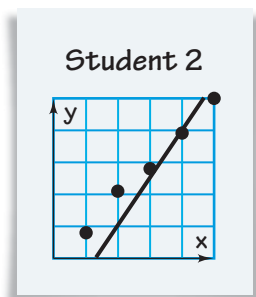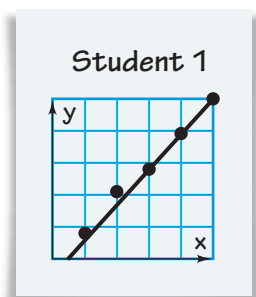# Applications

1. Below are some results from the bridge experiment in a CMP class.

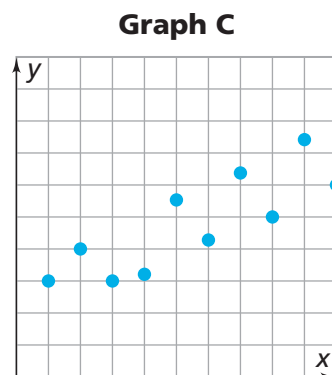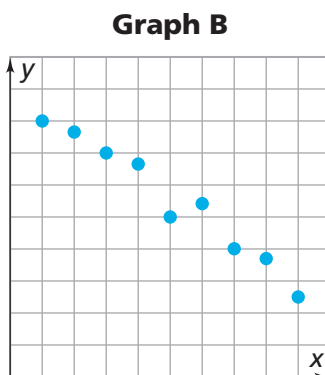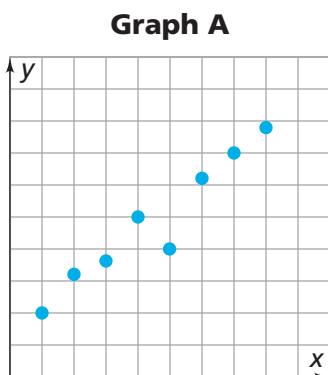   **Bridge-Thickness Experiment**

Number of Layers	2	4	6	8
Breaking Weight (pennies)	15	30	50	65

   a. Plot the (number of layers, breaking weight) data. Draw a line that models the data.

   b. Find an equation for the line you drew.

   c. Use your equation to predict the breaking weights of paper bridges 3, 5, and 7 layers thick.

2. The two graphs below show the same data points. Which line models the data better? Explain.

   Student 1

   Student 2

3. Copy each graph onto grid paper. Draw a line that fits each set of data as closely as possible. Describe the strategies you used.

   Graph A

   Graph B

   Graph C

4. This table gives the average weights of Chihuahuas from birth to 16 weeks.

Average Weights for Chihuahuas

Age (wk)	0	2	4	6	8	10	12	14	16
Weight (oz)	4	9	13	17.5	21.5	25	30	34	39

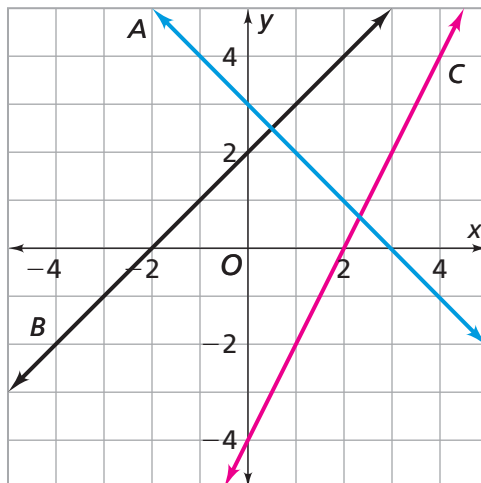SOURCE: *The Complete Chihuahua Encyclopedia*

a. Graph the (age, weight) data. Draw a line that models the data pattern.

b. Write an equation of the form $y = mx + b$ for your line. Explain what the values of m and b tell you about this situation.

c. Use your equation to predict the average weight of Chihuahuas for odd-numbered ages from 1 to 15 weeks.

d. What average weight does your linear model predict for a Chihuahua that is 72 weeks old? Explain why this prediction is likely to be inaccurate.

5. The U-Wash-It car wash did market research to determine how much to charge for a car wash. The company made this table based on its findings.

U-Wash-It Projections

Price per Wash ($)	0	5	10	15	20
Customers Expected per Day	100	80	65	45	20

a. Graph the (price, expected customers) data. Draw a line that models the data pattern.

b. Write an equation in the form $y = mx + b$ for your graph. Explain what the values of m and b tell you about this situation.

c. Use your equation to find the number of customers expected for prices of $2.50, $7.50, and $12.50.

6. Here is a graph of three lines.

a. Complete the table.

Line	Constant Rate of Change	y-intercept	x-intercept
A	■	■	■
B	■	■	■
C	■	■	■

b. Here are the equations of the three lines. Match each line with its equation.

equation D: $y = 2 + x$ equation E: $y = -4 + 2x$ equation F: $y = 3 - x$

line A   line B   line C

7. Two points determine a line.

a. Which of these points are on the line that passes through $(0, 3)$ and $(2, 5)$?

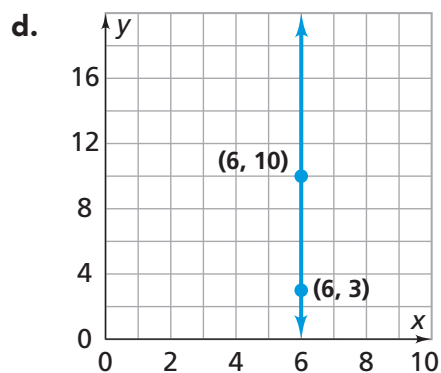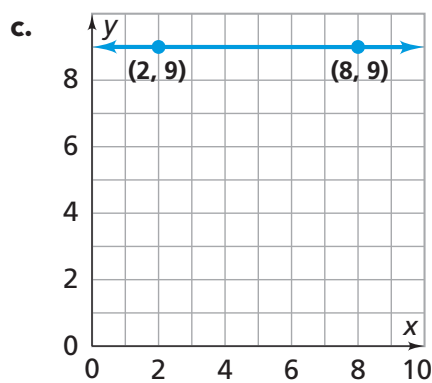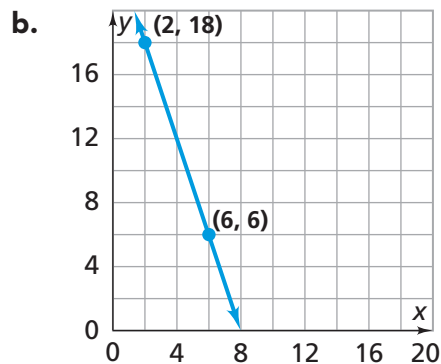 $(4, 7)$ $(4, 8)$ $(4, 10)$
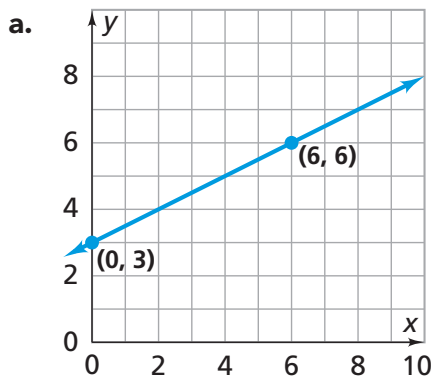
b. Which of these points are on the line that passes through $(-2, 10)$ and $(1, 4)$?

   $(2, 0)$ $(2, 2)$ $(2, 10)$

8. Find the slope, *y*-intercept, and equation of each line.

a.

b.

c.

d.

Assume that the relationships in Exercises 9–12 are linear.

9. Kaya buys a $20 phone card. She is charged $.15 per minute for calls. What equation gives the value *v* left on her card after she makes *t* minutes of calls?

10. A typical American baby weighs about 8 pounds at birth and gains about 1.5 pounds per month for the first year of life. What equation relates weight *w* in pounds to age *a* in months?

1 month   **6 months**   **1 year**

11. Dakota lives 1,500 meters from school. She leaves for school, walking at a speed of 60 meters per minute. Write an equation for her distance d in meters from school after she walks for t minutes.

12. A car can average 140 miles on 5 gallons of gasoline. Write an equation for the distance d in miles the car can travel on g gallons of gas.

13. Write a linear equation relating x and y for each table.

a.

x	0	3	6	10
y	2	8	14	22

b.

x	0	3	6	10
y	20	8	−4	−20

c.

x	2	4	6	8
y	5	8	11	14

d.

x	0	3	6	9
y	20	11	2	−7

For Exercises 14–19, find an equation for the line that satisfies the conditions.
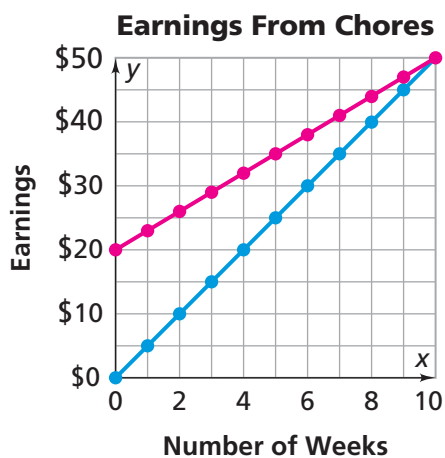
14. slope 4.2; y-intercept (0, 3.4)

15. slope $\frac{2}{3}$; y-intercept (0, 5)

16. slope 2; passing through (4, 12)

17. passing through (0, 15) and (5, 3)

18. passing through (−2, 2) and (5, −4)

19. parallel to the line with equation $y = 15 - 2x$ and passing through (3, 0)

20. Write an equation for each line in the graph below.

21. Anchee and Jonah earn weekly allowances for doing chores over the summer.

- Anchee's father pays her $5 each week.

- Jonah's mother paid him $20 at the beginning of the summer and now pays him $3 each week.

The relationships between number of weeks and dollars earned are shown in this graph.

Earnings From Chores

a. Which line represents Jonah's earnings? Which line represents Anchee's earnings? Explain.

b. Write two linear equations in the form $y = mx + b$ to show the relationships between Anchee's earnings and the number of weeks she works and between Jonah's earnings and the number of weeks he works.

c. In each equation, what do the values of m and b tell you about the relationship between the number of weeks and the dollars earned?

d. What do the values of m and b tell you about each line?

For Exercises 22–25, do the following.
   (a) Solve the equation and show your steps.
   (b) Graph the related linear function. (For example, for
      $5.5x + 32 = 57$, **graph** $y = 5.5x + 32$.)
   (c) Label the point on the graph that gives the solution.

22. $5.5x + 32 = 57$

23. $-24 = 4x - 12$

24. $5x - 51 = 24$

25. $74 = 53 - 7x$

26. At Water Works Amusement Park, the daily profit from the concession stands depends on the number of park visitors. The equation $P = 2.50v - 500$ gives the estimated profit P in dollars if v people visit the park. In parts (a)–(c), use a graph to estimate the answer. Then find the answer by writing and solving an equation or inequality.

   a. For what number of visitors will the profit be about $2,000?

   b. One day 200 people visit the park. What is the approximate concession-stand profit for that day?

   c. For what number of visitors will the profit be at least $500?

27. The following formulas give the fare f, in dollars, charged by two bus companies for trips of d miles.

   • Transcontinental: $f = 0.15d + 12$

   • Intercity Express: $f = 5 + 0.20d$

   In parts (a)–(c), use a graph to estimate the answer. Then find the answer by writing and solving an equation or inequality.

   a. For Transcontinental, how many miles is a trip that costs $100?

   b. For Intercity Express, how far can a person travel for a fare that is at most $100?

   c. Is there a distance for which the fare for the two bus lines is the same? If so, give the distance and the fare.

In Exercises 28–30, solve each equation. Show the steps in your solutions.

28. $5x + 7 = 3x - 5$ 29. $7 + 3x = 5x - 5$ 30. $2.5x - 8 = 5x + 12$

In Exercises 31–34, find at least three values of x for which the inequality is true.

31. $4x \leq 12$ 32. $3x < 18$

33. $4x + 5 \leq 13$ 34. $3x - 9 \leq 18$

35. Every Friday, the mechanic for Columbus Public Schools records the miles driven and gallons of gas used by each school bus. One week, the mechanic records the data below.

Data for Columbus Bus Fleet

Bus Number	1	2	3	4	5	6	7	8
Gas Used (gal)	5	8	12	15	18	20	22	25
Miles Driven	80	100	180	225	280	290	320	375

a. Write a linear equation that models the relationship between miles driven d and gallons of gas used g.

b. Use your equation to predict the number of miles a school bus could travel on 10 gallons of gas.

c. Use your equation to predict the number of gallons of gas required to drive a school bus 250 miles.

d. What do the values of m and b in your equation $d = mg + b$ tell about the fuel efficiency of the school bus fleet?

36. One of the most popular items at a farmers' market is sweet corn. This table shows relationships among the price of the corn, the supply of corn (how much corn the market has), and the demand for the corn (how much corn people want to buy).

Sweet Corn Supply and Demand

Price per Dozen ($)	1.00	1.50	2.00	2.50	3.00	3.50
Demand (dozens)	200	175	140	120	80	60
Supply (dozens)	40	75	125	175	210	260

a. Why do you think the demand for corn decreases as the price goes up?

b. Why do you think the supply of corn increases as the price goes up?

c. Write a linear equation that models the relationship between demand d and price p.

d. Write a linear equation that models the relationship between supply s and price p.

e. Use graphs to estimate the price for which the supply equals the demand. Then find the price by solving symbolically.

Connections

37. Tell whether each table represents a linear relationship. Explain your reasoning.

a.

x	2	4	6	8	10	12	14
y	0	1	2	3	4	5	6

b.

x	1	2	3	4	5	6	7
y	0	3	8	15	24	35	48

c.

x	1	4	6	7	10	12	16
y	2	−1	−3	−4	−7	−9	−13

38. For parts (a)–(d), copy the table. Then use the equation to complete the table. Tell whether the relationship is linear. Explain your reasoning.

a. $y = -3x - 8$

x	−5	−2	1	4
y	■	■	■	■

b. $y = 4(x - 7) + 6$

x	−3	0	3	6
y	■	■	■	■

c. $y = x(3x + 2)$

x	−3	0	3	6
y	■	■	■	■

d. $y = 4 - 3x$

x	−3	0	3	10
y	■	■	■	■

Copy each pair of numbers in Exercises 39–44. Insert $<$, $>$, or $=$ to make a true statement.

39. -5 ■ 3

40. $\frac{2}{3}$ ■ $\frac{1}{2}$

41. $\frac{9}{12}$ ■ $\frac{3}{4}$

42. 3.009 ■ 3.1

43. $-\frac{2}{3}$ ■ $-\frac{1}{2}$

44. -4.25 ■ -2.45

45. Madeline sets the scale factor on a copy machine at 150%. She then uses the machine to copy a polygon. Write an equation that relates the perimeter of the polygon after the enlargement, a, to the perimeter before the enlargement, b.

For Exercises 46–54, evaluate the expression without using a calculator.

46. $-15 + (-7)$ **47.** $-7 - 15$ **48.** $-7 - (-15)$

49. $-15 + 7$ **50.** $-20 \div 5$ **51.** $-20 \div (-5)$
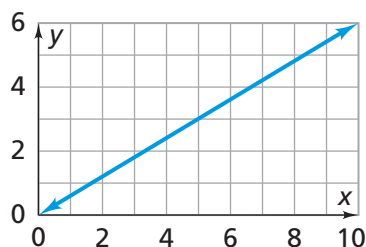
52. $20 \div (-4)$ **53.** $-20 \div (-2.5)$ **54.** $-20 \cdot (-2.5)$

55. You can express the slope of a line in different ways. The slope of the line below is $\frac{6}{10}$, or 0.6. You can also say the slope is 60% because the rise is 60% of the run.

These numbers represent slopes of lines.
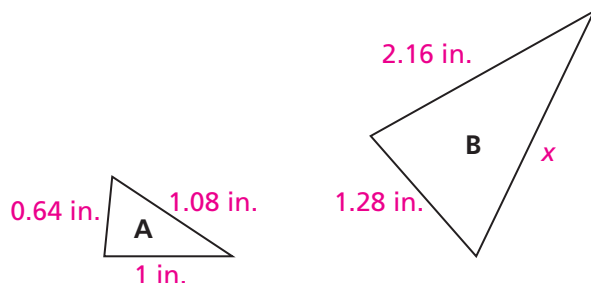
$\frac{-4}{-2}$ 60% $\frac{4}{4}$ 1.5   150%   200%

a. Which numbers represent the same slope?

b. Which number represents the greatest slope?

c. Which number represents the least slope?

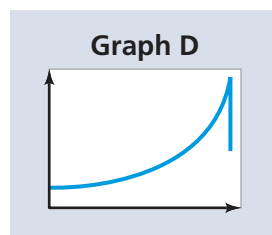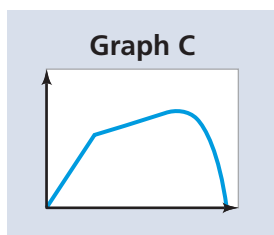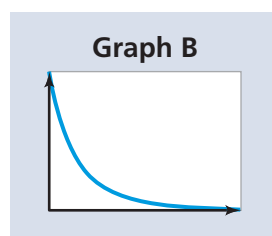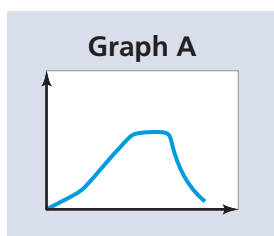**56.** The figures below are *similar*. (They have the same shape but are different sizes.)

a. Find the value of x.

b. What is the scale factor from Triangle A to Triangle B?

c. What is the scale factor from Triangle B to Triangle A?

d. How are the scale factors in parts (b) and (c) related?

57. Read the following stories and look at the graphs.

   a. Match each story with a graph. Tell how you would label the axes of the graph. Explain how each part of the story is represented in the graph.

   - **Story 1** A parachutist is taken up in a plane. After she jumps, the wind blows her off course. She ends up tangled in the branches of a tree.

   - **Story 2** Ella puts some money in the bank. She leaves it there to earn interest for several years. Then one day, she withdraws half the money in the account.

   - **Story 3** Gerry has a big pile of gravel to spread on his driveway. On the first day, he moves half the gravel from the pile to his driveway. The next day he is tired and moves only half of what is left. The third day he again moves half of what is left in the pile. He continues in this way until the pile has almost disappeared.
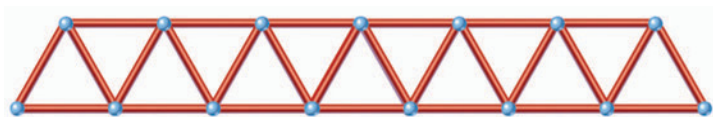

Graph A

Graph B

Graph C

Graph D

   b. One of the graphs does not match a story. Make up your own story for that graph.

Extensions

58. Recall that Custom Steel Products builds trusses from steel pieces. Here is a 7-foot truss.

7-foot truss made from 27 rods

a. Which of these formulas represents the relationship between truss length L and number of pieces r?

$$r = 3L \qquad r = L + (L - 1) + 2L \qquad r = 4(L - 1) + 3 \qquad r = 4L - 1$$

b. How might you have reasoned to come up with each formula?

59. **Multiple Choice** Recall that Custom Steel Products uses steel pieces to make staircase frames. Here are staircase frames with 1, 2, and 3 steps.
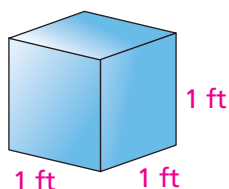

| 1 step | 2 steps | 3 steps |
| made from 4 rods | made from 10 rods | made from 18 rods |

Which of these formulas represents the relationship between the number of steps n and number of pieces r?

A. $r = n^2 + 3n$ **B.** $r = n(n + 3)$ **C.** $r = n^2 + 3$ **D.** $r = (n + 3)n$

Custom Steel Products builds cubes out of square steel plates measuring 1 foot on a side. Below is a 1-foot cube. Use this information for Exercises 61–63.

1 ft
1 ft   1 ft

60. How many square plates are needed to make a 1-foot cube?

61. **Multiple Choice** Suppose CSP wants to triple the dimensions of the cube. How many times greater than the original area will the surface area of this larger cube be?

   A. 2   **B.** 3   **C.** 4   **D.** 9

62. **Multiple Choice** Suppose CSP triples the dimensions of the original cube. How many times the volume of the original cube is the volume of the new cube?

   F. 8   **G.** 9   **H.** 27   **J.** 81

63. A bridge-painting company uses the formula $C = 5,000 + 150L$ to estimate painting costs. C is the cost in dollars, and L is the length of the bridge in feet. To make a profit, the company increases a cost estimate by 20% to arrive at a bid price. For example, if the cost estimate is $10,000, the bid price will be $12,000.

   a. Find bid prices for bridges 100 feet, 200 feet, and 400 feet long.

   b. Write a formula relating the final bid price to bridge length.

   c. Use your formula to find bid prices for bridges 150 feet, 300 feet, and 450 feet long.

   d. How would your formula change if the markup for profit was 15% instead of 20%?

64. At Yvonne's Auto Detailing, car washes cost $5 for any time up to 10 minutes, plus $.40 per minute after that. The managers at Yvonne's are trying to agree on a formula for calculating the cost c for a t-minute car wash.

a. Sid thinks $c = 0.4t + 5$ is correct. Is he right?

b. Tina proposes the formula $c = 0.4(t - 10) + 5$. Is she right?

c. Jamal says Tina's formula can be simplified to $c = 0.4t + 1$. Is he right?

Write an equation for each relationship.

65. The Bluebird Taxi Company charges $3.00 for the first 2 miles of any trip and $2.40 for each mile after that. How is the taxi fare related to the distance of a trip?

66. An airport offers free parking for 30 minutes and then charges $2.00 for each hour after that. How is the price for parking related to the total time a car is parked?

67. The Regal Cinema makes $6.50 on each ticket sold. The cinema has operating expenses of $750 per day, as well. How is daily profit related to number of tickets sold?

68. Rush Computer Repair sends technicians to businesses to fix computers. Technicians charge a fixed fee of $50, plus $50 per hour. How is total cost for a repair related to the time the repair takes?