1. The table below represents a linear situation.

<table>
<thead>
<tr>
<th>x</th>
<th>f(x)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>-14</td>
</tr>
<tr>
<td>5</td>
<td>-18</td>
</tr>
<tr>
<td>6</td>
<td>-22</td>
</tr>
<tr>
<td>7</td>
<td>-26</td>
</tr>
</tbody>
</table>

Use this table to construct the function that it represents.

- A. \( f(x) = -4x - 18 \)
- B. \( f(x) = 2x - 4 \)
- C. \( f(x) = -4x + 2 \)
- D. \( f(x) = 4x + 10 \)

2. A particular strain of bacteria reproduces every 2 hours. If 10 bacterial cells are placed in a petri dish, how many bacterial cells will there be in the dish after 12 hours?

- A. 60
- B. 64
- C. 640
- D. 40,960

3. A phone company offers two packages of service. Package A is $45.00 per month with an additional charge of $0.20 per minute for long distance. Package B is $65.00 per month with an additional charge of $0.15 per minute for long distance. How many minutes have to be used for the costs of both plans to be the same?

- A. 400
- B. 60
- C. 600
- D. 40

4. A company is holding a dinner reception in a hotel ballroom. The graph represents the total cost of the ballroom rental and dinner.

Which function represents the data displayed in the graph?

- A. \( f(x) = 7.50x + 625.00 \)
- B. \( f(x) = 625.00x + 0.75 \)
- C. \( f(x) = 625.00x + 7.50 \)
- D. \( f(x) = 0.75x + 625.00 \)

5. The decay of an isotope is represented by the graph below.

About how many grams of the isotope will remain after 20 days?

- A. 15.50
- B. 13.18
- C. 7.75
- D. 0.04
6. If the function for predicting the growth of a population is given as \( F = 4.9(1.014)^t \), what can be concluded about the growth rate?

- A. The population is growing at a rate of 0.14%.
- B. The population is growing at a rate of 4.9%.
- C. The population is growing at a rate of 1.4%.
- D. The population is growing at a rate of 0.014%.

7. A company gives yearly raises to their employees. The salaries at the company are based on the equation below, where \( S \) is the salary before taxes and \( t \) is the time since the date of hire in years.

\[
S = 33,113 + 600t
\]

What is the minimum number of years an employee would have to stay to make a salary of over $45,000 per year?

- A. 21 years
- B. 2 years
- C. 19 years
- D. 20 years

8. A pan is heated to 358°F, then removed from the heat and allowed to cool in a kitchen where the room temperature is a constant 74°F. The formula below can be used to find \( D \), the difference in temperature between the pan and the room after \( t \) minutes.

\[
D = 284e^{-0.04t}
\]

What is the approximate temperature of the pan after it has been away from the heat for 7 minutes?

- A. 288.6°F
- B. 214.6°F
- C. 140.6°F
- D. 449.8°F

9. The size of the rainforest in El Salvador is currently decreasing at a rate of 24% per year. The amount of rainforest in El Salvador \( t \) years from now is given by the equation \( F = F_0(1 + r)^t \), where \( F \) is the amount of rainforest remaining \( t \) years from now, \( F_0 \) is the current amount of rainforest, and \( r \) is the rate at which the rainforest is changing.

If there are currently 210,000 square miles of rainforest in El Salvador, about how many square miles of rainforest will there be in 3 years?

- A. 118,000
- B. 92,000
- C. 26,000
- D. 195,000

10. The graph below represents the bacteria population after \( t \) minutes.

Construct the function which represents the data displayed in the graph.

- A. \( P(t) = 200(2)^t \)
- B. \( P(t) = 50(2)^t \)
- C. \( P(t) = 4^t + 50 \)
- D. \( P(t) = 50(4)^t \)
Linear and Exponential Functions

1. C
2. C
3. A
4. A
5. A
6. C
7. D
8. A
9. B
10. D

Explanations

1. A linear function can be represented by an equation in slope-intercept form, shown below, where \( m \) represents the slope, and \( b \) represents the \( y \)-intercept.

\[
f(x) = mx + b
\]

First, determine the slope of the line. Notice that the \( x \)-values increase by 1. The difference between the \( f(x) \)-values will reveal the slope.

\[
\begin{align*}
-18 - (-14) &= -4 \\
-22 - (-18) &= -4 \\
-26 - (-22) &= -4
\end{align*}
\]

So, the slope is -4.

The \( y \)-intercept occurs at the point where \( x \) is zero. The table does not show an \( x \)-value of zero. Instead, use the point-slope form of a line, shown below, where \((x_1, y_1)\) represents a point on the line, and \( m \) represents the slope.

\[
(y - y_1) = m(x - x_1)
\]

Substitute the point (4, -14) and the slope, -4, into the equation. Then, transform the equation so that it is in slope-intercept form.

\[
\begin{align*}
(y - (-14)) &= -4(x - 4) \\
y + 14 &= -4x + 16 \\
y &= -4x + 16 - 14
\end{align*}
\]

Therefore, the function \( f(x) = -4x + 2 \) represents the linear situation in the table.

2. Bacterial growth can be modeled by an exponential function of the form below, where \( a \) represents the number of bacteria present in the initial sample, \( t \) represents the amount of time that has passed since the initial sample was taken, and \( r \) represents the amount of time the bacteria takes to reproduce once.

\[
f(t) = a \cdot 2^{\frac{t}{r}}
\]

Use the given values for \( a, t, \) and \( r \) to determine the number of bacterial cells in the sample after 12 hours.

\[
f(t) = (10 \text{ cells}) \cdot 2^{\frac{12 \text{ hr}}{\text{hr}}} = (10 \cdot 2^6) \text{ cells} = 640 \text{ cells}
\]

Therefore, there will be 640 bacterial cells in the dish after 12 hours.

3. The graph is a linear function represented by an equation of the form \( f(x) = mx + b \), where \( m \) is the rate of change and \( b \) is the initial value.

First, calculate the rate of change, or slope, between any two points on the graph. In this case, use the points (10, 700) and (30, 850).

\[
m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{\$850 - \$700}{30 \text{ attendees} - 10 \text{ attendees}} = \frac{\$150}{20 \text{ attendees}} = \$7.50 \text{ per attendee}
\]

Next, determine the initial value. The initial value is the value of \( f(x) \) when \( x \) equals 0.

According to the graph, the initial value is $625.00,
Name ________________________________  

Linear and Exponential Functions

Therefore, the function that represents the graph is \( f(x) = 7.50x + 625.00 \).

4. The graph can be represented by an exponential decay function of the form \( A(t) = a(1 - r)^t \), where \( a \) represents the initial amount, \( r \) represents the rate of decrease, and \( t \) represents the number of time periods.

To find the function, first determine the percent decrease in the amount of the isotope each day by using the values provided in the graph.

\[
\frac{340 - 289}{400} \times 100 = 85\%
\]

Therefore, the isotope is decreasing by 15% each day.

Now, solve the exponential decay function when \( a \) equals 400, \( r \) equals 0.15, and \( t \) equals 20.

\[
A(20) = 400(1 - 0.15)^{20} \\
= 400(0.85)^{20} \\
\approx 15.50
\]

Therefore, about 15.50 grams of the isotope will be remaining after 20 days.

5. First, represent the cost of each plan with a linear equation where \( x \) represents the number of long distance minutes used over a one-month period.

Plan A: \( 0.2x + 45 \)  
Plan B: \( 0.15x + 65 \)

Then, determine the number of minutes that would need to be used for both plans to cost the same.

\[
0.2x + 45 = 0.15x + 65 \\
0.05x = 20 \\
x = 400
\]

6. The standard form for an exponential function with a percentage rate of growth is \( F = F_0(1 + r)^t \), where \( F_0 \) is the initial value, \( r \) is the rate of increase, and \( t \) is the time in years.

Find the actual growth rate by subtracting 1 from 1.014, and then change the real number, 0.014, into a percentage by multiplying by 100.

The percentage of growth becomes 1.4%, and thus, it can be concluded that the population is growing at a rate of 1.4%.

7. To determine the minimum number of years, substitute $45,000 in for \( S \) in the given equation, and then solve for \( t \).

\[
\begin{align*}
45,000 &= 33,113 + 600t \\
11,887 &= 600t \\
19.81 \text{ years} &= t
\end{align*}
\]

Since raises are only given once a year, an employee would have to stay a minimum of 20 years to make a salary of over $45,000 per year.

8. First, substitute \( t = 7 \) into the formula and solve for \( D \).

\[
D = 284e^{-0.04(7)} \\
D \approx 214.6^\circ F
\]

Next, since \( D \) is the difference between the temperatures of the pan and of the room, add \( D \) to the temperature of the room to find the temperature of the pan.

\[
74^\circ F + 214.6^\circ F = 288.6^\circ F
\]

9. First, find \( r \) by converting the percent into a real number. Also, since the problem states that the size of the rainforest is decreasing, the rate will be negative.
\[ r = -24\% = \frac{-24}{100} = -0.24 \]

Now, substitute the known values into the given equation.

\[
F = F_0(1 + r)^t
\]
\[
= 210,000(1 + (-0.24))^3
\]
\[
= 210,000(1 - 0.24)^3
\]
\[
= 210,000(0.76)^3
\]
\[
\approx 210,000 \times 0.438976
\]
\[
\approx 92,000
\]

10. Exponential functions are of the form \( f(x) = a(b)^x \), where \( b \) is greater than zero and not equal to one.

Calculate the common ratio. The calculations below use the points \((0, 50), (0.5, 100), (1, 200), (1.5, 400), (2, 800), \) and \((2.5, 1,600)\).

\[
\frac{100}{50} = 2 \quad \frac{200}{100} = 2 \quad \frac{400}{200} = 2 \quad \frac{800}{400} = 2 \quad \frac{1600}{800} = 2 \quad \frac{1}{1}
\]

The change in the \( t \)-values is 0.5, so divide 2 by 0.5.

\[
\frac{2}{0.5} = 4
\]

So, the common ratio is 4.

Thus, the exponential function will have the form \( P(t) = a(4)^t \).

Use the point \((0, 50)\) to find the value of \( a \).

\[
P(0) = a(4)^0
\]
\[
50 = a(1)
\]
\[
50 = a
\]

Therefore, the function that represents the data in the graph is \( P(t) = 50(4)^t \).