

F.LE.1a***SELECTED RESPONSE**

Select the correct answer.

- For some exponential function $f(x)$, $f(0) = 12$, $f(1) = 18$, and $f(2) = 27$. How does $f(x)$ change when x increases by 1?
 - $f(x)$ grows by a factor of $\frac{2}{3}$.
 - $f(x)$ grows by a factor of $\frac{3}{2}$.
 - $f(x)$ increases by 6.
 - $f(x)$ increases by 9.
- The balance B of an account earning simple interest is \$1000 when the account is opened, \$1075 after one year, and \$1150 after two years. How does the balance of the account change from one year to the next?
 - The balance increases by 7.5%.
 - The balance decreases by 7.5%.
 - The balance increases by \$75.
 - The balance increases by \$150.

Select all correct answers.

- Marco starts reading a 350-page book at 9 a.m. The number of pages P Marco has left to read t hours after 9 a.m. is modeled by the function $P(t) = 350 - 45t$. During which of the following time periods does Marco read the same number of pages he reads between 11 a.m. and 1 p.m.?
 - 9 a.m. to 11 a.m.
 - 11 a.m. to 12 noon
 - 12:30 p.m. to 1:30 p.m.
 - 2 p.m. to 4 p.m.
 - 1:30 p.m. to 3.30 p.m.

Match each statement in the proof with the correct reason below.

Given: $x_2 - x_1 = x_4 - x_3$, $f(x) = ab^x$ Prove: $\frac{f(x_2)}{f(x_1)} = \frac{f(x_4)}{f(x_3)}$

_____ 4. $x_2 - x_1 = x_4 - x_3$, $f(x) = ab^x$

_____ 5. $b^{x_2 - x_1} = b^{x_4 - x_3}$

_____ 6. $\frac{b^{x_2}}{b^{x_1}} = \frac{b^{x_4}}{b^{x_3}}$

_____ 7. $\frac{ab^{x_2}}{ab^{x_1}} = \frac{ab^{x_4}}{ab^{x_3}}$

_____ 8. $\frac{f(x_2)}{f(x_1)} = \frac{f(x_4)}{f(x_3)}$

- Given
- Power of powers property
- Distributive property
- Subtraction property of equality
- Definition of $f(x)$
- Quotient of powers property
- If $x = y$, then $b^x = b^y$
- Multiplication property of equality

CONSTRUCTED RESPONSE

9. Complete the reasoning to prove that linear functions grow by equal differences over equal intervals.

Given: $x_2 - x_1 = x_4 - x_3$

$f(x)$ is a linear function of the form $f(x) = mx + b$.

Prove: $f(x_2) - f(x_1) = f(x_4) - f(x_3)$

$$\begin{aligned}
 &x_2 - x_1 = x_4 - x_3 \\
 &m(x_2 - x_1) = m(x_4 - x_3) \\
 &mx_2 - mx_1 = mx_4 - mx_3 \\
 &mx_2 + b - mx_1 - b = mx_4 + \underline{\hspace{1cm}} - mx_3 - \underline{\hspace{1cm}} \\
 &(mx_2 + b) - (mx_1 + b) = \underline{\hspace{2cm}} \\
 &f(x_2) - f(x_1) = \underline{\hspace{2cm}}
 \end{aligned}$$

Given

Addition and subtraction properties

Distributive property

Definition of $f(x)$

10. Sandra's annual salary S , in dollars, after working at the same company for t years is given by the function

$S(t) = 38,000 + 1500t$.

a. Complete the table showing Sandra's salary after each year for the first five years.

Time, t (years)	Salary, S (dollars)
1	
2	
3	
4	
5	

b. Show that Sandra's salary increases by the same amount each year.

11. The population of a certain town is 3500 people in 2000. The population of the town P is modeled by the function $P(t) = 3500(0.97)^t$, where t is the number of years after 2000.

a. By what factor did the population change between 2000 and 2001? Between 2001 and 2002? Round your answers to the nearest hundredth. Show your work. What do you notice?

b. By what factor did the population change between 2000 and 2002? Between 2001 and 2003? Round your answers to the nearest hundredth. Show your work. What do you notice?

F.LE.1b*

SELECTED RESPONSE

Select the correct answer.

1. In which of the following situations does Michael's salary change at a constant rate relative to the year?

- A Michael's starting salary is \$9500 and increases by 4% each year.
- B Michael's starting salary is \$9500 and increases by \$500 each year.
- C Michael's starting salary is \$9500. He receives a \$500 raise after one year and a \$600 raise after the second year.
- D Michael's starting salary is \$9500. He receives a 4% raise after one year and a 5% raise after the second year.

2. The table shows the population of two cities. Which city's population is changing at a constant rate per year?

Year	City A	City B
2009	700,000	570,000
2010	697,500	580,000
2011	694,500	590,000
2012	690,500	600,000

- A A
- B B
- C Both A and B
- D Neither A nor B

Select all correct answers.

3. Determine which situations describe an amount of money changing at a constant rate relative to a unit change in time of the specified unit.

- A The value of David's car decreases by 11% each year.
- B Susan adds \$50 to a savings account each week.
- C The price of a stock each week is 105% of its price from the previous week.
- D Monica pays \$700 for car insurance the first year and pays an additional \$10 per year.
- E The amount Ariel and Miguel pay to rent a car for \$40 a day.

CONSTRUCTED RESPONSE

4. For which of these functions does the function value change at a constant rate per unit change in x ? Explain.

x	$f(x)$	$g(x)$	$h(x)$
1	6	1	31
2	12	2	25
3	20	4	19
4	30	8	13
5	42	16	7

5. Samantha started a new job, and is paid \$10.50 an hour. Each month, Samantha earns a \$0.25 per hour raise. Does Samantha's hourly pay grow at a constant rate per unit change in month? Explain.

6. Alonzo and Katy hike 4 miles in 2 hours and then break to eat lunch. After lunch, they hike for 45 minutes and travel 1.5 miles. Not including the time spent eating lunch, do Alonzo and Katy hike at a constant rate? If not, explain why not. If so, what is the unit rate?

7. Tim works as a salesperson for a furniture store.
His first year, he earns a base pay of \$25,000 plus a 5% commission on every item he sells. His second year, he earns a base pay of \$26,000 plus a 6.5% commission.

His third year, he earns a base pay of \$27,040 plus an 8% commission.

Decide if each of the quantities below changes at a constant rate per unit change in year. Explain your answers.

a. Tim's base pay.

b. Tim's commission rate.

8. Companies A and B each employ 500 workers. Company A decides to increase its workforce by 10% each year. Company B decides to increase its workforce by 50 workers each year.

a. Complete the table to show each company's workforce for the first 3 years after implementing the plan to increase its workforce. Round down to the nearest person.

Year	Company A	Company B
0	500	500
1		
2		
3		

b. For each company, find the amount by which the workforce changed each year. Which company's workforce has a constant rate of growth per unit change of year? Show your work.

c. Use your results from part b to determine that company's workforce 4 years after implementing the plan to increase its workforce.

F.LE.1c***SELECTED RESPONSE**

Select the correct answer.

1. In which of the following situations does Pam's hourly wage change by a constant percent per unit change in year?
- (A) Pam's starting hourly wage is \$14.50 per hour the first year, and it increases by \$1.50 each year.
- (B) Pam's starting hourly wage is \$13.00. She receives a \$0.50 per hour raise after one year, a \$0.75 per hour raise after the second year, a \$1.00 per hour raise after the third year, and so on.
- (C) Pam's hourly wage is \$20 per hour in the first year, \$22 per hour the second year, \$24.20 per hour the third year, and so on.
- (D) Pam's starting hourly wage is \$15.00. Her hourly wage is \$15.75 after one year, \$17.00 after two years, \$18.75 after three years, and so on.
2. The table shows the value, in dollars, of three cars after they are purchased. Which car's value decreases by a constant percent?

Year	Car A	Car B	Car C
0	\$21,000	\$18,000	\$25,000
1	\$18,000	\$15,625	\$22,500
2	\$15,000	\$13,250	\$20,250

- (A) Car A
- (B) Car B
- (C) Car C
- (D) Cars B and C

Select all correct answers.

3. Which of the following situations describe a quantity that increases by a constant percent that is at least 20% per unit time?
- (A) There are 400 bacteria in a Petri dish the first day, 700 the second day, 1225 the third day, and so forth.
- (B) The number of fish in the lake is 24 the first year, 48 in the second year, 72 in the third year, and so on.
- (C) The number of visitors for a website is 4000 one month, 5200 the second month, 6760 the third month, and so on.
- (D) The price for a gallon of cooking oil is \$3.00 the first year, \$3.30 the second year, \$3.63 the third year, and so on.
- (E) The population of a town is 10,000 the first year, 11,500 the second year, 13,225 the third year, and so on.

CONSTRUCTED RESPONSE

4. For which of these functions does the function value change at a constant factor per unit change in x ? Explain.

x	$f(x)$	$g(x)$	$h(x)$
1	512	18	65
2	128	16	33
3	32	14	17
4	8	12	9
5	2	10	5

5. In one year, a population of endangered turtles laid 8000 nests. Each year, the number of nests is half as many as the number of nests in the previous year. Does the number of nests change by a constant percent per unit change in a year? Explain.

6. The table shows the mass, in grams, of the radioactive isotope carbon-11 after it starts decaying. Does the mass of the substance decay by a constant percent each minute? If so, find the decay rate. Explain and round to the nearest hundredth of a percent. If not, explain why not.

Time (minutes)	Mass (grams)
0	500
1	483.24
2	467.05
3	451.40

7. Carol inherited three antiques one year. The value, in dollars, of each antique for the first few years after she inherited the antiques is shown in the table.

Time (years)	Antique toy	Antique vase	Antique chair
0	\$70.00	\$25.00	\$100.00
1	\$77.00	\$30.00	\$108.00
2	\$84.70	\$37.50	\$116.64
3	\$93.17	\$47.50	\$125.97

Which antiques have a value that grows by a constant factor relative to time? Of those antiques, which antique increases its value at a faster rate? Explain your answers.

8. Two competing companies redesigned their websites during the same month. The table shows the number of visits each website receives per month after the redesigns. Jeff thinks that the number of visits for both websites grows by a constant percent per month.

Month	Company A	Company B
0	120,000	150,000
1	126,000	153,000
2	132,300	157,590
3	138,915	159,166

a. Is Jeff correct about company A? Justify your answer.

b. Is Jeff correct about company B? Justify your answer.

F.LE.2*

SELECTED RESPONSE

Select all correct answers.

1. Emile is saving money to buy a bicycle. The amount he has saved is shown in the table. Which of the functions below describe the amount A , in dollars, Emile has saved after t weeks?

Weeks	Amount
1	\$30
2	\$45
3	\$60
4	\$75
5	\$90
6	\$105

- (A) $A(t) = 15 + 15(t - 1)$
 (B) $A(t) = 30 + 15(t - 1)$
 (C) $A(t) = 15 + 15t$
 (D) $A(t) = 30 + 15t$
 (E) $A(t) = 30(1.5)^t$
 (F) $A(t) = 15(2)^t$

Select the correct answer.

2. Which function models the relationship between x and $f(x)$ shown in the table?

x	$f(x)$
2	1
4	5
6	9

- (A) $f(x) = \frac{1}{2}x$ (C) $f(x) = 2x - 3$
 (B) $f(x) = x - 1$ (D) $f(x) = 4x - 7$
3. Sasha invests \$1000 that earns 8% interest compounded annually. Which function describes the value V of the investment after t years?
- (A) $V(t) = 1000 + 80t$
 (B) $V(t) = 1000(0.08)^t$
 (C) $V(t) = 1000(0.92)^t$
 (D) $V(t) = 1000(1.08)^t$

CONSTRUCTED RESPONSE

4. A \$100 amount is invested in two accounts. Account 1 earns 0.25% interest compounded monthly, and account 2 earns 0.25% simple interest monthly. Write two functions that model the balances B_1 and B_2 of both accounts, in dollars, after t months.
- _____
- _____

5. An initial population of 1000 bacteria increases by 25% each day.

a. Is the population growth best modeled by a linear function or an exponential function? Explain.

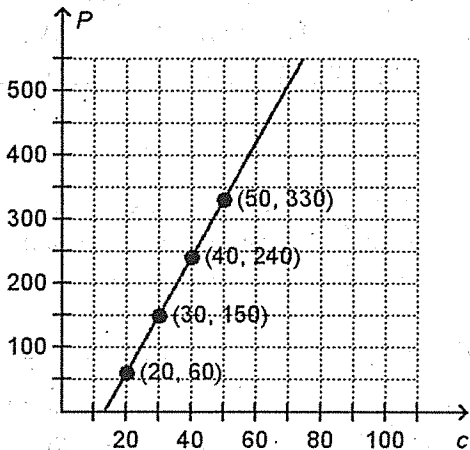
b. Write a function that models the population P after t days.

6. The value of a stock over time is shown in the table. Write an exponential function that models the value V , in dollars, after t years. Show your work.

Time, in years	Value, in dollars
0	18.00
1	16.20
2	14.58
3	13.12
4	11.81
5	10.63

7. The number of seats in each row of an auditorium can be modeled by an arithmetic sequence. The 5th row in this auditorium has 36 seats. The 12th row in this auditorium has 64 seats. Write an explicit rule for an arithmetic sequence that models the number of seats s in the n th row of the auditorium. Show your work.

8. The art club is creating and selling a comic book as part of a fundraiser. The graph shows the profit P earned from selling c comic books.

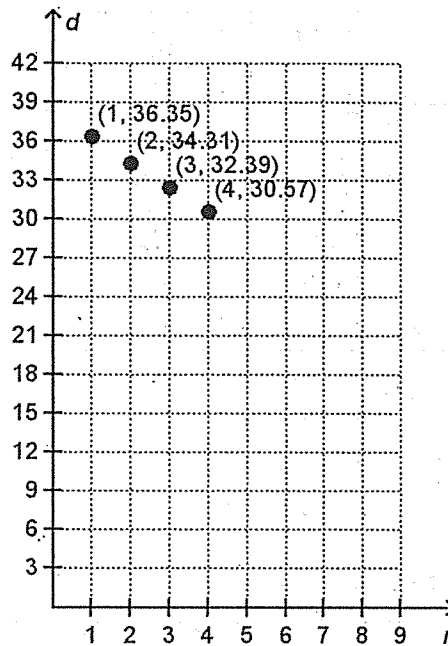


- Use the graph to write a linear function $P(c)$ that models the profit P from selling c comic books.

- What is the real-world meaning of the slope and P -intercept of your function?

- How many comic books does the club have to sell in order to make \$375? Show your work.

9. The neck of a guitar is divided by frets in such a way that pressing down on each fret changes the note produced when the guitar is played. The first fret of a guitar is placed 36.35 mm from the end of the guitar's neck. The second fret is placed 34.31 mm from the first fret. The distances, d , in millimeters, of the first four frets relative to the previous fret are shown in the graph below.



- Consider the sequence of distances between the frets. Is the sequence arithmetic or geometric? Find a common difference or ratio to justify your answer.

- Write an explicit rule for $d(n)$, the distance between fret n and the fret below it. Show your work.

- Use your rule from part b to determine the distance between the 19th and 20th frets.

F.LE.3*

SELECTED RESPONSE

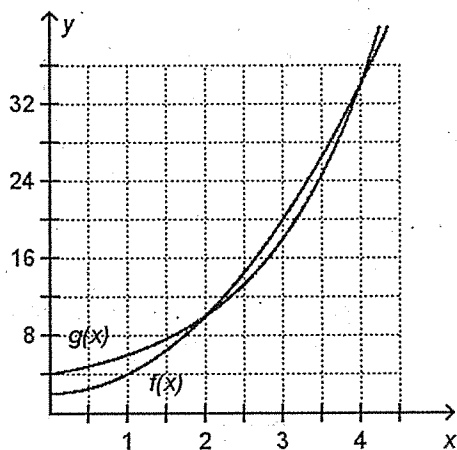
Select all correct answers.

1. The value V_A of stock A t months after it is purchased is modeled by the function $V_A(t) = t^2 + 1.50$. The value V_B of stock B t months after it is purchased is modeled by the function $V_B(t) = 10(1.25)^t$. Based on the model, for which t -values is the value of stock B greater than the value of stock A?

- (A) $t = 5$
- (B) $t = 6$
- (C) $t = 7$
- (D) $t = 11$
- (E) $t = 12$

Select the correct answer.

2. $f(x) = 2x^2 + 2$ and $g(x) = 2^{x+1} + 2$ are graphed on the grid below. For what x -values is $g(x) > f(x)$?



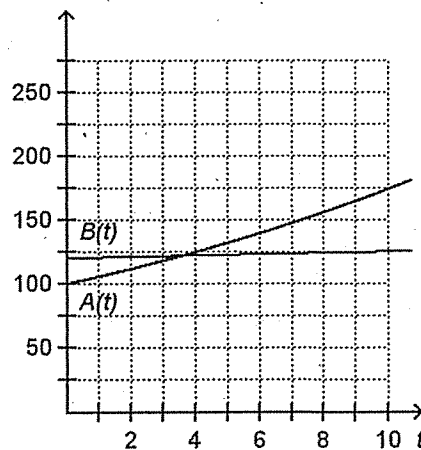
- (A) $x > 4$
- (B) $x > 2$
- (C) $0 < x < 2$ and $x > 4$
- (D) $2 < x < 4$

3. As x increases without bound, which of the following eventually has greater function values than all the others for the same values of x ?

- (A) $f(x) = 3x^2$
- (B) $f(x) = 2x^3$
- (C) $f(x) = 3(2^x)$
- (D) $f(x) = 3x + 2$

Select the correct answer for each lettered part.

4. Two websites launched at the beginning of the year. The number of visits $A(t)$ to website A is given by some exponential function, where t is the time in months after the website is launched. The number of visits $B(t)$ to website B is given by some quadratic function. The graph of each function is shown below. For each of the given t -values, compare $A(t)$ and $B(t)$.



- a. $t = 2$ $A(t) < B(t)$ $A(t) > B(t)$
- b. $t = 3$ $A(t) < B(t)$ $A(t) > B(t)$
- c. $t = 4$ $A(t) < B(t)$ $A(t) > B(t)$
- d. $t = 5$ $A(t) < B(t)$ $A(t) > B(t)$
- e. $t > 12$ $A(t) < B(t)$ $A(t) > B(t)$

CONSTRUCTED RESPONSE

5. The population A of town A and the population B of town B t years after 2000 is described in the table.

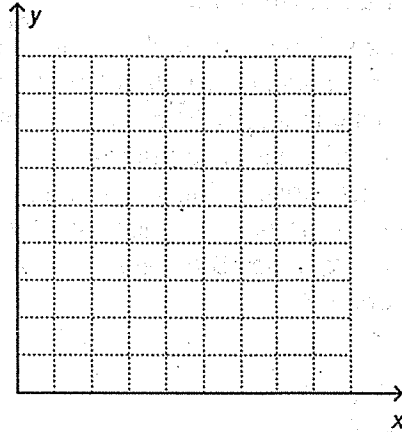
Time, t (years)	Town A population, $A(t)$	Town B population, $B(t)$
0	1500	1500
1	1800	1725
2	2100	1984
3	2400	2281
4	2700	2624
5	3000	3017
6	3300	3470
7		
8		

- a. Write functions for $A(t)$ and $B(t)$.

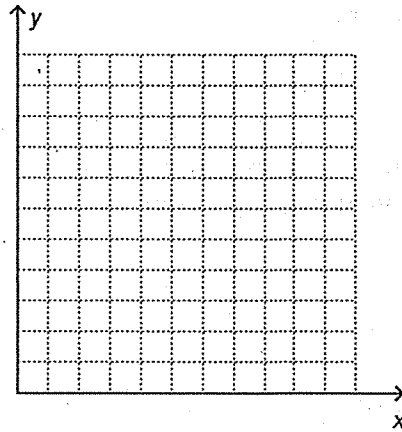
- b. Use your functions from part a to complete the table, rounding to the nearest person.
- c. If the populations continue to increase in the same way, how do the populations compare for every year after 2008? Explain how you can tell without calculating the populations for every year.

6. Let $f(x) = x + 4$, $g(x) = x^4$, and $h(x) = 4^x$ for $x \geq 0$.

- a. Graph $f(x)$ and $h(x)$.



- b. Graph $g(x)$ and $h(x)$.



- c. How do the values of $h(x)$ compare to the values of $f(x)$ and $g(x)$ as x increases without bound?

- d. Use the graphs and your answer from part c to make a conjecture about how the values of exponential functions compare to the values of linear and polynomial functions as x increases without bound.

F.LE.5***SELECTED RESPONSE**

Select the correct answer.

- The function $A(d) = 0.45d + 180$ models the amount A , in dollars, that Terry's company pays him based on the round-trip distance d , in miles, that Terry travels to a job site. How much does Terry's pay increase for every mile of travel?
 - \$0.45
 - \$180.00
 - \$180.45
 - \$180.90
- Drake is considering buying one of the four popular e-readers where the e-reader's premium services is a monthly charge. The functions $A_1(t) = 5t + 350$, $A_2(t) = 10t + 250$, $A_3(t) = 499$, and $A_4(t) = 15t + 179$ model the total amount of money A , in dollars, that Drake spends after buying the e-reader and subscribing to t months of the e-reader's premium services. Which e-reader has the greatest monthly subscription cost?
 - E-reader 1 with cost $A_1(t)$
 - E-reader 2 with cost $A_2(t)$
 - E-reader 3 with cost $A_3(t)$
 - E-reader 4 with cost $A_4(t)$
- Each bacterium in a petri dish splits into 2 bacteria after one day. The function $b(d) = 600 \cdot 2^d$ models the number of bacteria b in the petri dish after d days. What is the initial number of bacteria in the petri dish?
 - 2
 - 300
 - 600
 - 1200

Select all correct answers.

- The function $a(t) = 44,000(1.045)^t$ models Johanna's annual earnings a , in dollars, t years after she starts her job. Which of the following statements are true about Johanna's salary?
 - Johanna initially earns \$44,000 per year.
 - Johanna initially earns \$45,980 per year.
 - Johanna's salary increases by 1.045% per year.
 - Johanna's salary increases by 4.5% per year.
 - Johanna's salary increases by 104.5% per year.

CONSTRUCTED RESPONSE

- The function $h(t) = -1200t + 15,000$ models the height h , in feet, of an airplane t minutes after it starts descending in order for it to land. What is the height of the airplane when it begins to descend? Explain.

- The function $P(r) = 256 \left(\frac{1}{2}\right)^r$ represents the number of players P remaining after r single-elimination rounds of a tennis tournament.
 - What is the initial number of players in the tournament? Explain.

 - What fraction of players remaining after $r - 1$ rounds are eliminated in the r th round? Explain.

7. The function $P(r) = 1250(0.98)^t$ models the premium P , in dollars, that Steven pays for automotive insurance each year after having the insurance for t years.

a. What is the amount that Steven pays for the first year of his insurance coverage?

b. What is the percentage decrease of Steven's premium every year? Explain.

8. A family is traveling in a car at a constant average speed during a road trip. The function $d(t) = 65t + 715$ models the distance d , in miles, the family is from their house t hours after starting to drive on the second day of the road trip.

a. At what average speed is the family's car traveling? Explain.

b. What is the distance between the family's house and the point where they started driving on the second day? Explain.

9. A census from the government determines the official population of jurisdictions. The census is taken once every decade. The function $A(c) = 50,600(1.08)^c$ models the official value for the population of city A, where c is the number of censuses taken since the first census. Similarly, $B(c) = 75,850(1.069)^c$ models the official value for the population of city B.

a. Which city had a larger population in the first census? Explain.

b. Which city's official value for its population is growing at a faster rate between the censuses? Explain.

