Math 9: 6.1 Representing Patterns

Key Ideas

• Many pictorial and written patterns can be represented using a table of values or a linear equation.

The pentagonal table can seat five people. The tables can be connected to form longer tables.

<table>
<thead>
<tr>
<th>Number of Tables, t</th>
<th>Number of Sides, s</th>
<th>Pattern: Multiply t by 3 and Add 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>3</td>
<td>11</td>
<td>11</td>
</tr>
</tbody>
</table>

The equation that models the pattern is \( s = 3t + 2 \).

• Linear equations can be verified by substituting values.

Substitute \( t = 3 \) into the equation:

\[
s = 3(3) + 2 = 9 + 2 = 11
\]

The calculated value matches the value in the table.

Check Your Understanding

Communicate the Ideas

1. a) Explain how to develop a linear equation to represent this pattern.

b) What is the equation? Explain what each variable represents.

c) Compare your equation with one of a classmate’s.

2. Christina and Liam work in a shoe store and earn a flat rate of $35/day plus $6.25 for every pair of shoes they sell. Each got a different value for how much they would earn after selling eight pairs of shoes.

Christina: I substituted \( p = 8 \) into the equation \( w = 6.25p + 35 \). When I solved for \( w \), I got $85.

Liam: I substituted \( p = 8 \) into the equation \( w = 6.25p \). When I solved for \( w \), I got $50.

Who is correct? Explain how you know. What mistake did the other person make?

3. Describe to a partner how you could determine the ninth value in the following number pattern: 4, 7.5, 11, 14.5, 18, ... .

Practise

For help with #4 to #6, refer to Example 1 on pages 212–213.

4. a) Describe the relationship between the number of regular octagons and the number of sides in this pattern.

b) Make a table of values showing the number of sides for each figure in relation to the number of octagons.

c) Write an equation to model the number of sides of each shape. Explain what each variable represents.

d) How many sides would a shape made up of 17 octagons have?

e) How many octagons are needed to make a figure with 722 sides?

5. a) Make a table of values to show the number of circles in relation to the figure number.

b) Describe the relationship between the number of circles and the figure number.

c) Develop an equation that can be used to determine the number of circles in each figure. Explain what each variable represents.

d) How many circles are in Figure 17?

e) Which figure number has 110 circles?

6. Laura used green and white tiles to create a pattern.

a) Make a table of values to show the number of green tiles in relation to the figure number.

b) Describe the relationship between the number of green tiles and the figure number.

c) Develop an equation to model the number of green tiles. Explain what each variable represents.

d) How many green tiles are in Figure 24?

e) Which figure number has 176 green tiles? Verify your answer.

For help with #7 to #9, refer to Example 2 on pages 214–215.

7. Matt created the following number pattern: 7, 16, 25, ... .

a) Make a table of values for the first five terms.

b) Develop an equation that can be used to determine the value of each term in the number pattern.

c) What is the value of the 123rd term?

d) Which term has a value of 358?

8. The figure shows two regular heptagons connected along one side. Each successive figure has one additional heptagon. Each side length is 1 cm.

a) Draw the first six figures. Then, describe the pattern.

b) Make a table of values showing the perimeter for the first six figures.

c) What equation can be used to determine the perimeter of each figure? Identify each variable.

d) What is the perimeter of Figure 12?

e) How many heptagons are needed to create a figure with a perimeter of 117 cm?
Math 9: 6.1 Representing Patterns

9. Jessica created a number pattern that starts with the term $-5$. Each subsequent number is 3 less than the previous number.
   a) Make a table of values for the first five numbers in the pattern.
   b) What equation can be used to determine each number in the pattern? Verify your answer by substituting a known value into your equation.
   c) What is the value of the 49th term?
   d) Which term has a value of $-119$? Verify your answer.

10. What linear equation models the relationship between the numbers in each table?
   a) $\begin{array}{c|c}
   x & y \\
   \hline
   0 & 13 \\
   1 & 16 \\
   2 & 19 \\
   3 & 22 \\
   \end{array}$
   b) $\begin{array}{c|c}
   x & y \\
   \hline
   0 & 17 \\
   1 & 24 \\
   2 & 31 \\
   3 & 38 \\
   \end{array}$
   c) $\begin{array}{c|c}
   x & y \\
   \hline
   1 & -1.3 \\
   2 & 1.4 \\
   3 & 4.1 \\
   4 & 6.8 \\
   \end{array}$
   d) $\begin{array}{c|c|c|c|c}
   x & f & g & h & w \\
   \hline
   1 & 1 & -0.5 & 2 & -4 \\
   2 & 2 & 3 & -7.5 & 4 \\
   \end{array}$

Apply

11. Rob is in charge of arranging hexagonal tables for a parent-night presentation. The tables, which can seat six people, can be connected to form longer tables.
   a) Develop an equation to model the pattern. Identify each variable.
   b) How many parents can be seated at a row of five tables?
   c) Check your answer for part b). Show your work.
   d) A group of 30 people want to sit together. How many tables must be joined together to seat them?

12. A school pays a company $125 to design gym T-shirts. It costs an additional $13 to make each T-shirt.
   a) Copy and complete the table of values.
   
<table>
<thead>
<tr>
<th>Number of T-Shirts</th>
<th>Cost ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>125</td>
</tr>
<tr>
<td>5</td>
<td>200</td>
</tr>
<tr>
<td>10</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td></td>
</tr>
<tr>
<td>35</td>
<td>950</td>
</tr>
</tbody>
</table>
   
   b) Develop an equation to determine the cost of the T-shirts. Explain the meaning of the numerical coefficient.
   c) What would it cost to make 378 T-shirts?
   d) If the school store has a budget of $2345 for T-shirts, how many T-shirts can be ordered?

13. An art store sells square picture frames with a border of tiles that each measure 2 cm by 2 cm. The smallest frame is 10 cm by 10 cm and requires 16 tiles.
   a) Develop an equation to model the number of tiles required for each size of frame.
   b) How many tiles are needed to make a frame that is 30 cm by 30 cm?
   c) What are the dimensions of a square frame made with 196 tiles?

14. Edmund Halley, after whom Halley’s comet was named, predicted that the comet would appear in 1758. The comet appears approximately every 76 years.
   a) Use a table to show the years of the next six sightings after 1758.
   b) When will Halley’s comet appear in your lifetime?
   c) Write an equation that can be used to predict the years when Halley’s comet will appear.
   d) Will Halley’s comet appear in the year 2370? How did you arrive at your answer?

15. Find the pattern that expresses all the numbers that are 1 more than a multiple of 3.
   a) What is the 42nd number?
   b) How can your pattern test to see if 45678 is 1 more than a multiple of 3?

16. A landscaper is planting elm trees along a street in a new subdivision. If elm trees need to be spaced 4.5 m apart, then how long is a row of 41 trees?
   a) A landscaper is planting elm trees along a street in a new subdivision. If elm trees need to be spaced 4.5 m apart, then how long is a row of 153 trees?
   b) The street is 100 m long. If the landscaper wants to line the street on both sides with elm trees, how many trees will be needed? Will the trees be evenly spaced along the entire street?

17. A ball is dropped from a height of 2 m. The ball rebounds to $\frac{2}{3}$ of the height it was dropped from. Each subsequent rebound is $\frac{2}{3}$ of the height of the previous one.
   a) Make a table of values for the first five rebounds.
   b) What is the height of the fourth rebound bounce?
   c) Is this a linear relation? Explain how you know.

Science Link
A comet, which is made of frozen gas and dust, orbits around the sun. The dust tail of a comet can be up to 10 000 000 km long. This is 2.5 times as great as the average distance from Earth to the moon.

Math Link
You are in charge of developing a racing course for a sailboat race on Lake Diefenbaker, in Saskatchewan. Five classes of sailboats will race on courses that are the same shape, but different lengths.
   a) Design a racing course based on a regular polygon. The shortest course must be at least 5 km long. The longest course must be no longer than 35 km.
      • Draw and label a diagram of the racing course. Show at least the first four courses. Record the total length of each course.
   b) Develop a linear relation related to your racing course.
      • Make a table of values.
      • Develop a linear equation that represents the relationship between the course number and the course distance.
   c) Develop a problem related to your racing course. Provide the solution and verify it.
Math 9: 6.2 Interpreting Graphs

Check Your Understanding

Communicate the Ideas

1. Josh asked you to help him understand interpolation and extrapolation. Use an example and a graph to help explain how interpolation and extrapolation are similar and how they are different.

2. Grace says it would be reasonable to interpolate values on these graphs. Is she correct? Explain.

3. Develop a situation that involves a linear relation. Draw and label the corresponding graph. Develop a question and answer that requires extrapolating a value on the graph. Compare your work with that of a classmate.

Practise

For help with #4 to #7, refer to Example 1 on page 222.

4. The graph shows a linear relation between distance and time.

5. The graph shows a linear relation.

6. The graph shows a linear relation.

7. The table of values represents the distance that Sophie cycles in relation to time.

8. The graph shows a linear relation between distance and time.

9. The graph shows a linear relation.

10. The graph shows a linear relation.

11. The table of values represents the drop in temperature after noon on a winter day.

For help with #8 to #11, refer to Example 2 on pages 223–224.

A–C–: #1, 2, 4, 7, 8, 11, 13–15 (10, 16–19)*
Apply

12. a) In a bulk food store, trail mix costs $2.40 per 250 g. Plot the data on a graph.

<table>
<thead>
<tr>
<th>Mass of Trail Mix, m (g)</th>
<th>250</th>
<th>500</th>
<th>750</th>
<th>1000</th>
<th>1250</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost, C ($)</td>
<td>2.40</td>
<td>4.80</td>
<td>7.20</td>
<td>9.60</td>
<td>12.00</td>
</tr>
</tbody>
</table>

b) From the graph, approximate how much 2000 g of trail mix would cost.

c) From the graph, approximate how much trail mix you would get for $13.

13. The submarine HMCS Victoria can dive to a depth of 200 m.

14. A grade 9 class earns a profit of 53¢ for each program they sell for the school play.

<table>
<thead>
<tr>
<th>Number of Programs</th>
<th>0</th>
<th>100</th>
<th>200</th>
<th>300</th>
<th>400</th>
</tr>
</thead>
<tbody>
<tr>
<td>Income ($)</td>
<td>0</td>
<td>53</td>
<td>106</td>
<td>159</td>
<td>212</td>
</tr>
</tbody>
</table>

15. Sean learned in his cooking class that the time it takes to cook a roast depends upon its mass. The graph shows the relationship between cooking time and the mass of a roast.

<table>
<thead>
<tr>
<th>Roast Cooking Time, t (h)</th>
<th>0</th>
<th>0.5</th>
<th>1</th>
<th>1.5</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass, m (kg)</td>
<td>1.25</td>
<td>2.25</td>
<td>4.20</td>
<td>5.25</td>
<td>6.25</td>
</tr>
</tbody>
</table>

a) Is it reasonable to interpolate or extrapolate values on this graph? Explain.

b) How long does it take Victoria to reach a depth of 140 m?

c) What is the submarine’s depth after 4 min?

16. A cell phone company charges a $33.95 monthly fee and long-distance charges at a rate of $0.35 per minute. The graph shows the monthly cost of phone calls based on the number of long-distance minutes.

<table>
<thead>
<tr>
<th>Monthly Cost ($)</th>
<th>0</th>
<th>25</th>
<th>50</th>
<th>75</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Minutes</td>
<td>0</td>
<td>25</td>
<td>50</td>
<td>75</td>
<td>100</td>
</tr>
</tbody>
</table>

a) Is it reasonable to interpolate or extrapolate values on this graph? Explain.

b) What would be the approximate monthly bill for 60 min of long-distance calls?

c) Approximately how many minutes of long-distance calls could you buy for $50?

17. The graph represents the relationship between the cost of renting a power washer and rental time.

<table>
<thead>
<tr>
<th>Cost ($)</th>
<th>0</th>
<th>50</th>
<th>100</th>
<th>150</th>
<th>200</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Days</td>
<td>0</td>
<td>2</td>
<td>4</td>
<td>6</td>
<td>8</td>
</tr>
</tbody>
</table>

a) How much does it cost to rent a power washer for four days? What is the cost per day? How do you know?

b) How long could you rent the power washer if you had $420?

Extend

18. The table shows the relationship between stopping distance and speed of a vehicle.

<table>
<thead>
<tr>
<th>Speed, s (km/h)</th>
<th>15</th>
<th>30</th>
<th>45</th>
<th>60</th>
<th>75</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stopping Distance, d (m)</td>
<td>6</td>
<td>15</td>
<td>28</td>
<td>42</td>
<td>65</td>
</tr>
</tbody>
</table>

a) Plot the data on a graph. Draw a line to join the data points to best approximate the trend.

b) What happens to stopping distance as speed increases?

c) Estimate the stopping distances for speeds of 5 km/h, 55 km/h, and 80 km/h.

d) Estimate the speed before a driver applied the brake for stopping distances of 10 m, 50 m, and 100 m.

e) About how much farther is the stopping distance at 50 km/h than it is at 30 km/h? at 70 km/h than at 50 km/h?

f) Why do you think the graph is not a straight line?
19. The speed of a falling skydiver is shown for the first 8 s.

<table>
<thead>
<tr>
<th>Time (s)</th>
<th>Speed (m/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>15</td>
</tr>
<tr>
<td>3</td>
<td>20</td>
</tr>
<tr>
<td>4</td>
<td>25</td>
</tr>
<tr>
<td>5</td>
<td>30</td>
</tr>
<tr>
<td>6</td>
<td>35</td>
</tr>
<tr>
<td>7</td>
<td>40</td>
</tr>
</tbody>
</table>

a) Approximately how long would it take for the skydiver to reach terminal velocity?

b) Approximately how far would the skydiver fall in that time?

c) Why do you think the graph is approximately a straight line?

Did You Know?
Terminal velocity is the maximum speed that a skydiver can reach when falling. Air resistance prevents most skydivers in free fall from falling any faster than 54 m/s.

Math Link
The area of the ocean called the Intertropical Convergence Zone (ITCZ) has little or no wind. Before propellers and motors, sailors used a relatively light anchor called a kedge to help them move across this region. The kedge anchor, which was attached to a line, was rowed out approximately 650 m ahead of the ship and dropped to the sea floor. A crew on the ship then grabbed the line and hauled it in to pull the ship to the anchor, a distance of 650 m. This process, called kedging, was repeated until the boat passed through the ITCZ.

a) Create a table of values showing the relationship between the number of kedges and the total distance travelled.

b) Plot the data on a graph. Label the graph.

c) Determine the value for how many kedges it would take to traverse the width of the ITCZ.

d) How did the skills you have learned in this chapter help you solve part c)?

Did You Know?
The ITCZ is located between 5° north and 5° south of the equator and is approximately 1100 km wide. Note how the position of the ITCZ moves during the year.

Web Link
To learn more about the Intertropical Convergence Zone (ITCZ), go to www.mathlinks9.ca and follow the links.
Math 9: 6.3 Graphing Linear Relations

Show You Know

a) Write the linear equation that represents the graph.
b) Explain how you know the graph matches the equation.

Key Ideas

- You can graph a linear relation represented by an equation.
  - Use the equation to make a table of values.
  - Graph using the coordinate pairs in the table. The graph of a linear relation forms a straight line.

$$k = \frac{5}{9}$$

<table>
<thead>
<tr>
<th>j</th>
<th>k</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-9.0</td>
</tr>
<tr>
<td>1</td>
<td>-8.8</td>
</tr>
<tr>
<td>2</td>
<td>-8.6</td>
</tr>
<tr>
<td>3</td>
<td>-8.4</td>
</tr>
<tr>
<td>4</td>
<td>-8.2</td>
</tr>
<tr>
<td>5</td>
<td>-8.0</td>
</tr>
</tbody>
</table>

- The graph of a linear relation can form a horizontal or a vertical line.
- You can use graphs to solve problems by interpolating or extrapolating values.

Check Your Understanding

Communicate the Ideas

1. You are given a linear equation. Describe the process you would follow to represent the equation on a graph. Use an example to support your answer.

2. Use examples and diagrams to help explain how horizontal and vertical lines and their equations are similar and how they are different.

Practise

For help with #4 to #7, refer to Example 1 on pages 232–234.

4. Ian works part-time at a movie theatre. He earns $8.25/h. The relationship between his pay, $p$, and the time he works, $t$, can be modelled with the equation $p = 8.25t$.
   a) Show the relationship on a graph.
   b) Explain how you know the graph represents the equation.
   c) Ian works 8 h in one week. Use two methods to determine his pay.

5. Andrea is travelling by bus at an average speed of 85 km/h. The equation relating distance, $d$, and time, $t$, is $d = 85t$.
   a) Show the relationship on a graph.
   b) How long does it take Andrea to travel 300 km?

6. Choose the letter representing the graph that matches each linear equation.
   a) $y = 5x$
   b) $y = -2x + 3$
   c) $y = -\frac{x}{4} + 6$

A~C-: #2-4, 6-8, 10, 12, 13 (7, 16-21)*

Web Link

For practice matching graphs and linear equations, go to www.mathlinks9.ca and follow the links.
A~C-: #2-4, 6-8, 10, 12, 13 (7, 16-21)*

12. Create a graph and a linear equation to represent each table of values.

14. Sanjay conducted an experiment to determine how long it takes to heat water from 1 °C to its boiling point at 100 °C. He plotted his data on a graph.

a) Approximately how long did it take for the water to reach boiling point? Explain your reasoning.
b) What was the temperature of the water after 10 min?
c) At what rate did the water temperature increase? Explain your reasoning.

15. Paul drives from Edmonton to Calgary. He uses a table to record the data.

a) Graph the linear relation.
b) How far did Paul drive in the first 2 h?
c) How long did it take Paul to drive 200 km?
d) Write the equation that relates time and distance.
a) What was Paul’s average driving speed? What assumptions did you make?

To learn about using a graphing calculator to enter data on a table and plot the data on a graph, go to www.mathlinks9.ca and follow the links.
### 16. The relationship between degrees Celsius (°C) and degrees Fahrenheit (°F) is modelled by the equation \( F = \frac{9}{5} C + 32. \)
  a) Graph the relationship for values between -50 °C and 120 °C.
  b) Water boils at 100 °C. What is this temperature in degrees Fahrenheit?
  c) Water freezes at 0 °C. How did you represent this on your graph?
  d) At what temperature are the values for °C and °F the same?

### 17. Scuba divers experience an increase in pressure as they descend. The relationship between pressure and depth can be modelled with the equation \( P = 10.13d + 102.4, \) where \( P \) is the pressure, in kilopascals, and \( d \) is the depth below the water surface, in metres.
  a) Graph the relationship for the first 50 m of diving depth.
  b) What is the approximate pressure at a depth of 15 m? Verify your answer.
  c) The maximum pressure a scuba diver should experience is about 500 kPa. At what depth does this occur? Verify your answer.
  d) What does “+ 102.4” represent in the equation? How is it represented on the graph?

### 18. The graph shows the normal range of length for girls from birth to age 36 months.
  a) For what age range does girls’ growth appear to represent a linear relation?
  b) For what age range, does girls’ growth appear to represent a non-linear relation?

### 19. Janice left the school at 12 noon riding her bike at 20 km/h. Flora left school at 12:30 riding her bike at 24 km/h.
  a) Draw a distance–time graph to plot the data for both cyclists during the first four hours. Use a different colour for each cyclist.
  b) How can you tell from the graph that Flora has caught up to Janice?
  c) About what time did Flora catch up to Janice?
  d) If Janice and Flora continued to ride at their respective speeds, at what time would they again be apart by a distance of 2 km?

### 20. An online music download site offers two monthly plans. Plan A offers $10 plus $1 per download and Plan B offers $1.50 per download.
  a) Graph both linear relations on the same grid.
  b) Explain the conditions under which each deal is better.

### 21. Simple interest is paid according to the formula \( I = p \times r \times t, \) where \( p \) is the principal, \( r \) is the rate of interest per year, and \( t \) is the time in years. The interest is not added to the principal until the end of the time period. Canada Savings Bonds offer a simple interest bond payable at 3.5% per year up to a maximum of ten years.
  a) Create a table of values to show the interest earned on a $1000 bond for the ten-year period.
  b) Use a graph to show the interest earned over ten years.
  c) How many years would it take to earn $100 interest? $200 interest?
  d) If you could leave the principal beyond the ten-year period, estimate the number of years it would take to earn $500 interest.
Math 9: 9.1 Representing Inequalities

Key Ideas
- A linear inequality compares linear expressions that may not be equal. \( x \geq -3 \) means that \( x \) is greater than or equal to \(-3\).
- Situations involving inequalities can be represented verbally, graphically, and algebraically.
- Verbally: Use words.
- Graphically: Use visuals, such as diagrams and graphs.
- Algebraically: Use mathematical symbols, such as numbers, variables, operation signs, and the symbols \( <, >, \leq, \) and \( \geq \).
- An inequality with the variable on the right can be interpreted two ways. \( 8 < x \) can be read "8 is less than \( x \)." This is the same as saying "\( x \) is greater than 8."

Check Your Understanding
Communicate the ideas
1. Consider the inequalities \( x > 10 \) and \( x \geq 10 \).
   a) List three possible values for \( x \) that satisfy both inequalities. Explain how you know.
   b) Identify a number that is a possible value for \( x \) in one but not both inequalities.
   c) How are the possible values for inequalities involving \( > \) or \( < \) different than for inequalities involving \( \geq \) or \( \leq \)? Give an example to support your answer.
2. On a number line, why do you think an open circle is used for the symbols \( < \) and \( > \), and a closed circle for the symbols \( \leq \) and \( \geq \)?
3. Tiffany and Charles have each written an inequality to represent numbers that are not more than 15. Their teacher says that both are correct. Explain why.
   Charles: \( 15 \geq x \)
   Tiffany: \( x \leq 15 \)
4. Consider the inequality \( x \neq 5 \).
   a) List at least three possible values for \( x \).
   b) How many values are not possible for \( x \)? Explain.
   c) Explain how you would represent the inequality on a number line.

Practise
For help with #5 to #9, refer to Example 1 on pages 342–343.
5. Write the inequality sign that best matches each term. Use an example to help explain your choice for each.
   a) at least
   b) fewer than
   c) maximum
   d) must exceed
6. For which inequalities is 4 a possible value of \( x \)? Support your answer using two different representations.
   a) \( x > 3 \)
   b) \( x < 4 \)
   c) \( x > -9 \)
   d) \( x \geq 4 \)
7. Write a word statement to express each meaning of each inequality. Give three possible values of \( y \) on a number line.
   a) \( y \geq 8 \)
   b) \( y < -12 \)
   c) \( y \leq 6.4 \)
   d) \( y > -12.7 \)
8. At the spring ice fishing derby, only fish 32 cm or longer qualify for the prize categories. A person must be under twelve years of age to qualify for a child’s ticket at the movies. Let \( a \) represent the age of the person.
   a) What could the inequality be?
   b) Mark any three values on the number line. Explain how you would represent the inequality on a number line.
9. Write a word statement to express each inequality.
   a) \( y \geq 10 \)
   b) \( y > 5 \)
   c) \( y < 15 \)
10. Express each inequality algebraically in two different ways.
    a) \( x < -12 \)
    b) \( x > 3 \)
    c) \( x > -25 \)
11. Sketch a number line to show each inequality.
    a) \( x > 3 \)
    b) \( x < 12 \)
    c) \( x \geq -19 \)
    d) \( -3 \geq x \)
12. Represent each inequality graphically.
    a) \( y \leq 10.7 \)
    b) \( y \geq -5.3 \)
    c) \( y < -\frac{4}{5} \)
    d) \( 4.8 > x \)
For help with #13 to #15, refer to Example 3 on page 345.
13. For each combination of inequalities, show the possible values for \( x \) on a number line.
    a) \( x > 12 \) and \( x < 17 \)
    b) \( x \geq -3 \) and \( x \leq 0 \)
    c) \( x \geq 1 \) and \( x \leq 4 \)
    d) \( x < -\frac{4}{2} \) and \( x > -11 \)
14. a) Represent the possible values for \( y \) graphically, if \( y > -9.3 \) and \( y < -6.7 \).
    b) Mark any three values on the number line. For each one, explain whether it is a possible value for \( y \).
15. Represent the values shown in red on each number line by a combination of inequalities.
    a) \( \frac{1}{2} \)
    b) \( \frac{1}{3} \)
    c) \( \frac{1}{4} \)
Apply

16. The manager of a clothing store has set goals for her sales staff. Express each goal algebraically.
   a) The monthly total sales, \( m \), will be a minimum of \$18,000.
   b) At month end, the total time, \( t \), spent counting store inventory will be at most 8 h.
   c) The value of total daily sales, \( d \), will be more than \$700.

17. If Emily keeps a daily balance of at least \$1500 in her bank account, she will pay no monthly fees.
   a) Draw a number line to represent the situation.
   b) If \( x \) represents her daily balance, write an inequality that represents the possible values for \( x \) when she will pay no fees.

18. Paul is training for a race and hopes to beat the record time. The number line represents the finishing times that will allow him to beat the record. The finishing times range from 40 s to 60 s.
   a) Write a statement to express the finishing times that will allow him to beat the record.
   b) Express the inequality algebraically.

19. a) Develop a problem that could be represented by an inequality. Express the inequality verbally.
    b) Graph the inequality.
    c) Express the inequality algebraically.

20. Owen has a coupon for a restaurant.
    a) Owen buys a meal for \$10.75. If \( m \) is the cost of his second meal, write an inequality to represent the possible values of \( m \) that will allow him to use the coupon.
    b) Represent the inequality graphically.

21. Shanelle is buying insurance for a car to drive to and from work. The cost of insurance will be higher if she works farther than 15 km from home.
    a) Verbally express the inequality that represents the possible values for the distance for which Shanelle will have to pay more insurance.
    b) Sketch a number line to represent the inequality.

22. During winter, ice roads allow access to remote places in northern communities. The ice road to Aklavik, NWT is made through the Mackenzie River Delta. The ice road to Tuktoyuktuk travels up the Mackenzie River and out onto the sea ice. Ice roads are made by flooding the existing ice on a river or lake until it reaches the required thickness.

23. a) If the inequalities \( x \geq 6 \) and \( x \leq 6 \) are both true, describe the possible values for \( x \).
    b) What would a number line showing possible values of \( x \) look like for this situation? Justify your answer.

24. Bluesky is building a wooden puzzle triangle. She has cut two sides that measure 30 cm and 80 cm, respectively. The longest side of the triangle is 80 cm. Write inequalities to represent the possible lengths for the third side of the triangle.

25. What values of \( x \) would each of the following combinations of inequalities represent? Explain verbally and show graphically.
   a) \( x > 4 \) and \( x < 7 \)
   b) \( x < 4 \) and \( x < 7 \)
   c) \( x > 4 \) and \( x > 7 \)
   d) \( x < 4 \) and \( x > 7 \)

Literacy Link

A metric tonne (t) is a measurement of mass that equals 1000 kg.

For safety reasons, there are restrictions such as the ones shown.

Ice Road Limits

- Weight: 4 t
- Speed: 30 km/h
- Minimum Space Between Vehicles: 50 m

Represent each restriction
a) graphically
b) algebraically

Extend

23. a) If the inequalities \( x \geq 6 \) and \( x \leq 6 \) are both true, describe the possible values for \( x \).
    b) What would a number line showing possible values of \( x \) look like for this situation? Justify your answer.

24. Bluesky is building a wooden puzzle triangle. She has cut two sides that measure 30 cm and 80 cm, respectively. The longest side of the triangle is 80 cm. Write inequalities to represent the possible lengths for the third side of the triangle.

25. What values of \( x \) would each of the following combinations of inequalities represent? Explain verbally and show graphically.
   a) \( x > 4 \) and \( x < 7 \)
   b) \( x < 4 \) and \( x < 7 \)
   c) \( x > 4 \) and \( x > 7 \)
   d) \( x < 4 \) and \( x > 7 \)

Math Link

For safety reasons, some amusement park rides have age and height restrictions for riders.

a) Choose an amusement park ride that you have seen or design one of your own. Describe your ride.

b) For your ride, consider the safety restrictions or conditions that you might impose on riders. List at least three restrictions. Use terms of your choice.

c) Represent each restriction algebraically using a different variable for each.

d) Sketch a sign. Use words and graphics that clearly inform riders about each of your restrictions.
### Math 9: 9.2 Solving Single-Step Inequalities

**Key Ideas**

- The solution to an inequality is the value or values that makes the inequality true. For example, 2, 3, or 22.84.
- A specific solution is any value greater than 2. For example, 2.1, 3, or 22.84.
- The set of all solutions is the value or values that makes the inequality true.
- To verify the solution to an inequality, substitute possible values into the inequality:
  - Substitute a value greater than the boundary point to check if both sides are equal.
  - Substitute the boundary point to check if both sides are equal.
  - Substitute a value greater than the inequality symbol is correct.
- The solution to the inequality is the value or values that makes the inequality true.
- A specific solution is any value greater than 2. For example, 2.1, 3, or 22.84.
- The set of all solutions is the value or values that makes the inequality true.
- To verify the solution to an inequality, substitute possible values into the inequality:
  - Substitute a value greater than the boundary point to check if both sides are equal.
  - Substitute the boundary point to check if both sides are equal.
  - Substitute a value greater than the inequality symbol is correct.
- The solution to the inequality is the value or values that makes the inequality true.
- A specific solution is any value greater than 2. For example, 2.1, 3, or 22.84.
- The set of all solutions is the value or values that makes the inequality true.
- To verify the solution to an inequality, substitute possible values into the inequality:
  - Substitute a value greater than the boundary point to check if both sides are equal.
  - Substitute the boundary point to check if both sides are equal.
  - Substitute a value greater than the inequality symbol is correct.

**Check Your Understanding**

**Communicate the Ideas**

1. Maria and Ryan are discussing the inequality $2x > 10$.

   **Maria:** Maria and Ryan are discussing the inequality $2x > 10$.

   **Ryan:** I agree that 6 is a solution but it is not the whole solution.

   **What does Ryan mean?**

2. Explain how the process for verifying a solution is different for a linear inequality than for a linear equation. Discuss your answer with a classmate.

3. What process would you use to solve the inequality $-15x \leq 90$?

4. Represent on a number line:
   - the linear equation $6x = 18$
   - the linear inequality $6x \geq 18$

   Compare the solutions. How are they the same? How are they different?

**Practise**

For help with #5 to #8, refer to Example 1 on pages 352-353.

5. Solve each inequality.
   - $x - 7 \geq 22$
   - $8.6 + x > -5.2$
   - $100 \leq x + 65$

6. Solve each inequality.
   - $6y \geq 54$
   - $29 > -2y$
   - $3.1y \leq -12.4$
   - $-1.6y < -10$

7. Solve each inequality.
   - $\frac{x}{3} > 30$
   - $\frac{x}{-4} \geq -9$
   - $2 \geq \frac{x}{1.2}$
   - $-\frac{1}{3}x < 5$

8. Look at the following operations. For each one, does the inequality symbol need to be reversed when the operation is performed on both sides of an inequality? Why or why not?
   - Subtract 5.
   - Multiply by 6.
   - Add $-15$.
   - Divide by $-3$.
   - Multiply by $-1.7$.
   - Divide by $0.3$.

9. Verify whether the specific solution is correct for each inequality.
   - $x - 2.5 \leq 10; x = 12$
   - $3x \geq 21; x = 8$
   - $-4x < 20; x = -3$
   - $-\frac{1}{3}x \leq 3; x = -20$

10. Verify whether the specific solution satisfies each inequality.
   - $y - 10.2 \geq 18; y = 30$
   - $-6y \leq 36; y = -7$
   - $\frac{-2}{3}y \geq 10; y = 10$
   - $\frac{1}{2}y < 13; y = -2$

11. Show whether $x < 4$ is the solution for each inequality.
   - $3x > 12$
   - $10 + x > 14$
   - $1 > \frac{x}{4}$
   - $-x > -4$

12. Verify that the solution shown on each number line is correct.
   - $x + 10 > 14$
   - $-3.2 < \frac{x}{3}$

13. Verify each solution represented graphically.
   - $-10 \geq x - 1$
   - $-5x \geq -62$
Math 9: 9.2 Solving Single-Step Inequalities

For help with #14 and #15, refer to Example 3 on page 355.

14. The Super Fencing Company builds cedar fences for homes at a cost of $85 per section of fence, including tax. How many sections of fence could you buy if you could spend no more than $1400? 
   a) Model the problem using an inequality. 
   b) Solve the inequality. 
   c) Is the boundary point a reasonable solution for the number of fence sections? Explain. 

15. Megan is competing in a series of mountain bike races this season. She gets 6 points for each race she wins. If she gets more than 50 points in total, she will move up to the next racing category. How many races wins this season will allow her to move up to the next category? 
   a) Use an inequality to represent the problem. 
   b) Determine the solution and use it to solve the problem. 
   c) Is the boundary point a reasonable solution for the number of race wins? Explain. 

16. For each of the following inequalities, state three values that are specific solutions and three values that are non-solutions. 
   a) $-5 + x < -10$ 
   b) $-3x < 24$ 

17. Colin’s teacher asked him to solve the inequality $-5x \geq -15$. His solution was $x \leq 3$. He explained that he reversed the inequality symbol because of the negative number. Write a more accurate explanation. 

18. A local sports complex offers the following options for sharpening skates. 

   **Skate Sharpening Rates**
   
   **Standard Rate:** $5.75 per pair of skates 
   **Special:** $49 per month for unlimited sharpening 

   a) Estimate at what point the special would be the better option. Show the process you used. Why do you think your method provides a reasonable estimate? 
   b) Model and solve the problem using an inequality. Compare the answer to your estimate. 

19. The owner of a craft store donates 3% of her profits to a local charity every month. If she wants to donate at least $250 this month, how much profit will the business need to earn? 
   a) Model and solve the problem using an inequality. 
   b) Verify your solution. Show your work. 

20. Andrew’s family is driving from Winnipeg to Saskatoon. Before leaving, they fill the gas tank with 57 L of fuel. The car uses fuel at an average rate of 8.4 L/100 km for highway driving. How many kilometres can they drive on this amount of fuel? What assumptions did you make? 

21. Natalie is entering the 3200-m event at an upcoming meet. Each lap of the track is 400 m. Her goal is to beat the current record of 9 min 23 s. How fast must she run each lap, on average, to beat the record? 
   a) Explain why the situation can be modelled using the inequality $8x < 563$. 
   b) Solve the problem and verify your solution. Show your work. 

22. Fiona has a rewards card that gives her a reward point for every $5 she spends. If she earns at least 120 points in a year, she gets a bonus. How much does she need to spend to get at least 120 points? 

23. Chris has a weekend business building doghouses. Each doghouse takes 4 h to build and is sold for $115. Chris wants to earn at least $1000 per month. He wants to work no more than 50 h on his business per month. 
   a) Write two inequalities to model the situation. 
   b) Solve each inequality. 
   c) What possible numbers of doghouses can he build each month and stay within his guidelines? 

24. Solve and check the inequality $-\frac{2}{3}x < \frac{1}{3}$. 

   a) Solve the inequality on a number line. 

25. If $-2x > 22$ and $-4x < 60$, determine the possible values of $x$ that satisfy both inequalities. Show your solution on a number line. 

26. A food company that is developing a new energy bar has not decided on the size of the bar. The recipe includes 9% protein and 13% fat. The company wants the bar to contain at least 6 g of protein and no more than 10 g of fat. Use two inequalities to determine the possible range of masses for the bar. 

27. Consider the inequality $ax \leq 5a$. 
   a) Solve the inequality if $a > 0$. 
   b) Solve the inequality if $a < 0$. 

28. Solve each combination of inequalities. 
   a) $-5 \leq x + 9$ and $x + 9 \leq 8$ 
   b) $-2 < 3x$ and $2x < 12$ 
   c) $-15 \leq -6x$ and $-6x < 9$ 

---

Math Link

Some amusement parks offer single-ride tickets, where you pay each time you ride, and all-day passes, where you pay once for unlimited rides. The prices for both types of tickets need to be high enough for the amusement park to earn a profit but low enough that people decide to come. 

Search various media, such as newspapers, magazines, and the Internet. Look for information about ticket prices at amusement parks. 

a) Choose a price for single-ride tickets and a price for all-day passes. Explain why your choices are reasonable. 

b) Use an inequality to determine the number of rides that make one option a better deal than the other. 

c) Your friends plan on going on seven rides in your amusement park. Which is the better option for them? Show your work.
Math 9: 9.3 Solving Multi-Step Inequalities

Check Your Understanding

Communicate the Ideas

1. Describe the similarities and differences between the process for solving a multi-step linear equation and a multi-step linear inequality. Discuss your answer with a classmate.

2. Consider the inequality $3x + 10 > 5x + 22$. Lindsay started to solve the inequality by subtracting $3x$ from both sides. Victoria told her to start by subtracting $3x$ from both sides.
   a) Use Lindsay’s approach to solve the inequality.
   b) Use Victoria’s approach to solve the inequality.
   c) Are the solutions the same? Explain.
   d) Explain why you think Victoria gave her advice. Is her reasoning helpful in solving the inequality? Explain.
   e) Which method of solving the inequality do you prefer? Explain why.

Practise

For help with #3 to #7, refer to Example 1 on pages 361–363.

3. Solve each inequality and verify the solution.
   a) $5x - 19 < 36$
   b) $27 + 2x > -13$
   c) $3 \leq \frac{x}{5} - 7$

4. Determine the solution of each inequality.
   a) $-5y + 92 \geq 40$
   b) $2.2 > 10.6 + 4y$
   c) $\frac{y}{2} - 2 < 16$
   d) $\frac{3}{2}x^2 + 6 \leq 10\frac{4}{5}$

5. a) Verify that $x \geq 8$ is the correct solution to the inequality $3x + 11 \geq 35$.
    b) Verify that $x < -3$ is the correct solution to the inequality $24 - 5x > 39$.

6. Solve each inequality and verify the solution.
   a) $7x < 2x + 30$
   b) $10x - 22 \geq 8x$
   c) $-12x + 10 > 19 - 4x$
   d) $\frac{1}{2}(x + 5) > 22$

7. Determine each solution.
   a) $-2y > 8y - 20$
   b) $9y - 17 \leq 8 + 6.5y$
   c) $3.4 - 1.3y < 0.5y - 2.2$
   d) $\frac{3}{4}y - 1 \geq -\frac{1}{1(1 - 2y)}$

For help with #8 and #9, refer to Example 2 on pages 363–364.

8. For each situation
   a) Choose a variable and explain what it represents
   b) Write an inequality
   c) Solve the inequality and interpret the solution.
   
   9. John is considering two paper delivery jobs. The Advance will pay $10 plus $0.05 for each paper delivered daily, and the Times will pay $15 plus $0.04 for each paper delivered daily. How many papers delivered each day would make the Advance the better offer?
   a) Write an inequality to model the problem.
   b) Solve the inequality and interpret the solution.

Apply

10. Kim is comparing the rates at two car rental companies for a one-day rental. She wants to determine how many kilometres she would need to drive for ABC Rentals to be the better rental option.

   a) Estimate the number of kilometres that would make ABC Rentals the better option.
   b) Represent the situation using an inequality.
   c) Solve the inequality and interpret the solution.
   d) Compare the solution with your estimate.

11. Kevin is comparing job offers at two stores. Dollar Deal offers $8/h plus 10% commission. Great Discounts offers $18/h with no commission. What do Kevin’s weekly sales need to be in order for Dollar Deal to pay more? Assume that he works an 8-h day five days per week.

12. The student council is considering two different companies to print the school’s yearbooks. Great Graphics charges $2.50 plus $12.25 per book. Print Express charges $900 plus $9.50 per book. How many orders for yearbooks would make Print Express the better option?

13. Greenway Golf Course offers two plans for paying for buckets of balls at the driving range. How many buckets of balls used per month make the members’ plan the better deal?

Greenway Golf Course Rates

<table>
<thead>
<tr>
<th>Plan</th>
<th>Original Price</th>
<th>New Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Plan</td>
<td>$6 per bucket</td>
<td>$1.50 per bucket</td>
</tr>
<tr>
<td>Member’s Plan</td>
<td>$900 plus $1.50 per bucket</td>
<td></td>
</tr>
</tbody>
</table>

14. Molly has a business making candles. Her business costs are $200 plus $0.70 per candle made. She charges her customers $3.50 for each candle. If she sells all of the candles she makes, how many candles sold would allow her to make a profit?
Math 9: 9.3 Solving Multi-Step Inequalities

15. Two full water storage tanks are being drained for maintenance. The first tank holds 800 L of water and drains at a rate of 18 L/min. The second tank holds 500 L of water and drains at a rate of 7 L/min. Use an inequality to determine when the first tank will contain less water than the second tank.

16. Rob and Ashley are riding their bicycles uphill. Currently, Rob is 5.7 km from the top and climbing at 0.24 km/min. Ashley is 4.5 km from the top and riding at 0.17 km/min.
   a) Estimate when Rob will be closer to the top than Ashley.
   b) Use an inequality to determine when Rob will be closer to the top than Ashley.

   Extend

17. Solve $\frac{2}{3}(2x - 5) < \frac{1}{2}(x + 2)$.
   Show the solution on a number line.

18. If $2x + 5 > 10$ and $5x - 4 < 20$, determine the possible values of $x$. Show your solution on a number line.

19. Lauren charges $12 to cut lawns for neighbours. It takes her 25 min to cut each lawn and 40 min per month to maintain her lawn mower. She wants to earn $400 each month without working more than 16 h cutting lawns. How many lawns can Lauren cut in a month and stay within her guidelines? Use two inequalities to determine the range for the number of lawns that she can cut.

20. Ella’s teacher asked which is greater, $x$ or $-x$? Ella said that $x$ is always greater than $-x$.
   a) Write an inequality to represent Ella’s response and solve it. When, if ever, is Ella correct?
   b) Ella’s teacher explained that her response is correct for some values of $x$ only. For what values of $x$ is Ella incorrect? Give one specific solution where Ella is correct and one where she is incorrect.

21. Solve $-13 \leq 5 - 2x$ and $5 - 2x \leq 9$.

22. Given that $b < 0$, solve the inequality $3 > bx + 3$.

---

Math Link

An amusement park manager needs to ensure that the park is profitable. For the park to make a profit, the total revenue needs to be more than the total expenses.

There are fixed expenses and revenues that remain the same. There are also variable expenses and revenues that depend on the number of visitors.

The manager estimates operating expenses and revenues for the park per visitor. These are shown in the table. Assuming the park offers ten rides, fill in the missing information.

a) What is the total of the variable expenses per visitor? What are the total fixed costs? Write an expression to represent the total expenses.

b) What is the total of the variable revenues per visitor? What are the total fixed revenues? Write an expression to represent the total revenues.

c) Develop and solve an inequality to determine the number of visitors needed per day to make a profit. Justify your solution mathematically.

<table>
<thead>
<tr>
<th>Daily Expenses</th>
<th>$13</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total variable operating costs per visitor</td>
<td>$13</td>
</tr>
<tr>
<td>Total fixed costs ($5000 + $1200 per ride)</td>
<td>$13</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Daily Revenues</th>
<th>$38</th>
</tr>
</thead>
<tbody>
<tr>
<td>Admission (includes ride pass) per visitor</td>
<td>$38</td>
</tr>
<tr>
<td>Food per visitor</td>
<td>$25</td>
</tr>
<tr>
<td>Souvenirs per visitor</td>
<td>$10</td>
</tr>
<tr>
<td>Parking per visitor</td>
<td>$10</td>
</tr>
<tr>
<td>Total variable revenues per visitor</td>
<td>$38</td>
</tr>
<tr>
<td>Fixed revenue from sponsorship</td>
<td>$2500</td>
</tr>
</tbody>
</table>

---
10. The graph shows the relationship between air pressure, in kilopascals, and altitude, in metres.

\[ \text{Air Pressure (kPa)} = 90 + 150 \times \text{Altitude (m)} \]

a) What is the approximate air pressure at an altitude of 1500 m? 2400 m?

b) Approximately at what altitude is the air pressure 90 kPa? 60 kPa?

c) Does it make sense to interpolate or extrapolate values on this graph? Explain.

11. There are 15 schools in an urban school district. The table shows data about the student and teacher populations for eight of the schools.

<table>
<thead>
<tr>
<th>Students</th>
<th>Teachers</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>9</td>
</tr>
<tr>
<td>250</td>
<td>15</td>
</tr>
<tr>
<td>300</td>
<td>17</td>
</tr>
<tr>
<td>450</td>
<td>23</td>
</tr>
<tr>
<td>700</td>
<td>33</td>
</tr>
<tr>
<td>150</td>
<td>11</td>
</tr>
<tr>
<td>1025</td>
<td>46</td>
</tr>
<tr>
<td>650</td>
<td>31</td>
</tr>
</tbody>
</table>

a) Graph the relationship between the number of students and teachers.

b) How many teachers might be in a school that has 830 students? 1200 students?

c) How many students might attend a school that employs 30 teachers? 50 teachers?

d) How much money will Derek have in his account after 35 weeks?

e) How long will it take him to save $500?

7. Derek has $36 in his bank account. He plans to deposit $15 every week for a year.

a) Create a table of values for his first five deposits.

b) What equation models this situation?

c) How much money will Derek have in his account after 3.5 weeks?

d) How long will it take him to save $500?

6.1 Representing Patterns, pages 210–219

6. a) Make a table of values for the toothpick pattern.

<table>
<thead>
<tr>
<th>Number of Toothpicks</th>
<th>Number of Layers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>

b) Describe the pattern.

c) Develop an equation relating the number of toothpicks to the number of layers.

d) How many toothpicks are in Figure 10? Verify your answer.

e) How do the numerical values in the equation represent the pattern?

6.2 Interpreting Graphs, pages 220–230

9. Many tree planters are paid according to how many trees they plant. The following graph shows the daily wages earned at a rate of $0.09 per tree planted.

a) Graph the linear relation for the first five days.

b) In order to earn $420 in one day, approximately how many trees would a planter need to plant?

c) How much money will Taylor make in a day if she sells 12 pairs of shoes? Use two methods for solving the problem.

d) How much money will Taylor make in a day if she sells 12 pairs of shoes?

e) Many tree planters are paid according to how many trees they plant. The following graph shows the daily wages earned at a rate of $0.09 per tree planted.

10. The graph shows the relationship between air pressure, in kilopascals, and altitude, in metres.

\[ \text{Air Pressure (kPa)} = 90 + 150 \times \text{Altitude (m)} \]

a) What is the approximate air pressure at an altitude of 1500 m? 2400 m?

b) Approximately at what altitude is the air pressure 90 kPa? 60 kPa?

c) Does it make sense to interpolate or extrapolate values on this graph? Explain.

11. There are 15 schools in an urban school district. The table shows data about the student and teacher populations for eight of the schools.

<table>
<thead>
<tr>
<th>Students</th>
<th>Teachers</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>9</td>
</tr>
<tr>
<td>250</td>
<td>15</td>
</tr>
<tr>
<td>300</td>
<td>17</td>
</tr>
<tr>
<td>450</td>
<td>23</td>
</tr>
<tr>
<td>700</td>
<td>33</td>
</tr>
<tr>
<td>150</td>
<td>11</td>
</tr>
<tr>
<td>1025</td>
<td>46</td>
</tr>
<tr>
<td>650</td>
<td>31</td>
</tr>
</tbody>
</table>

a) Graph the relationship between the number of students and teachers.

b) How many teachers might be in a school that has 830 students? 1200 students?

c) How many students might attend a school that employs 30 teachers? 50 teachers?

d) How much money will Derek have in his account after 35 weeks?

e) How long will it take him to save $500?

7. Derek has $36 in his bank account. He plans to deposit $15 every week for a year.

a) Create a table of values for his first five deposits.

b) What equation models this situation?

c) How much money will Derek have in his account after 3.5 weeks?

d) How long will it take him to save $500?

6.1 Representing Patterns, pages 210–219

6. a) Make a table of values for the toothpick pattern.

<table>
<thead>
<tr>
<th>Number of Toothpicks</th>
<th>Number of Layers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>

b) Describe the pattern.

c) Develop an equation relating the number of toothpicks to the number of layers.

d) How many toothpicks are in Figure 10? Verify your answer.

e) How do the numerical values in the equation represent the pattern?

6.2 Interpreting Graphs, pages 220–230

9. Many tree planters are paid according to how many trees they plant. The following graph shows the daily wages earned at a rate of $0.09 per tree planted.

a) Graph the linear relation for the first five days.

b) In order to earn $420 in one day, approximately how many trees would a planter need to plant?

c) How much money will Taylor make in a day if she sells 12 pairs of shoes? Use two methods for solving the problem.

d) How much money will Taylor make in a day if she sells 12 pairs of shoes?

e) Many tree planters are paid according to how many trees they plant. The following graph shows the daily wages earned at a rate of $0.09 per tree planted.

10. The graph shows the relationship between air pressure, in kilopascals, and altitude, in metres.

\[ \text{Air Pressure (kPa)} = 90 + 150 \times \text{Altitude (m)} \]

a) What is the approximate air pressure at an altitude of 1500 m? 2400 m?

b) Approximately at what altitude is the air pressure 90 kPa? 60 kPa?

c) Does it make sense to interpolate or extrapolate values on this graph? Explain.

11. There are 15 schools in an urban school district. The table shows data about the student and teacher populations for eight of the schools.

<table>
<thead>
<tr>
<th>Students</th>
<th>Teachers</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>9</td>
</tr>
<tr>
<td>250</td>
<td>15</td>
</tr>
<tr>
<td>300</td>
<td>17</td>
</tr>
<tr>
<td>450</td>
<td>23</td>
</tr>
<tr>
<td>700</td>
<td>33</td>
</tr>
<tr>
<td>150</td>
<td>11</td>
</tr>
<tr>
<td>1025</td>
<td>46</td>
</tr>
<tr>
<td>650</td>
<td>31</td>
</tr>
</tbody>
</table>

a) Graph the relationship between the number of students and teachers.

b) How many teachers might be in a school that has 830 students? 1200 students?

c) How many students might attend a school that employs 30 teachers? 50 teachers?

d) How much money will Derek have in his account after 35 weeks?

e) How long will it take him to save $500?
Chapter 6 Practice Test

For #1 to #3, select the best answer.
Use the pattern below to answer #1 and #2.

1. Which table of values best represents the pattern?
   - A) Figure Number (f) 1 2 3 4
     Number of Sides (s) 18 36 54 72
   - B) Figure Number (f) 1 2 3 4
     Number of Sides (s) 18 28 38 48
   - C) Figure Number (f) 1 2 3 4
     Number of Sides (s) 12 20 28 36
   - D) Figure Number (f) 1 2 3 4
     Number of Sides (s) 12 24 36 48

2. Which equation represents the pattern?
   - A) \( s = 12f \)
   - B) \( s = 8f + 4 \)
   - C) \( s = 10f + 8 \)
   - D) \( s = 18f \)

3. Which equation represents this graph?

   \[ y = 2x + 4 \]

   \[ y = 4x - 1 \]

   \[ y = 3x + 3 \]

   \[ y = x + 5 \]

4. When \( x = 1.5 \) on the graph, the approximate \( y \)-coordinate is

5. When \( y = -8 \) on the graph, the approximate \( x \)-coordinate is

6. A number pattern starts with the number \(-2\). Each number is 4 less than the previous number.
   a) Make a table of values for the first five numbers in the pattern.
   b) What equation can be used to determine each number in the pattern? Verify your answer.
   c) What is the value of the 11th number in the pattern?

7. A cheese party pizza costs $21.25. The graph shows the cost of adding additional toppings.

<table>
<thead>
<tr>
<th>Cost of Pizza</th>
<th>Number of Toppings</th>
</tr>
</thead>
<tbody>
<tr>
<td>21.25</td>
<td>1</td>
</tr>
<tr>
<td>22.75</td>
<td>2</td>
</tr>
<tr>
<td>24.25</td>
<td>3</td>
</tr>
<tr>
<td>25.75</td>
<td>4</td>
</tr>
<tr>
<td>27.25</td>
<td>5</td>
</tr>
</tbody>
</table>

   a) What is the approximate cost of a party pizza with five toppings?
   b) Is it reasonable to interpolate values on this graph? Explain.

8. Create a table of values and a graph for each equation.
   a) \( y = -2x + 6 \)
   b) \( y = 2x - 6 \)
   c) \( y = 6 \)

9. How are the graphs in #8 similar? How are they different?

Extended Response

10. A cross-country ski park contains five different trails. The diagram shows the trails, with each trail being successively larger.

   - Trail 1
   - Trail 2
   - Trail 3
   - Trail 4
   - Trail 5

   Each side length of the shortest trail is 2 km. The side length of each consecutive trail is 0.5 km longer than the previous one.

   a) Construct a table of values to show the relationship between the trail number and the total distance of each trail.
   b) What equation represents the relationship?
   c) Graph the linear relation.
   d) If a sixth trail were added, what would be its total distance?

Math Link: Wrap It Up!

You are planning a canoe trip with some friends. Where are you going? How long will your trip be? How many people are going?

You are in charge of ordering food supplies to meet the energy requirements of your group. For the trip, the amount of food energy required by a canoeist can be modelled by the equation \( a = \frac{c}{100} - 17 \), where \( a \) represents the person’s age and \( c \) represents the number of calories.

Use the Internet, travel brochures, or other sources to find information about your trip.

a) Write a paragraph describing your trip.
b) Create a table of values for your data about total food energy requirements for the group.
c) Graph the linear relation.
d) Develop a problem based on your graph that also includes interpolation and extrapolation and provide a solution. Show your work.
Math 9 - Unit 5 ( Chapters 6 & 9) Review

Chapter 9 Review

Key Words
For #1 to #6, write the term from the list that completes each statement.

algebraically
boundary point
closed circle
graphically
inequality
open circle
solution

1. A mathematical statement comparing expressions that may not be equivalent is called a(n)
   inequality.
2. Inequalities can be represented on a number line or using symbols.
3. On a number line, a(n) indicates that the boundary point is not a possible solution.
4. For the inequality \( x > 5 \), the value of 7 is a specific
   solution.
5. On a number line, the value that separates solutions from non-solutions is called the
   inequality represented on each number line.
6. On a number line, a(n) indicates that the boundary point is a possible solution.

9.1 Representing Inequalities, pages 340–349

7. An Internet business is preparing a flyer to advertise a sale. Express each statement as an
   inequality.
   a) Savings of up to 40%!
   b) Free shipping for purchases of $500 or more!
   c) Over 80 major items on sale!
8. Road racers use bicycles that are designed to go as fast as possible. Cycling organizations
   place restrictions on bicycle design to ensure fairness and rider safety. Express each
   restriction as an inequality.
   a) The minimum allowable road racing bicycle mass is 6.8 kg.
   b) A road racing bicycle can be no more than 185 cm in length.
9. Verbally and algebraically express the inequality represented on each number line.
   a) \( x < -5 \)
   b) \( x \leq 10 \)
10. Sketch a number line to represent each inequality.
    a) \( u < -4 \)
    b) \( v \geq 4 \)

9.2 Solving Single-Step Inequalities, pages 350–359

12. Solve each inequality.
    a) \( d - 7 > -10 \)
    b) \( 2.7 < a - 2.7 \)
    c) \( -11 \geq b \)
    d) \( -\frac{1}{3}c > 3.2 \)

13. Verify that the solution shown on each number line is correct. If a number line is
    incorrect, explain why.
    a) \( -5x \geq -40 \)
    b) \( -10 > 4x \)

14. Tim earns $14.50/h working for his parents' business during the summer. His goal is to earn at least $600 each week. How many hours will Tim need to work each week to
   achieve his goal?
   a) Write an inequality to model the problem.
   b) Solve the inequality and interpret the solution.
15. Danielle is treating her friends to ice cream. Each scoop of ice cream costs $2.25. She wants to spend less than $30. How many scoops of ice cream can she buy and stay within her limit?
   a) Verify whether the number line shows the correct solution for \( 5x + 4 \leq 6x - 1 \).
   b) Describe a second method to verify the solution.
16. Solve each inequality and verify the solution.
    a) \( b \leq \frac{5}{3} \)
    b) \( 9x + 30 > 13x \)
    c) \( 3x \leq 8x + 5 \)
    d) \( 5x + 8 < 4x - 12 \)
    e) \( 17 - 3x \leq 7x + 3 \)
    f) \( 2(3x + 4) > 5(6x + 7) \)

17. a) Verify whether \( x \geq 5 \) is the correct solution for \( 5x + 4 \leq 6x - 1 \).
    b) Describe a second method to verify the solution.
18. A student committee is planning a sports banquet. The cost of the dinner is $450 plus
    $24 per person. The committee needs to keep the total costs for the dinner under $2000. How many people can attend the banquet?
19. Greg is considering two different plans for music downloads. How many tracks purchased would make plan A the better option?
   Plan A
   $0.97 per track purchased plus $10.00/month unlimited PC streaming plus $15.00/month for downloading songs to an MP3 player
   Plan B
   $0.99 per track purchased plus $9.00/month unlimited PC streaming plus $144.00/year for downloading songs to an MP3 player
15. Dylan is organizing a curling tournament. The sports complex charges $115/h for the ice rental. Dylan has booked it for 6 h. He will charge each of the 14 teams in the tournament an entrance fee. How much must he charge each team in order to make a profit?

**Extended Response**

13. Consider the inequality $6x - 4 > 9x + 20$.
   a) Solve the inequality algebraically.
   b) Represent the solution graphically.
   c) Give one value that is a specific solution and one that is a non-solution.
   d) To solve the inequality, Min first subtracted 9x from both sides. Alan first subtracted 6x from both sides. Which method do you prefer? Explain why.

14. The Lightning Soccer Club plans to buy shirts for team members and supporters. Pro-V Graphics charges a $75 set-up fee plus $7 per shirt. BT Designs has no set-up fee but charges $10.50 per shirt. How many shirts does the team need to order for Pro-V Graphics to be the better option?

**Short Answer**

8. Represent each inequality on a number line.
   a) $-3 < x$
   b) $x \leq 6.8$

9. Verify whether $x > -3$ is the correct solution to the inequality $8 - 5x < 23$. Show your thinking. If the solution is incorrect, explain why.

10. Christine is researching a career as an airline pilot. One airline includes the following criteria for pilots. Express each of the criteria algebraically as an inequality.
   a) Pilots must be shorter than 185 cm.
   b) Pilots must be at least 21 years old.

11. Solve and graph each inequality.
   a) $-6 + x \geq 10$
   b) $2.4x - 11 > 4.6$
   c) $12 - 8x < 17 - 6x$

12. Represent each situation algebraically as an inequality.
   a) Luke earns $4.75 per item sold and must earn over $30.
   b) It takes Nicole 3 h to sew beads on a pair of mitts. She has no more than 40 h of time to sew beads on all the mitts she plans to give to her relatives as presents.

13. Consider the following algebraic expressions. Choose the best answer.

   a) Which expression is equivalent to $2x - 4$?
      A $3x - 5$
      B $2x + 1$
      C $x - 4$
      D $x - 1$

   b) Which expression represents $3(x - 2)$?
      A $3x - 5$
      B $3x - 4$
      C $3x - 6$
      D $6x - 4$

14. The number line representing the inequality $x < 5$ would have a(n) circle at 5 and an arrow pointing to the
   A left
   B right
   C up
   D down

15. The solution to $-4x < 16$ is
   A $x > 4$
   B $x > -4$
   C $x < 4$
   D $x < -4$