4$. The stock had a relative high value of about 2.4 points above the opening price after 2 hours and then a relative low value of about 1.4 points below the opening price after 4 hours.
End Behavior: As *x* increases, *y* increases. As the day goes on, the stock increases in value.

ANSWER:

Nonlinear; the *y*-intercept is 0, so there is no change in the stock value at the opening bell. The *x*-intercepts are 0, about 3.2, and about 4.5, so there is no change in the stock value after 0 hours, after about 3.2 hours, and after about 4.5 hours after the opening bell. The graph has no line symmetry. The stock went up in value for the first 3.2 hours, then dropped below the starting value from about 3.2 hours until 4.5 hours, and finally went up again after 4.5 hours. The stock value starts the day increasing in value for the first 2 hours, then it goes down in value from 2 hours until 4 hours, and after 4 hours it goes up in value for the remainder of the day. The stock had a relative high value after 2 hours and then a relative low value after 4 hours. As the day goes on, the stock increases in value.

2.



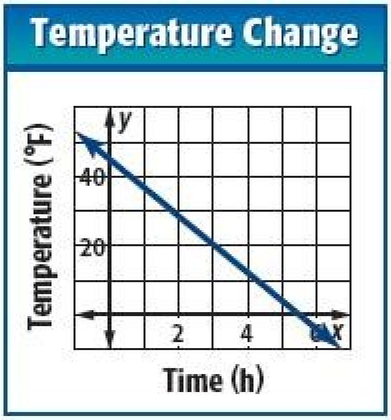
SOLUTION:

Linear or Nonlinear: The graph is not a line, so the function is nonlinear.
***y*-Intercept:** The y-intercept is about 60, so there is an initial production cost of about $60.
***x*-Intercept:** There are no *x*-intercepts, so the cost per widget will never be $0.
Symmetry: The graph has line symmetry about the line $x = 16$. The cost of producing 0 to 16 widgets is the same as the cost of producing 16 to 32 widgets.
Positive/Negative: The function is always positive. There is always a cost for producing any number of widgets.
Increasing/Decreasing: The function decreases between *x*-values of 0 to 16, and increases for *x*-values between 16 and 32. The average production cost decreases for making 0 to 16 widgets and then goes up for producing 16 to 32 widgets.
Relative Extrema: There is a relative minimum of 10 at $x = 16$. The lowest production cost of $10 per widget occurs when 16 widgets are produced.
End Behavior: As x increases, y increases. As greater numbers of widgets are produced, the average cost per widget will continue to increase.

ANSWER:

Nonlinear; the y-intercept is about 60, so there is an initial production cost of about $60. There are no *x*-intercepts, so the cost per widget will never be $0. The cost of producing 0 to 16 widgets is the same as the cost of producing 16 to 32 widgets. There is always a cost for producing any number of widgets. The average production cost decreases for making 0 to 16 widgets and then goes up for producing 16 to 32 widgets. The lowest production cost occurs when 16 widgets are produced. As greater numbers of widgets are produced, the average cost per widget will continue to increase.

3.



SOLUTION:

Linear or Nonlinear: The graph is a line, so the function is linear.
y-Intercept: The y-intercept is about 45, so the temperature was about 45°F when the measurement started.
x-Intercept: The x-intercept is about 5.5, so after about 5.5 hours, the temperature was 0°F.
Symmetry: The graph has no line symmetry.
Positive/Negative: The function is positive for x-values from 0 to about 5.5 and negative for x-values greater than 5.5. The temperature is above zero for the first 5.5 hours, and then below zero after 5.5 hours.
Increasing/Decreasing: The function decreases over the entire domain. The termperature is going down for the entire time.
Relative Extrema: There are no extrema.
End Behavior: As x increases, y decreases. As the time increases, the temperature will continue to drop, which is not very likely.

ANSWER:

Linear; the y-intercept is about 45, so the temperature was about 45°F when the measurement started. The x-intercept is about 5.5, so after about 5.5 hours, the temperature was 0°F. The graph has no line symmetry. The temperature is above zero for the first 5.5 hours, and then below zero after 5.5 hours. The temperature is going down for the entire time. There are no extrema. As the time increases, the temperature will continue to drop, which is not very likely.

CCSS SENSE-MAKING Identify the function graphed as linear or nonlinear. Then estimate and interpret the intercepts of the graph, any symmetry, where the function is positive, negative, increasing, and decreasing, the *x*-coordinate of any relative extrema, and the end behavior of the graph.

4.

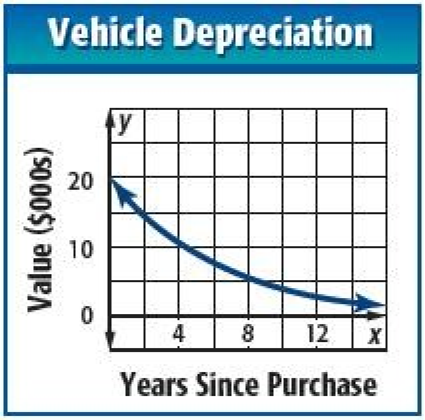
SOLUTION:

Linear or Nonlinear: The graph is a line, so the function is linear.
***y*-Intercept:** The *y*-intercept is about –400, so the mowing service has a start-up cost of about $400.
***x*-Intercept:** The *x*-intercept is about 4, so after about 4 weeks, the profit will be $0.
Symmetry: The graph has no line symmetry.
Positive/Negative: The function is negative for *x*-values from 0 to about 4, and positive for *x*-values greater than 4. The profits will be in the negative until after about 4 weeks, and then will be positive for all time afterwards.
Increasing/Decreasing: The function increases over the entire domain. The profits are constantly increasing.
Relative Extrema: There are no extrema.
End Behavior: As *x* increases, *y* decreases. As the number of weeks increases, the profits will increase.

ANSWER:

Linear; the *y*-intercept is about –400, so the mowing service has a start-up cost of about $400. The *x*-intercept is about 4, so after about 4 weeks, the profit will be $0. The graph has no line symmetry. The profits will be in the negative until after about 4 weeks, and then will be positive for all time afterwards. The profits are constantly increasing. There are no extrema. As the number of weeks increases, the profits will increase.

5.



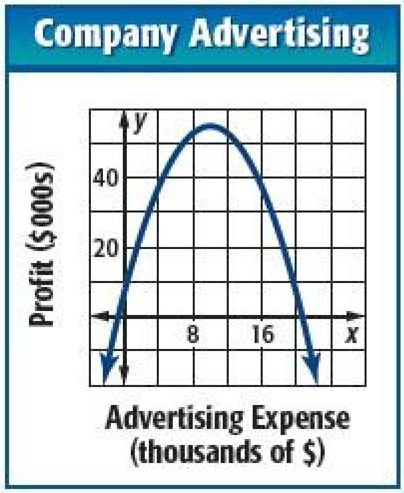
SOLUTION:

Linear or Nonlinear: The graph is not a line, so the function is nonlinear.
y-Intercept: The y-intercept is about 20, which means that the purchase price of the vehicle was about $20,000.
x-Intercept: There is no x-intercept, so the value of the vehicle is never $0.
Positive/Negative: The function is positive for all values of x. This means that the value of the vehicle will always be greater than $0.
Increasing/Decreasing: The function is decreasing for all values of x. The vehicle is losing value over time.
Relative Extrema: The function has no relative minima or maxima. There is no maximum or minimum vehicle value.
End Behavior: As x-increases, y-decreases. This means that the value of the car is expected to continue to decrease.

ANSWER:

Nonlinear; the y-intercept is about 20, so the purchase price of the vehicle was about $20,000. There is no x-intercept, so the value of the vehicle will never equal 0. The graph has no line symmetry. The value of the vehicle is always positive.The value of the vehicle is always decreasing. There are no extrema. As the number of years increase, the value of the vehicle decreases.

6.



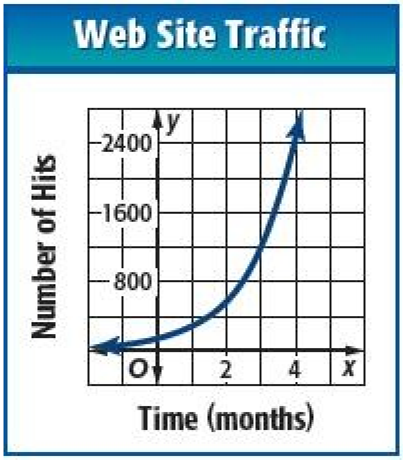
SOLUTION:

Linear or Nonlinear: The graph is not a line, so the function is nonlinear.
***y*-Intercept:** The y-intercept is about 5, which means that the company has a profit of about $5000 without spending any money on advertising.
***x*-Intercept:** The x-intercepts are about –1 and about 21. This indicates that the profit is $0 for advertising expenses of $–1000 or $21,000. The –1 intercept has no meaning, since the company can not spend a negative amount of money on advertising.
Symmetry: The graph is symmetric about the line $x = 10$. Spending between $0 and $10,000 on advertising will produce the same profits as spending between $10,000 and $20,000.
Positive/Negative: The function is positive between about 0 and 21 and negative for about $x < –1$ and for about $x > 21$. The company will make a profit if they spend between $0 and about $21,000. If they spend more than $21,000 on advertising, they will lose money.
Increasing/Decreasing: The function is increasing for $x < 10$ and decreasing for $x > 10$. The profits will increase until the company spends about $10,000, and then the profits will decrease for any amount greater than $10,000.
Relative Extrema: There is a relative maximum at about $x = 10$. This means that spending about $10,000 will produce the greatest profit.
End Behavior: As x increases, y decreases, and as x decreases, y decreases. As more money is spent on advertising, the profits will decrease so that the company is losing money.

ANSWER:

Nonlinear; the y-intercept is about 5, so the company has a profit of about $5000 without spending any money on advertising. The x-intercepts are about -1 and about 21, so the company will make a profit of $0 if they spend $21,000 on advertising. The graph is symmetric about the line $x = 10$. Spending between $0 and $10,000 on advertising will produce the same profits as spending between $10,000 and $20,000. The company will make a profit if they spend between $0 and $21,000. If they spend more than $21,000 on advertising, they will lose money. The profits will increase until the company spends about $10,000, and then the profits will decrease for any amount greater than $10,000. Spending about $10,000 will produce the greatest profit. As more money is spent on advertising, the profits will decrease so that the company is losing money.

7.



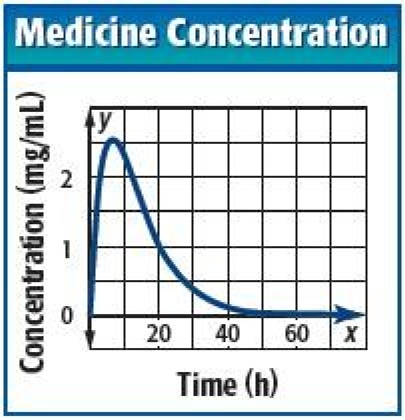
SOLUTION:

Linear or Nonlinear: The graph is not a line, so the function is nonlinear.
y-Intercept: The y-intercept is about 100. This means that the web site had 100 hits before the time began.
x-Intercept: There is no x-intercept, so the number of hits was never 0.
Symmetry: The graph has no line symmetry.
Positive/Negative: The function is positive for all values of x. This means that the web site has never experienced a time of inactivity.
Increasing/Decreasing: The function is increasing for all values of x. This means that the web site has never experienced a time of inactivity.
Relative Extrema: The function has no relative minima or maxima. There is no maximum or minimum number of hits.
End Behavior: As x increases, y increases, This means that the upward trend in the number of hits is expected to continue.

ANSWER:

Nonlinear; the y-intercept is about 100. This means that the web site had 100 hits before the time began. There is no x-intercept. The function is positive for all values of x. This means that the web site has never experienced a time of inactivity. The function is increasing for all values of x, with no relative maxima or minima. As x-increases, y-increases, which means that the upward trend in the number of hits is expected to continue.

8.



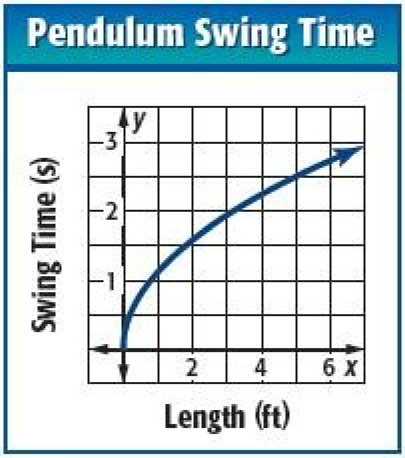
SOLUTION:

Linear or Nonlinear: The graph is not a line, so the function is nonlinear.
***y*-Intercept:** The *y*-intercept is 0, which means that at the start, there was no medicine in the bloodstream.
***x*-Intercept:** There appears to be no *x*-intercept, which means that the medicine does not every fully leave the bloodstream for the time shown.
Symmetry: The graph has no line symmetry.
Positive/Negative: The function is positive for all values of x, which means that after the medicine is taken, there is always some amount in the bloodstream.
Increasing/Decreasing: The function is increasing between about $x = 0$ and $x = 8$ and decreasing for $x > 8$. This means that the concentration of medicine increased over the first 8 hours to a maximum concentration of about 2.5 mg/mL, and then decreased.
Relative Extrema: The function has a relative maximum of about 1.5 at about $x = 8$. This means that the concentration of medicine was at a maximum of about 2.5 mg/mL after 8 hours.
End Behavior: As *x* increases, *y* decreases towards 0. This means that the concentration of medicine in the bloodstream becomes less and less, until there is practically none left.

ANSWER:

Nonlinear; the *y*-intercept is 0, which means that at the start, there was no medicine in the bloodstream. There appears to be
no *x*-intercept, which means that the medicine does not ever fully leave the bloodstream for the time shown. The function is positive for all values of *x*, which means that after the medicine is taken, there is always some amount in the bloodstream. The function is increasing between about $x = 0$ and $x = 8$ and decreasing for $x > 8$, with a maximum value of about 1.5 at about $x = 8$. This means that the concentration of medicine increased over the first 8 hours to a maximum concentration of about 2.5 mg/mL, and then decreased.
As *x* increases, the value of *y* decreases towards 0, which means that the concentration of medicine in the bloodstream becomes less and less, until there is practically none left.

9.



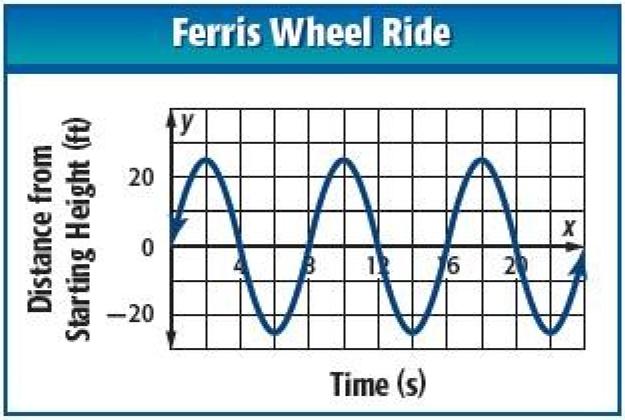
SOLUTION:

Linear or Nonlinear: The graph is not a line, so the function is nonlinear.
x- and y-Intercept: The x- and y-intercept is 0, which means for a pendulum with no length cannot complete a swing.
Symmetry: The graph has no line symmetry.
Positive/Negative: The function is positive for all values of x, so swing time is never negative.
Increasing/Decreasing: The function is increasing for all values of x. This means that as the pendulum gets longer, the time it takes for it to complete one full swing increases.
Relative Extrema: The function has no relative minima or maxima. There is no maximum or minimum swing time.
End Behavior: Also, as x increases, y increases, so as the pendulum gets longer, the time it takes for it to complete one full swing increases.

ANSWER:

Nonlinear; the x- and y-intercept is 0, which means that a pendulum with no length cannot complete a swing. The function is positive and increasing for all values of x. Also, as x increases, y increases. The function has no relative minima or maxima. This means that as the pendulum gets longer, the time it takes for it to complete one full swing increases.

10. **FERRIS WHEEL** At the beginning of a Ferris wheel ride, a passenger cart is located at the same height as the center of the wheel. The position y in feet of this cart relative to the center t seconds after the ride starts is given by the function graphed above. Identify and interpret the key features of the graph. (Hint: Look for a pattern in the graph to help you describe its end behavior.)



SOLUTION:

Linear or Nonlinear: The graph is not a line, so the function is nonlinear.
y-Intercept: The y-intercept is 0, indicating that the cart started at the same height as the center of the wheel.
x-Intercepts: The x-intercepts are 4, 8, 12, 16, 20, and 24, indicating that the ride returned to this same height 4, 8, 12, 16, and 20 seconds after the ride started.
Positive/Negative: The function is positive between times 0 and 4, 8 and 12, and 16 and 20 seconds. During these times, the cart was higher than the center of the wheel. The function is negative between times 4 and 8, 12 and 16, and 20 and 24 seconds. During these times, the car was lower than the center of the wheel.
Increasing/Decreasing: The function is increasing between times 0 and 2, 6 and 10, 14 and 18, and 22 and 24 seconds. During these times, the wheel was rotating such that the cart was ascending. The function is decreasing between times 2 and 6, 10 and 14, 18 and 22 seconds. During these times, the wheel was rotating such that the cart was descending.
Relative Extrema: The cart reached a maximum height of about 25 feet above the center of the wheel 2, 10, and 18 seconds after the ride started and a minimum height of about 25 feet below the center of the wheel 6, 14, and 22 seconds after the ride started.
End Behavior: The up and down pattern in the graph suggests that if the ride continues for more than 24 seconds, the cart will continue to move back and forth between 25 feet above and 25 feet below the center of the wheel.

ANSWER:

The graph is nonlinear with a y-intercept of 0, indicating that the cart started at the same height as the center of the wheel. The x-intercepts are 4, 8, 12, 16, 20, and 24, indicating that the ride returned to this same height 4, 8, 12, 16, and 20 seconds after the ride started.

The function is positive between times 0 and 4, 8 and 12, and 16 and 20 seconds. During these times, the cart was higher than the center of the wheel. The function is negative between times 4 and 8, 12 and 16, and 20 and 24 seconds. During these times, the car was lower than the center of the wheel. The function is increasing between times 0 and 2, 6 and 10, 14 and 18, and 22 and 24 seconds. During these times, the wheel was rotating such that the cart was ascending. The function is decreasing between times 2 and 6, 10 and 14, 18 and 22 seconds. During these times, the wheel was rotating such that the cart was descending.

The cart reached a maximum height of about 25 feet above the center of the wheel 2, 10, and 18 seconds after the ride started and a minimum height of about 25 feet below the center of the wheel 6, 14, and 22 seconds after the ride started. The up and down pattern in the graph suggests that if the ride continues for more than 24 seconds, the cart will continue to move back and forth between 25 feet above and 25 feet below the center of the wheel.

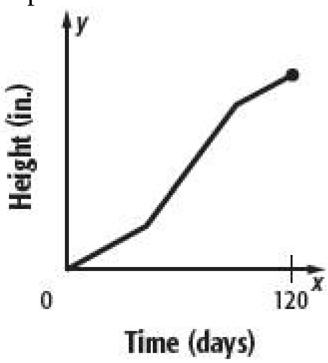
1-8 Interpreting Graphs of Functions

Sketch a graph of a function that could represent each situation. Identify and interpret the intercepts of the graph, where the graph is increasing and decreasing, and any relative extrema.

11. the height of a corn plant from the time the seed is planted until it reaches maturity 120 days later

SOLUTION:

Sample answer:



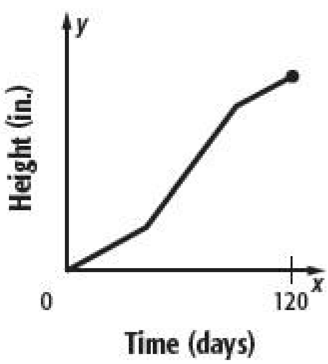
x- and y-Intercepts: The function has a y-intercept of 0 and an x-intercept of 0, indicating that the plant started with no height as a seed in the ground.

Increasing/Decreasing: The function is increasing over its domain, so that plant was always getting taller.

Relative Extrema: The function has no relative extrema, so the plant has no maximum or minimum height.

ANSWER:

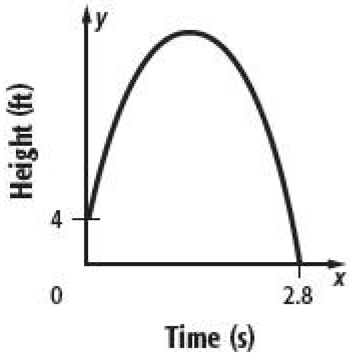
Sample answer: The function has a y-intercept of 0 and an x-intercept of 0, indicating that the plant started with no height as a seed in the ground. The function is increasing over its domain, so that plant was always getting taller. The function has no relative extrema.



12. the height of a football from the time it is punted until it reaches the ground 2.8 seconds later

SOLUTION:

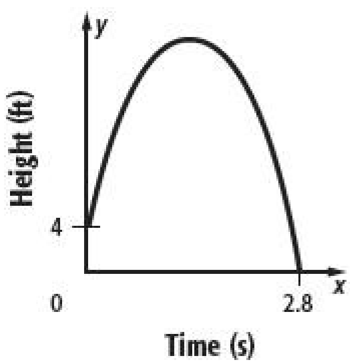
Sample answer:



***x*- and *y*-Intercepts:** The function has a y-intercept of 4 and an x-intercept of 2.8, indicating that the ball started at a height of 4 feet and returned to ground level after 2.8 seconds.
Increasing/Decreasing: The function is increasing between approximately 0 and 1.5 seconds after the punt and decreasing between 1.5 and 2.8 seconds after the punt.
Relative Extrema: The function has a relative maximum at about 1.5 seconds after the punt. At this time, the punt reached its maximum height.

ANSWER:

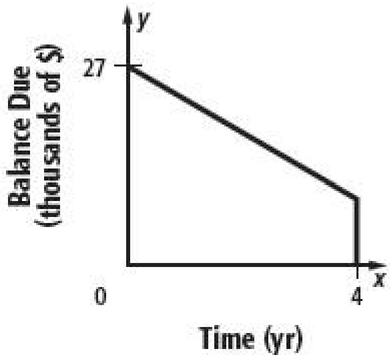
Sample answer: The function has a y-intercept of 4 and an x-intercept of 2.8, indicating that the ball started at a height of 4 feet and returned to ground level after 2.8 seconds. The function is increasing between approximately 0 and 1.5 seconds after the punt and decreasing between 1.5 and 2.8 seconds after the punt. The function has a relative maximum at about 1.5 seconds after the punt. At this time, the put reached its maximum height.



13. the balance due on a car loan from the date the car was purchased until it was sold 4 years later

SOLUTION:

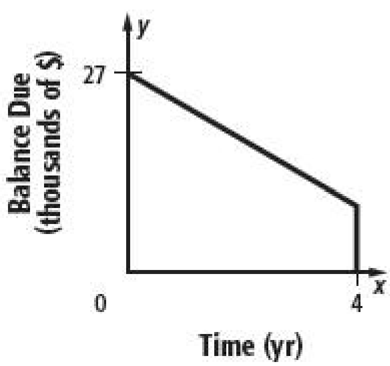
Sample answer:



x- and y-Intercepts: The function has a y-intercept of 27, indicating that the initial balance of the loan was \$27,000. The x-intercept of 4 indicates that the loan was paid off after 4 years.
Increasing/Decreasing: The function is decreasing over its entire domain, indicting that the amount owed on the loan was always decreasing.
Relative Extrema: The function has no relative extrema. There was no maximum or minimum balance due.

ANSWER:

Sample answer: The function has a y-intercept of 27, indicating that the initial balance of the loan was \$27,000. The x-intercept of 4 indicates that the loan was paid off after 4 years. The function is decreasing over its entire domain, indicting that the amount owed on the loan was always decreasing. The function has no relative extrema.



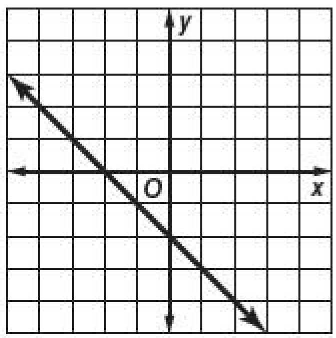
Sketch graphs of functions with the following characteristics.

14. The graph is linear with an *x*-intercept at –2. The graph is positive for $x < -2$, and negative for $x > -2$.

SOLUTION:

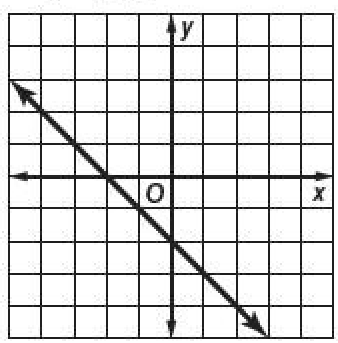
The graph is linear, so it is a line. The *x*-intercept is –2, so the plot the point (–2, 0). The function is positive for $x < -2$ and negative for $x > -2$, so the portion to the left of (–2, 0) is above the *x*-axis and the portion to the right of (–2, 0) is below the *x*-axis.

Sample graph:



ANSWER:

Sample graph:

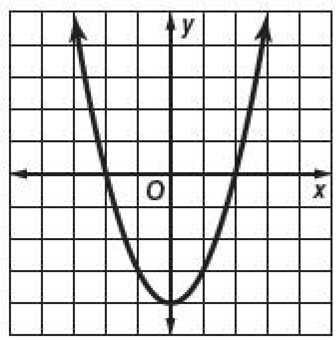


15. A nonlinear graph has x-intercepts at –2 and 2 and a y-intercept at –4. The graph has a relative minimum of –4 at x = 0. The graph is decreasing for $x < 0$ and increasing for $x > 0$.

SOLUTION:

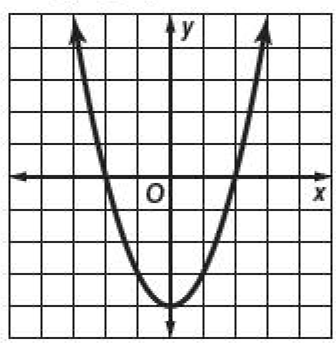
Plot the x-intercepts at (–2, 0) and (2, 0) and the y-intercept at (0, –4). Since the graph is nonlinear and decreasing for $x < 0$, draw a smooth curve starting somewhere to the left and above (–2, 0) that moves down through (–2, 0) to (–4, 0). Since the graph is has a relative minimum at $x = 0$ and is increasing for $x > 0$, turn at the point (–4, 0) and draw a smooth curve moving up as you move right, through (2, 0) and continuing to the upper right portion of the graph.

Sample graph:



ANSWER:

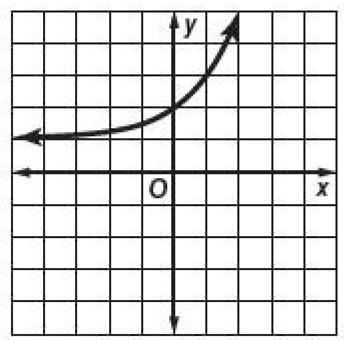
Sample graph:



16. A nonlinear graph has a y-intercept at 2, but no x-intercepts. The graph is positive and increasing for all values of x.

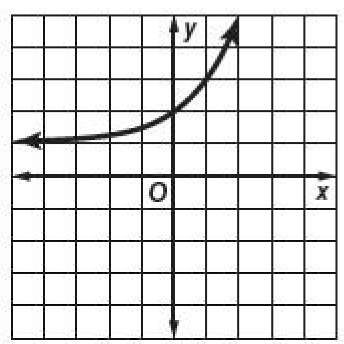
SOLUTION:

The graph is nonlinear, so it is a curve not a line. The y-intercept is 2, so plot (0, 2). Because there are no x-intercepts, the graph never intersects the x-axis. The function values are all positive and everywhere increasing, so the graph must curve upward from left to right. Sample graph:



ANSWER:

Sample graph:



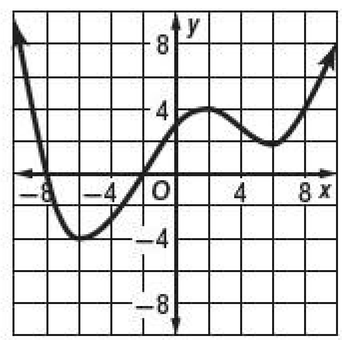
17. A nonlinear graph has x-intercepts at –8 and –2 and a y-intercept at 3. The graph has relative minimums at $x = –6$ and $x = 6$ and a relative maximum at $x = 2$. The graph is positive for $x < –8$ and $x > –2$ and negative between $x = –8$ and $x = –2$. As x decreases, y increases and as x increases, y increases.

SOLUTION:

The graph is a curve that passes through (–8, 0), (–2, 0), and (0, 3). The relative minimums at $x = –6$ and $x = 6$ indicate that the curve dips down at those x-values. The relative maximum indicates that the graph curves up at $x = 2$.

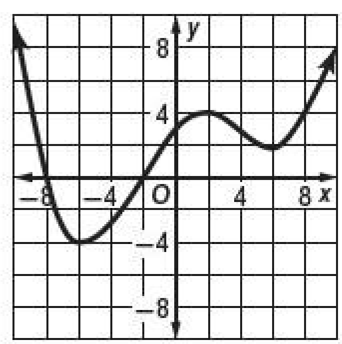
The graph is above the x-axis for $x < –8$ and $x > –2$ and below the x-axis otherwise. The end behavior indicates that the graph points upward on both the left and right.

Sample graph:



ANSWER:

Sample graph:



18. **CCSS CRITIQUE** Katara thinks that all linear functions have exactly one x-intercept. Desmond thinks that a linear function can have at most one x-intercept. Is either of them correct? Explain your reasoning.

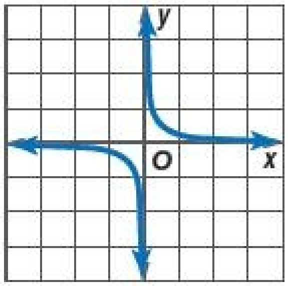
SOLUTION:

Neither is correct. While many linear functions have one x-intercept, there are linear functions that have no x-intercept like $y = 2$. The linear function $y = 0$ has infinitely many x-intercepts.

ANSWER:

Neither; the line $y = 2$ has no x-intercept while the line $y = 0$ has infinitely many x-intercepts.

19. **CHALLENGE** Describe the end behavior of the graph shown.



SOLUTION:

The graph approaches the x-axis as x increases and as x decreases. The function value of points on the x-axis is 0. Thus as x increases or decreases, y approaches 0.

ANSWER:

As x increases or decreases, y approaches 0.

1-8 Interpreting Graphs of Functions

20. **REASONING** Determine whether the following statement is *true* or *false*. Explain.

Functions have at most one y-intercept.

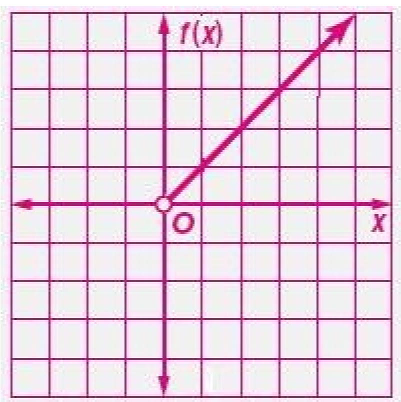
SOLUTION:

True; a function can have no more than one y-intercept. If a graph has more than one y-intercept, then it is not the graph of a function. When a relation has more than one y-intercept, then two points, (0, a) and (0, b), will cause the graph of the relation to fail the Vertical Line Test and not be a function. A function can also have no y-intercept if it is not defined for $x = 0$.

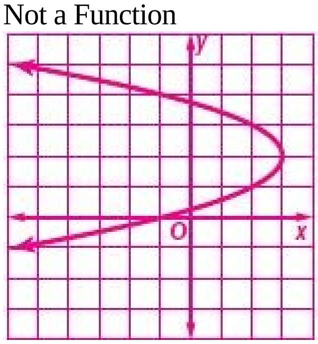
ANSWER:

True; a function can have no more than one y-intercept. If a graph has more than one y-intercept, then it is not the graph of a function. A function can also have no y-intercept if it is not defined for $x = 0$.

Function



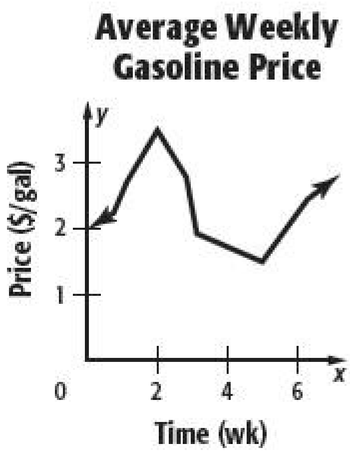
Not a Function



21. **OPEN ENDED** Sketch the graph of a function with one relative maximum and one relative minimum that could represent a real-world function. Label each axis and include appropriate units. Then identify and interpret the relative extrema of your graph.

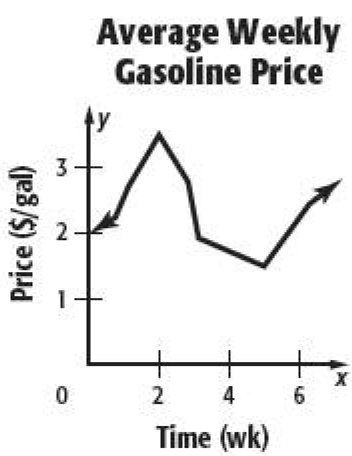
SOLUTION:

The graph has a relative maximum at about $x = 2$ and a relative minimum at about $x = 4.5$. This means that the weekly gasoline price spiked around week 2 at a high of about $3.50/gal and dipped around week 5 to a low of about $1.50/gal.



ANSWER:

The graph has a relative maximum at about $x = 2$ and a relative minimum at about $x = 4.5$. This means that the weekly gasoline price spiked around week 2 at a high of about $3.50/gal and dipped around week 5 to a low of about $1.50/gal.



22. **WRITING IN MATH** Describe how you would identify the key features of a graph described in this lesson using a table of values for a function.

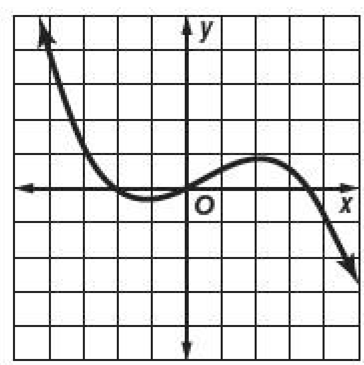
SOLUTION:

You could observe what the value of y is when x is zero to determine the y-intercept, and look for x-values that have a corresponding y-value of zero to determine the x-intercepts of the graph. The function is positive for x-values that have positive corresponding y-values and negative for x-values that have negative corresponding y-values. The function is increasing where as the x-values increase, the corresponding y-values increase and decreasing where as the x-values increase, the corresponding y-values decrease. A relative maximum is located where the y-values change from increasing to decreasing. A relative minimum is located where the y-values change from decreasing to increasing. To describe the end behavior of the function, observe the value of y as x decreases and the value of y as x-increases, noticing whether it continues to increase, decrease, or approach a specific value.

ANSWER:

Sample answer: You could observe what the value of y is when x is zero to determine the y-intercept, and look for x-values that have a corresponding y-value of zero to determine the x-intercepts of the graph. The function is positive for x-values that have positive corresponding y-values and negative for x-values that have negative corresponding y-values. The function is increasing where as the x-values increase, the corresponding y-values increase and decreasing where as the x-values increase, the corresponding y-values decrease. A relative maximum is located where the y-values change from increasing to decreasing. A relative minimum is located where the y-values change from decreasing to increasing. To describe the end behavior of the function, observe the value of y as x decreases and the value of y as x-increases, noticing whether it continues to increase, decrease, or approach a specific value.

23. Which sentence best describes the end behavior of the function shown?



A As x increases, y increases, and as x decreases, y increases.

B As x increases, y increases, and as x decreases, y decreases.

C As x increases, y decreases, and as x decreases, y increases.

D As x increases, y decreases, and as x decreases, y decreases.

SOLUTION:

The graph points upward on the left, so as x decreases, y increases. The graph points downward on the right, so as x increases, y decreases. This is choice C.

ANSWER:

C

24. Which illustrates the Transitive Property of Equality?

F If $c = 1$, then $c \times \frac{1}{c} = 1$.

G If $c = d$ and $d = f$, then $c = f$.

H If $c = d$, then $d = c$.

J If $c = d$ and $d = c$, then $c = 1$.

SOLUTION:

The Transitive Property of Equality says that if one quantity equals a second quantity and the second quantity equals a third quantity, then the first quantity equals the third quantity. In this case, the first quantity is c, the second quantity is d and the third quantity is f. Choice G illustrates the Transitive Property.

ANSWER:

G

25. Simplify the expression $5d(7-3) - 16d + 3 \cdot 2d$.

A $10d$

B $14d$

C $21d$

D $25d$

SOLUTION:

$5d(7 - 3) - 16d + 3 \cdot 2d$	
$= 5d(4) - 16d + 3 \cdot 2d$	Subtraction.
$= 5d(4) - 16d + 6d$	Multiply.
$= 20d - 16d + 6d$	Multiply.
$= 4d + 6d$	Simplify.
$= 10d$	Simplify.

Choice A is correct.

ANSWER:

A

26. What is the probability of selecting a red card or an ace from a standard deck of cards?

F $\frac{11}{26}$

G $\frac{1}{2}$

H $\frac{7}{13}$

J $\frac{15}{26}$

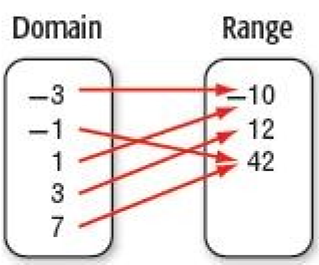
SOLUTION:
There are 26 red cards, and 4 aces in a deck of cards 2 of which are also red. So there are 26 + 4 – 2 or 28 cards that are red or an ace.

P(red card or ace) = $\frac{28}{52}$ or $\frac{7}{13}$

Choice H is correct.

ANSWER:
H

Determine whether each relation is a function.



27.

SOLUTION:
Each element of the domain is paired with a unique member of the range, so this is a function.

ANSWER:
yes

28. {(0, 2), (3, 5), (0, –1), (–2, 4)}

SOLUTION:
Each element of the domain is not paired with a unique member of the range, 0 is paired with both 2 and –1. So this is not a function.

ANSWER:
no

29.

x	y
17	6
18	6
19	5
20	4

SOLUTION:

Each element of the domain is paired with a unique member of the range, so this is a function.

ANSWER:

yes

30. **GEOMETRY** Express the relation in the graph at the right as a set of ordered pairs. Describe the domain and range.

SOLUTION:

Write an ordered pair for each point in the graph of the relation.{(1, 3), (2, 6), (3, 9), (4, 12), (5, 15), (6, 18), (7, 21)}
The domain is the set of all x-coordinates.
Domain: {1, 2, 3, 4, 5, 6, 7}
The range is the set of all y-coordinates.
Range: {3, 6, 9, 12, 15, 18, 21}

ANSWER:

{(1, 3), (2, 6), (3, 9), (4, 12), (5, 15), (6, 18),(7, 21)}

Domain: {1, 2, 3, 4, 5, 6, 7}
Range: {3, 6, 9, 12, 15, 18, 21}

Use the Distributive Property to rewrite each expression.

31. $\frac{1}{2}d(2d+6)$

SOLUTION:

$\frac{1}{2}d(2d+6)$

$=\frac{1}{2}d(2d)+\frac{1}{2}d(6)$ Distributive Property

$=\frac{1}{2}(2)d(d)+\frac{1}{2}d(6)$ Associative Property

$=d^2+3d$ Simplify.

ANSWER:

d^2+3d

32. $-h(6h-1)$

SOLUTION:

$$\begin{aligned}
&-h(6h-1) & \\
&= -h(6h) - (-h)(1) & \text{Distributive Property} \\
&= -h(h)(6) - (-h)(1) & \text{Associative Property} \\
&= -6h^2 - (-h) & \text{Simplify.} \\
&= -6h^2 + h & \text{Simplify.}
\end{aligned}$$

ANSWER:

$-6h^2 + h$

33. $3z - 6x$

SOLUTION:

$$\begin{aligned}
&3z - 6x & \\
&= 3(z) - 3(2x) & \text{Distributive Property} \\
&= 3(z - 2x) & \text{Distributive Property}
\end{aligned}$$

ANSWER:

$3(z - 2x)$

34. **CLOTHING** Robert has 30 socks in his sock drawer. 16 of the socks are white, 6 are black, 2 are red, and 6 are yellow. What is the probability that he randomly pulls out a black sock?

SOLUTION:

P(black sock) = $\frac{6}{30}$ or $\frac{1}{5}$

ANSWER:

$\frac{1}{5}$

Evaluate each expression.

35. $(-7)^2$

SOLUTION:

$$\begin{aligned}
(-7)^2 &= (-7)(-7) \\
&= 49
\end{aligned}$$

ANSWER:

49

36. 3.2^2

SOLUTION:

$$\begin{aligned}(3.2)^2 &= (3.2)(3.2)\\ &= 10.24\end{aligned}$$

ANSWER:

10.24

37. $(-4.2)^2$

SOLUTION:

$$\begin{aligned}(-4.2)^2 &= (-4.2)(-4.2)\\ &= 17.64\end{aligned}$$

ANSWER:

17.64

38. $\left(\frac{1}{4}\right)^2$

SOLUTION:

$$\begin{aligned}\left(\frac{1}{4}\right)^2 &= \left(\frac{1}{4}\right)\left(\frac{1}{4}\right)\\ &= \left(\frac{1}{16}\right)\end{aligned}$$

ANSWER:

$\frac{1}{16}$