Applications

1. **a.** It will take Allie $100$ s or $1$ min and $40$ s.
   Since Allie’s walking rate is $2$ m/s, if she travels $200$ m, it will take her $\frac{200}{2} = 100$ s.
   
   **b.** Grace will reach the fountain first. Since Grace is traveling at $1.5$ m/s and she has to go $90$ m, it will take Grace $\frac{90}{1.5} = 60$ s to reach the fountain, which is less time than it took Allie ($100$ s).
   
   **Note:** Students may make a table for each girl to find the answer.

2. **a.** $d = 20 + 2t$
   
   **b.** Gilberto’s graph intersects the $y$-axis at $20$, which is in between the points at which Henri’s and Emile’s graphs intersect the $y$-axis. Emile’s graph intersects the $y$-axis at $0$ meters and Henri’s at $45$ meters. Gilberto’s graph proceeds from the $y$-axis diagonally straight up to the right, intersecting Henri’s graph at $25$ seconds and then Emile’s graph at $40$ seconds.

3. **a.** The situation is like the race between Henri and Emile because the question asks when the person traveling at the greater rate will catch up to the other person. In both cases, the person traveling at the slower rate has a head start. In this situation, the head start is given as a time rather than a distance. (This distinction is blurred on the graph because the $y$-intercept indicates the head start as a distance rather than as a time.) Another difference is that after Ingrid catches up with Tara, they will probably start walking together, which will change Ingrid’s and maybe Tara’s graph as they adjust their walking rates to walk together.
   
   **b.** after $4$ min
   
   **c.** $1,000$ ft from Tara’s house
   
   **d.** The intersection of Tara’s graph at $500$ means that when Ingrid started walking fast, Tara was $500$ ft ahead of her. The intersection of Ingrid’s line at $0$ means that Ingrid was at Tara’s house when she started walking fast.
   
   **e.** Ingrid’s line is steeper. On the graph, her line is closer to vertical. The faster the person travels, the steeper the line will be.
   
   **Note:** Later, when students are able to write equations to represent graphs like this, they will see that the steepest line has the greatest coefficient for the variable on the $x$-axis. It may be interesting to note that the lines continue after Ingrid and Tara meet. Students may want to discuss what this part of the graph means. Some students may be ready to write equations for these graphs.
   
   **f.** Answers will vary. Possible answer: Their graphs will continue as a single line. If you extend the graphs past that point, the graphs might not be linear because the girls may travel at a new rate that is different from Tara’s and Ingrid’s original walking rate. So the graphs may not exhibit a constant rate of change.

4. **a.** Yes, because in each case, as the number of people at the party increases by a constant amount, the corresponding cost of the party increases by a constant amount.
   
   **b.** Rollaway: $y = 5x$;
   Wheelies: $y = 100 + 3x$
   
   **c.** If you continue the table of values for each plan showing Number of People and Cost, then you will look in the Cost column of each plan to see when they are equal. On the graph, you would use the $y$-coordinate of the point of intersection for Rollaway and Wheelies to tell you where the costs of the two plans are equal. You can decide which company to choose by looking either before the point of intersection or after it (depending on how many people will be attending) and finding the company whose line is below the other. This company will have a lesser cost.
5. a. $35 is the initial charge for skating. $4 is the price per student to skate.

b. Wheels to Go; on the graph, you would see which line had the smallest y-coordinate (cost) when the x-coordinate (number of people) was 60. On the table for each company, you would see which one had the lowest y-value (cost), when the x-coordinate number of people) was 60. In each equation, you would substitute 60 for the value of $n$ and find each cost by solving for $C$.

Rollaway’s cost is $300 because $5(60) = 300$. Wheelies’s cost is $280 because $100 + 3(60) = 280$, and Wheels to Go’s cost is $275 because $35 + 4(60) = 275$.

c. Rollaway: 100 people; Wheelies: no more than 133 people; Wheels to Go: no more than 116 people

d. i. (20, 115) Wheels to Go, because $35 + 4 \times 20 = 115$

ii. (65, 295) Wheelies, because $100 + 3 \times 65 = 295$

iii. (50, 250) Rollaway, because $5 \times 50 = 250$. Also Wheelies, because $100 + 3(50) = 250$.

e. Answers will vary. Possible answers:

For (20, 115): If you used Wheels to Go and 20 people skated, how much would it cost? For (65, 295): If you used Wheelies, and the cost was $295, how many people skated? For (50, 250): Which coordinate pair would satisfy the equations for Rollaway and Wheelies? Which coordinate pair would show the intersection of Rollaway and Wheelies when graphed? How many people, or at what cost, would there be no difference whether you chose Rollaway or Wheelies?

6. a. about 75 protein bars

Note: Students are reading answers from the graph, so some inaccuracy is expected.

b. $33.50 because 0.67(50) = 33.5; $83.75 because 0.67(125) = 83.75

Note: The 0.67 was derived from the points (0, 0) and (300, 200), showing that each protein bar would sell for $0.67.

c. For an income of $200, the band would have to sell about 300 protein bars. The cost would be $125, leaving a profit of about $75.

Note: Using 300 as the amount of bars and $0.34 as the cost of the bars, the answer is $73. Suggest that students try to write an equation for each line.

7. The graphs in a and b are linear. The equation for a is $y = 3x + 1$, and the equation for b is $y = 2x + 7$. The patterns in c and d are not linear, because there is no constant rate of change.

8. a. 100 brochures; methods will vary. Students may graph the two equations and find the intersection point, they may use a table of values, or may have substituted 100 into each equation.

b. Company A: 500 brochures, Company B: 260 brochures; Students may continue the graph or table to obtain these answers, or they may solve the equation for $n$.

c. Company A: The organizers will have to pay $15 as an initial cost.

Company B: The organizers will have to pay nothing as an initial cost.

d. Company A: The organizers will have to pay $0.10 per brochure.

Company B: The organizers will have to pay $0.25 per brochure.

e. Company A: As the number of brochures increases by 1, the cost increases by $0.10.

Company B: As the number of brochures increases by 1, the cost increases by $0.25
9. a. Tom’s Tunes: \( y = 60x \); Sabina’s Sounds: \( y = 40x + 100 \); DJ Derek: \( y = 30x + 175 \)
   b. The coefficient of \( x \) gives the cost per hour, or the DJ’s hourly rate.
   c. The \( y \)-intercept gives the initial charge for each DJ.
   d. Tom’s Tunes: $510; Sabina’s Sounds: $440; DJ Derek: about $430
   e. Tom’s Tunes: 7.5 h; Sabina’s Sounds: 8.75 h; DJ Derek: about 9.2 h

10. a. Plan 1: $140.40; Plan 2: $78
   b. Both plans require 25 weeks.
   c. Plan 1: \( y = 270 – 10.8x \); Plan 2: \( y = 150 – 6x \); \( y \) represents the amount of money you owe, and \( x \) represents the number of weeks. The 270 and the 150 represent the amount owed after making the down payment (if any down payment), and the 10.8 and the 6 represent how much you pay every week.
   d. The amount of money owed after 12 weeks would increase: Plan 1: $225.40; Plan 2: $163.
   Plan 1 requires the least number of weeks to pay off the skateboard now. It requires a little more than 32 weeks, while Plan 2 requires a little over 39 weeks to pay for the skateboard.
   The equations are now: Plan 1: \( y = 355 – 10.8x \); Plan 2: \( y = 235 – 6x \); \( y \) represents the money you owe, and \( x \) represents the number of weeks. The 355 and the 235 represent the amount owed after making the down payment (if any down payment), and the 10.8 and the 6 represent how much you pay every week.

11. a. 1.5
   b. increasing
   c. 0
   d. Possible answers: (2, 3), (0, 0), (4, 6)

12. a. –3
   b. decreasing
   c. 10
   d. Possible answers: (0, 10), (–5, 25), (2, 4)

13. a. –2
   b. decreasing
   c. 6
   d. Possible answers: (0, 6), (3, 0), (–2, 10)

14. a. 2
   b. increasing
   c. 5
   d. Possible answers: (0, 5), (–1, 3), (4, 13)

15. a. \( y = –2x + 4 \)
   b. Answers will vary. Possible answer: The point (6, 45) is on the graph. Two questions: How long must Dani baby-sit to make $45? How much money will she make if she baby-sits for 6 hours?

16. a. Trace the graph to find \( x \) from the point with 22 as the \( y \)-value.
   b. Find 22 in the \( y \) column and look at the corresponding value in the \( x \) column.
   c. Find the \( x \)-value of the point of intersection of \( y = 22 \) and \( y = 100 – 3x \).

17. a. Graph 3
   b. Graph 4
   c. Graph 2
   d. \( y = –2x + 4 \)
   Answers will vary for Exercises 18–21. Sample answers are provided.

18. 0, 1
19. 0, 1
20. 0, 1
21. 0, –1
22. iii
23. Solving $8 = 2x – 6$ gives us $x = 7$; we now know that $(7, 8)$ is a point on the graph of $y = 2x – 6$.
24. ii
25. The coordinates are 6 and 3 for the points: $(-1.2, 6)$ and $(3, -15)$
26. i, iii
27. ii, iv
28. v

Connections

29. a. $x \times -2 + x \times 3 = -2x + 3x = x$
   Note: This is a good opportunity to talk about the form $2x$ for 2 times $x$ and about the Commutative Property of Multiplication.
b. $(-4 + 2)x = -2x$
c. $x(1 - 4) = -3x$
30. a. True
   b. False; $5(0.7x + 5) = 3.5x + 25$, not $3.5x + 5$
c. True
31. a. $y = 180 - 15x$. In this equation, $180$ represents the amount they owe after making the down payment, $15$ represents the monthly payment, $x$ represents the number of months after they made the purchase, and $y$ represents the amount they still owe.
b. The $y$-intercept is $(0, 180)$, the amount they owe as soon as they have made the down payment. The $x$-intercept is $(12, 0)$. 12 is the number of months it will take until they owe nothing
32. $5(x + 3)$ or $5x + 15$;
   Note: This is an opportunity to revisit the Distributive Property and the role of parentheses in algebraic expressions.
33. a. $6 \times 15 + 4 \times 15 = (6 + 4)15$
b. $3 \times 9 + 3 \times 5 = 3(9 + 5)$
c. $6 \times 10 + (4 \times 10) + (6 \times 4) + (4 \times 4) = (6 + 4)(10 + 4) = 10 \times 14$
d. $8(x + 4) = 8x + 8(4) = 8x + 32$
34. a. $0.25$ per apple
   b. (See Figure 1.)
c. 4 apples; Since it costs $0.25 per apple, you could buy 4 apples.
d. The relationship between the number of apples and the total cost is linear since each apple costs $0.25, which gives a constant rate of change.
35. a. $0.75$ per bagel (divide 15 by 20)
b. $C = 0.75n$
c. $112.50$; $C = 0.75(150) = 112.50$

Figure 1

<table>
<thead>
<tr>
<th>Number of Apples</th>
<th>12</th>
<th>6</th>
<th>1</th>
<th>48</th>
<th>10</th>
<th>18</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost</td>
<td>$3</td>
<td>$1.50</td>
<td>$0.25</td>
<td>$12</td>
<td>$2.50</td>
<td>$4.50</td>
</tr>
</tbody>
</table>
36. Tamara is confused about the order of operations. She is adding \(-3 + 5\) to get 2 and then multiplying by \(-1\) instead of doing multiplication first.

37. a and b are false; c and d are true because of the order of operations; e is true; f is false because \(\frac{1}{2} \times \frac{3}{2} \times \frac{1}{2} = \frac{3}{8}\).

38. (See Figure 2.)
   a. 2 cups/day
   b. 50 cups
   c. \(f = 50 - 2d\)

39. a. i and 1; ii and 3; iii and 2; iv and 5; v and 4
   b. Answers will vary. Possible answer: 2; Jalissa started the race fast and then became tired and gradually decreased her speed.

40. a–b.

   ![Diagram]

   c. These three triangles are similar.

   d. The areas of the three triangles are 128 square units, 32 square units, and 8 square units, respectively.

41. a. **Rectangles With Perimeters of 20 m**

<table>
<thead>
<tr>
<th>Length</th>
<th>Width</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>1</td>
</tr>
<tr>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>

   b. 2 times length + 2 times width = 20, 
   \((2L + 2W = 20)\) or \(L + W = 10\)

   c. Yes. As the length increases by a constant amount, the width decreases by a constant amount.

   d. The area of the 1 \(\times\) 9 rectangle is 9. 
The area of the 2 \(\times\) 8 rectangle is 16. 
The area of the 3 \(\times\) 7 rectangle is 21. 
The area of the 4 \(\times\) 6 rectangle is 24. 
The 5 \(\times\) 5 rectangle has an area of 25.
Extensions

42. a. Linear
b. Nonlinear
c. Nonlinear

Note: Students may use graphs or tables to explain their answers to parts (a)–(c). For the equations in part (a), they should say that the table shows a constant rate of change or that the graph is a straight line. For the equations in parts (b) and (c), they should say that the table does not show a constant rate of change or that the points do not lie in a straight line.

43. Answers will vary. Possible answers:
   a. \( y = 50 \) \( y = 2x \) \( y = 0.5x \)
   b. (See Figure 3.)
   c. No; parallel lines will not intersect and, therefore, cannot form triangles.

44. a. Only \((3, 2)\) is on the line because \( 3 \times 3 - 7 = 2 \). The point \((3, 3)\) is above the line because the line goes through \((3, 2)\). The points \((3, 1)\) and \((3, 0)\) are below the line. (See Figure 4.)
   b. Answers will vary. Possible answer:
      \((0, -7)\) lies on the line, but \((0, 5)\), \((0, 4)\), and \((0, 10)\) lie above the line.
   c. The inequality \( y < 3x - 7 \) holds for the points \((4, 2)\) and \((7, 12)\) because \( 2 < 5 \) and \( 12 < 14 \). The inequality \( y > 3x - 7 \) holds for the points \((4, 7)\) and \((7, 16)\) because \( 7 > 5 \) and \( 16 > 14 \).

45. a. Clear Prints: \( C = 2n \)
   Posters by Sue: \( C = 15 + 0.5n \)
   The cost \( C \) to make posters for the walkathon is represented by each equation, where \( n \) is the number of posters.
   b. The costs are equal at 10 posters. For 10 posters, Clear Prints and Posters by Sue both charge $20.
   c. If fewer than 10 posters are ordered, Clear Prints has the better offer. If more than 10 are ordered, Posters by Sue has the better offer.
   d. When the cost \( C \) is $18, the number of posters is 9 for Clear Prints and 6 for Posters by Sue. Therefore, the class should buy their posters from Clear Prints.
   When the cost \( C \) is $28, the number of posters is 14 for Clear Prints and 26 for Posters by Sue. Therefore, the class should buy their posters from Posters by Sue.
   e. The equation for Clear Prints, \( C = 2n \), is true for \((9, 18)\), \((10, 20)\), and \((14, 28)\). Thus, the inequality \( C < 20 \), or \( 2n < 20 \), holds for the point \((9, 18)\).
   The equation for Posters by Sue, \( C = 15 + 0.5n \), is true for \((6, 18)\), \((10, 20)\), and \((26, 28)\). Thus, the inequality \( C > 20 \), or \( 15 + 0.5n > 20 \), holds for the point \((26, 28)\).