Answers
Chapter 1 Measurement Systems

1.1 SI Measurement

1. **a)** Example: The perimeter is estimated to be 10 cm or 100 mm. The circumference is estimated to be 12 cm or 120 mm.
   b) The perimeter is 12 cm or 120 mm. Using 3.14 as the value of pi, the circumference is 12.56 cm or 125.6 mm.
   c) Example: width of a fingernail
2. **a)** 5.2 cm; 52 mm
   b) 1.84 cm; 18.4 mm
3. **a)** No. Kilometres are the appropriate units to measure long distances. 1850.75 km
   b) No. Millimetres are more appropriate units to measure a short length. 42 mm
   c) Yes. Centimetres are commonly used to measure the circumference of a bicycle tire.
4. **a)** 31.9 km
   b) Example: length of 12 city blocks
5. Stefan runs twice the length, l, of the track plus a distance equal to the circumference of a circle having a diameter of 50 m.

   Let x represent the distance that Stefan runs.

   $x = 2l + \pi d$
   $x = 2(150 \text{ m}) + 3.14(50 \text{ m})$
   $x = 457 \text{ m}$

   Stefan runs a distance of 457 m.

   Vishaal runs twice the length of the track plus a distance equal to the circumference of a circle having a diameter of 50 m plus 20 dm.

   Convert 20 dm to metres.

   20 dm = 2 m

   The diameter of the circle is 50 m + 2 m, or 52 m.

   Let y represent the distance that Vishaal runs.

   $y = 2l + \pi d$
   $y = 2(150 \text{ m}) + 3.14(52 \text{ m})$
   $y = 463.28 \text{ m}$

   Vishaal runs a distance of 463.28 m, a distance that is 6.28 m farther than Stefan runs.
6. **a)** 0.4 mm
   b) Example: Millimetres are appropriate units to measure short lengths such as the length of a flea.
7. **a)** The scale rate is $\frac{1.5 \text{ cm}}{15 \text{ km}}$, which is equivalent to $\frac{1.5 \text{ cm}}{1\,500\,000 \text{ cm}}$. This simplifies to the ratio $\frac{1}{1\,000\,000}$.
   b) Example: The park is estimated to be 90 km in length by 50 km in width.
   c) On the map, the length of the park is approximately 8.9 cm and the width of the park is approximately 5.4 cm.
   Let x represent the length of the park.

   Set up a proportion:

   $$\frac{8.9 \text{ cm}}{x \text{ km}} = \frac{1.5 \text{ cm}}{15 \text{ km}}$$
   $$x = 89 \text{ km}$$

   The length of the park is 89 km.

   Let y represent the width of the park.

   Set up a proportion:

   $$\frac{5.4 \text{ cm}}{x \text{ km}} = \frac{1.5 \text{ cm}}{15 \text{ km}}$$
   $$x = 54 \text{ km}$$

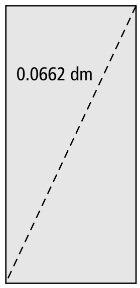
   The width of the park is 54 km.

   d) The map's distance from Waskesiu to the South Gate is approximately 4.1 cm. Let z represent the distance.

   Set up a proportion:

   $$\frac{4.1 \text{ cm}}{z \text{ km}} = \frac{1.5 \text{ cm}}{15 \text{ km}}$$
   $$z = 41 \text{ km}$$

   The distance from Waskesiu to the South Gate is approximately 41 km or 41 000 m.

8. 

Let x represent the scale factor. So, $7x$ represents the width of the newspaper page and $15x$ represents its length.

Convert 0.0662 dam to centimetres.

1 dam = 1000 cm

$\left(\frac{1000 \text{ cm}}{1 \text{ dam}}\right)(0.0662 \text{ dam}) = 66.2 \text{ cm}$

The length of the diagonal is 66.2 cm.

Use the Pythagorean theorem to solve for x:

$$(7x)^2 + (15x)^2 = (66.2)^2$$
$$49x^2 + 225x^2 = 4382.44$$
$$274x^2 = 4382.44$$
$$x^2 = 15.9943$$
$$x \approx 4$$

Therefore, the width is (4)(7) = 28 cm and the length is (4)(15) = 60 cm.

The dimensions of the newspaper page are 60 cm by 28 cm.

9. **a)** The largest area is obtained when a square-shaped field is formed. To obtain the largest square field, one field will be the smallest allowable area, which is 1 ha. This field will have dimensions of 100 m by 100 m. The larger square field shares a side with the 100 m by 100 m square field. So, 1600 m − 300 m or 1300 m of fencing are available to form the sides of the square. Therefore, the larger square field will be 325 m by 325 m.
   b) 115 625 m^2

10. **a)** polar radius: ≈ 1.25 cm; equatorial radius: ≈ 2.9 cm; oblateness of the ellipse: ≈ 0.57
   b) approximately 0.003 35
   c) The oblateness of a sphere is zero, which is close to the oblateness of Earth.

11. **a)** Example: Tukani first measures the length of the metre stick as it appears in the photograph. Then, he measures the height of the wall as it appears in the photograph using the first length as a referent. The number of these lengths that equal the height of the wall represent the wall's height, in metres.
   b) Examples may vary.
   c) Example: waist height of a person standing against the wall

1.2 Imperial Measurement

1. **a)** Estimate: 5 cm by 3 cm
   b) length: 2″; width: 1″
   c) Example: The width of a fingernail is a referent that can be used. Centimetres are an appropriate unit of length to measure the rectangle and the width of a fingernail is approximately 1 cm.

2. **a)** 15″
   b) 2716′
   c) 2.5 mi

3. **a)** $3\frac{3}{16}$″; Example: caterpillar
   b) 4.052″: Example: computer mouse

4. Examples may vary.

5. **a)** Let x represent the number of inches of snowfall. The value of x is 10 times the depth of the melted snow (i.e., the water).

$$x = \left(1\tfrac{1}{2}\right)(10)$$
$$x = \left(\tfrac{3}{2}\right)(10)$$
$$x = \frac{30}{2}$$
$$x = 15$$

15″ of snow fell in the 12-h period. To determine the snowfall per hour, divide 15″ by 12.

$$15'' \div 12 = \frac{15''}{12} = 1\tfrac{1}{4}''$$

The average snowfall per hour was $1\frac{1}{4}$″.

b) Multiply 36 in. by 10: (36 in.)(10) = 360 in. The amount of snow in an average season is 360 in. To find the average number of inches of snow falling each week, divide 360 by 24 (i.e., the number of weeks in six months):

$\frac{360 \text{ in.}}{24} = 15$ in.

The average snowfall per week is 15″.

6. a) The scale ratio is $\frac{1}{15}$.

b) The length of the scale drawing is 48″ and the width is 25.6″.

7. a) Convert 32 500 yd into miles.
1 mi = 1760 yd

Use unit analysis:

$(32\,500 \text{ yd})\left(\frac{1 \text{ mi}}{1760 \text{ yd}}\right) = 18.466 \text{ mi}$

Convert 78 000 yd into miles.

1 mi = 1760 yd

Use unit analysis:

$(78\,000 \text{ yd})\left(\frac{1 \text{ mi}}{1760 \text{ yd}}\right) = 44.318 \text{ mi}$

The total distance Josephine travelled is 18.466 mi + 44.318 mi, or 62.784 mi.

To find the distance that Marcus drove, use the Pythagorean theorem:

Let d equal the number of miles driven.

$d = \sqrt{18.466^2 + 44.318^2}$

$d = 48.011$

Therefore, Marcus drove 48.011 mi.

Let t_1 represent the time for Josephine to drive 62.784 mi. Time is equal to distance divided by rate of speed.

$t_1 = \frac{\text{distance}}{\text{speed}}$

$t_1 = \frac{62.784 \text{ mi}}{60 \text{ mph}}$

$t_1 = 1.0464$ h

Therefore, Josephine will reach the destination in 1.0464 h.

Let t_2 represent the time for Marcus to drive 48.011 mi. Time is equal to distance divided by rate of speed.

$t_2 = \frac{\text{distance}}{\text{speed}}$

$t_2 = \frac{48.011 \text{ mi}}{45 \text{ mph}}$

$t_2 = 1.0669$ h

Therefore, Marcus will reach the destination in 1.0669 h.

Josephine will arrive before Marcus.

b) To find how much sooner Josephine arrives, subtract: 1.0669 h − 1.0464 h = 0.0205 h. Josephine will arrive 0.0205 h or (0.0205)(60) = 1.23 min before Marcus. Rounding that value to the nearest minute, Josephine will arrive 1 min before Marcus.

8. Estimate examples: 60 000 s; 1000 min; 20 h. Calculated times: 63 360 s; 1056 min; 17 h 36 min

9. a) MN = 40 mm, PQ = 55 mm. The difference is 15 mm.

b) 11 pieces of MN and 8 pieces of PQ

10. a) Five 12′ boards laid end to end cover a length of 60′. Therefore, a deck with dimensions of 60′ by 10′ will consist of five sections of boards, with each section measuring 12′ by 10′. To determine how many rows of boards are needed per section, first convert the width of 10′ to inches: 10′(12 in. per ft) = 120 in. Since each board is 8 in. wide, the number of rows of boards to cover a width of 120 in. is: $\frac{120 \text{ in}}{8 \text{ in}} = 15$. Therefore, 15 boards are required in each of five sections, for a total of 75 boards to build the deck.

b) Since a space of $\frac{1}{4}$ in. must be left between rows of boards, one board in each section will need to be trimmed along its entire length in order to fit. With 15 boards, there are 14 spaces. The total width of these spaces is $(14)\left(\frac{1}{4} \text{ in}\right)$ or $3\frac{1}{2}$ in. For the last board to fit, the board will need to be trimmed by this amount.

The wastage will be $3\frac{1}{2}$ in. along the entire length of the deck. To determine the wastage in square inches, first convert 60′ to inches: 60′(12 in. per ft) = 720 in. Therefore, in square inches, the wastage is

$(720 \text{ in.})\left(3\frac{1}{2}\text{in.}\right) = 2520$ sq in.

11. a) 186.56 yd; 170.59 m
b) 1509.44 yd; 1380.23 m

12. a) 46 cubic yards
b) $10 752.50

13. a) 37.5 mi
b) 2.2 yd
c) 0.9375 mi
d) 3.75 chains
e) 1980 ft

1.3 Converting Between SI and Imperial Systems

Note: Because of rounding, some answers may vary.

1. a) Estimate: 2 in.
b) Estimate: $1\frac{1}{2}$in.

2. a) $2\frac{1}{4}$in.
b) $1\frac{5}{8}$in.

3. a) 64 mm
b) $2\frac{1}{2}''$
c) The conversion should be the same as the measurement. But, because of loss of accuracy in measuring, the two may not be exactly the same.

4. a) 107.95 mm **b)** 42.19 km
c) 94.0′ **d)** 414.5 cm

5. Units chosen for the conversion may differ.
a) 4.05 yd or 12.14′
b) 12.0 m
c) 826.77″ or 68.9′
d) 975.36 cm or 9.75 m
e) 42.98′ or 14.33 yd

6. a) The length of the swim is 1.5 km. To find the length of the run, multiply 1.5 km by $6\frac{2}{3}$.

Let l represent the length of the run in kilometres.

$= (1.5 \text{ km})\left(6\frac{2}{3}\right)$

$l = \left(\frac{3}{2}\text{ km}\right)\left(\frac{20}{3}\right)$

$l = 10$

The length of the run is 10 km.

To find the length of the bike ride, multiply 10 km by 4. The length of the ride is 40 km.

b) 1 mi = 1.609 km

Let x represent the number of miles in 1.5 km.

Set up a proportion:

$$\frac{x \text{ mi}}{1.5 \text{ km}} = \frac{1 \text{ mi}}{1.609 \text{ km}}$$
$$x = 0.9$$

The length of the swim is 0.9 mi.

Let y represent the number of miles in 10 km.

$$\frac{y \text{ mi}}{10 \text{ km}} = \frac{1 \text{ mi}}{1.609 \text{ km}}$$
$$y = 6.2$$

The length of the run is 6.2 mi.

Let z represent the number of miles in 40 km.

$$\frac{z \text{ mi}}{40 \text{ km}} = \frac{1 \text{ mi}}{1.609 \text{ km}}$$
$$z = 24.9$$

The length of the bike ride is 24.9 mi.

c) The total distance of the competition, in kilometres, is 1.5 km + 10 km + 40 km = 51.5 km. The total distance of the competition, in miles, is 0.9 mi + 6.2 mi + 24.9 mi = 32 mi

7. a) Peace River
b) approximately 4578 km
c) 3.9 times longer

8. a) Convert 2 yd to metres. Since 1 yd = 0.9144 m, 2 yd = 2(0.9144 m) or 1.8288 m.
Convert 1.75 yd to metres.

1 yd = 0.9144 m

Let x represent the number of metres in 1.75 yd.

Set up a proportion:

$$\frac{1 \text{ yd}}{0.9144 \text{ m}} = \frac{1.75 \text{ yd}}{x \text{ m}}$$
$$x = 1.6$$

Therefore, 1.75 yd = 1.6 m.

Convert 45 in. to centimetres.

1 in. = 2.54 cm

Let y represent the number of centimetres in 45 in.

Set up a proportion:

$$\frac{1 \text{ in.}}{2.54 \text{ cm}} = \frac{45 \text{ in.}}{y \text{ cm}}$$
$$y = 114.3 \text{ cm.}$$

Therefore, 45 in. = 114.3 cm.

Convert 60 in. to centimetres.

1 in. = 2.54 cm

Let z represent the number of centimetres in 60 in.

Set up a proportion:

$$\frac{1 \text{ in.}}{2.54 \text{ cm}} = \frac{60 \text{ in.}}{z \text{ cm}}$$
$$z = 152.4$$

Therefore, 60 in. = 152.4 cm.

b) Using the width of 114.3 cm, find the area of fabric in square metres by first converting 114.3 cm to 1.143 m.
Let A_1 represent the area of the fabric in square metres.

$A_1 = l \times w$

$A_1 = (1.143 \text{ m})(1.829 \text{ m})$

$A_1 = 2.09 \text{ m}^2$

So, the amount of fabric Molly will buy if she chooses the first width is 2.09 m^2.

Using the width of 152.4 cm, find the area of fabric in square metres by first converting 152.4 cm to 1.524 m.

Let A_2 represent the area of the fabric in square metres.

$A_2 = l \times w$

$A_2 = (1.524 \text{ m})(1.6 \text{ m})$

$A_2 = 2.44 \text{ m}^2$

The two areas are not equal. More material is needed if using the wider fabric. Therefore, Molly should choose the material with the narrower width to have a lesser amount left over.

9. a) 12 000
b) 34 km, assuming the torch was carried the same distance each of the 106 days from October 30 until February 12

10. Convert 25 mi to kilometres.
1 mi = 1.609 km
Let x represent the number of kilometres in 25 mi.

Set up a proportion:

$$\frac{1 \text{ mi}}{1.609 \text{ km}} = \frac{25 \text{ mi}}{x \text{ km}}$$
$$x = 40$$

There are 40 km in 25 mi. Therefore, Savario has travelled (240 km − 40 km) or 200 km in 2.5 h (4:30 p.m. to 7:00 p.m.).

Let s represent Savario's rate of speed. Speed is distance divided by time.

$$s = \frac{\text{distance}}{\text{time}}$$
$$s = \frac{200 \text{ km}}{2.5 \text{ h}}$$
$$s = 80 \text{ km/h}$$

Savario's speed is 80 km/h.

Let t represent the time to travel the remaining 40 km. Time is distance divided by rate of speed.

$$t = \frac{\text{distance}}{\text{speed}}$$
$$t = \frac{40 \text{ km}}{80 \text{ km/h}}$$
$$t = 0.5 \text{ h}$$

Therefore, Savario will arrive in Brandon at 7:30 pm.

11. a) No. A maximum speed limit of 80 km/h is approximately 50 mph.
b) approximately 68 mph
c) approximately 28 min
d) Example: One mile is approximately 1.6 km. Multiplying 53 mi by 1.5 is about 80 km, which means that multiplying 53 by 1.6 is more than 80 km. Therefore, the cousins are driving over the posted maximum speed limit of 80 km/h.

12. a) 1105.92 mm^2 or ≈ 1.7142 sq in.
b) 0.057 6 mm^2 or 0.000 089 28 sq in.

13. a) Let H_g represent your predicted adult height if you are a girl. To find your height in inches, first convert the height of each parent into inches:
father's height: 6 ft = 6(12 in.) = 72 in.

mother's height: 5ft 5in. = 5(12 in.) + 5 in. = 65 in.

Use these values in the appropriate formula.

$$H_g = \frac{(\text{father's height} - 5'' + \text{mother's height})}{2}$$

$$H_g = \frac{(72'' - 5'' + 65'')}{2}$$

$$H_g = 66''$$

Therefore, your predicted adult height is 66 inches or 5 ft 6 in.

If you are a boy, let H_b represent your predicted adult height. To find your height in inches, use the same values calculated above for your parents' heights and use the formula for boys:

$$H_b = \frac{(\text{father's height} + 5'' + \text{mother's height})}{2}$$

$$H_b = \frac{(72'' + 5'' + 65'')}{2}$$

$$H_b = 71''$$

Therefore, your predicted adult height is 71 in. or 5 ft 11 in.

b) In SI units, change the 5 in. in the formula to 12.7 cm. Use the father's and mother's heights in centimetres.

14. Example: 5 yd: $5 \text{ yd}\left(\frac{3 \text{ ft}}{1 \text{ yd}}\right) = 15 \text{ ft}$;

$$15 \text{ ft}\left(\frac{30.48 \text{ cm}}{1 \text{ ft}}\right) = 457.2 \text{ cm}$$

Chapter 1 Review

1.1 SI Measurement

1. a) Predictions may vary.
b) Using a can with a diameter of 6 cm, the circumference is 18.84 cm. So, the number of rotations to cover 2 m or 200 cm would be 200 ÷ 18.81 or 10.6 rotations.
c) Answers may vary.

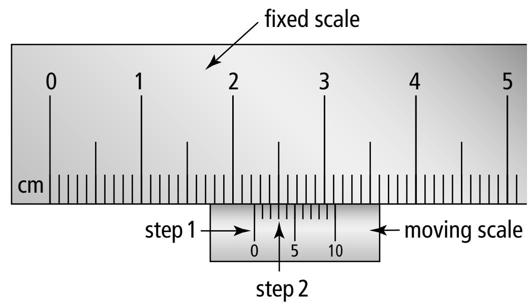
2. 5.4 cm

3. Example: Follow these steps to read a caliper:

Step 1. Read the value on the fixed scale that is located exactly at or just to the left of the zero on the moving scale.

Step 2. Identify the next line on the moving scale that aligns with a line on the fixed scale. Read the value on the moving scale.

Sample diagram:



The reading for the SI caliper in this example is 2.23 cm. (2.2 + 0.03 = 2.23)

4. 1 h is equal to (60 min/h)(60 s/min) = 3600 s.

Let x represent Montgomery's speed in metres per hour.

Set up a proportion:

$$\frac{100 \text{ m}}{9.78 \text{ s}} = \frac{x \text{ m}}{3600 \text{ s}}$$

$$x = 36\,809.8$$

Montgomery's speed is 36 809.8 m/h.

Change 36 809.8 m to kilometres.

Let y represent the number of kilometres.

Set up a proportion:

$$\frac{1000 \text{ m}}{1 \text{ km}} = \frac{36\,809.8 \text{ m}}{y \text{ km}}$$

$$y = 36.8$$

The runner's speed is 36.8 km/h.

5. Convert 6 318 138.7 m to kilometres.

Let x represent the radius of Earth, in kilometres.

Set up a proportion:

$$\frac{1000 \text{ m}}{1 \text{ km}} = \frac{6\,318\,138.7 \text{ m}}{x \text{ km}}$$

$$x = 6318.14$$

The radius of Earth is 6318.14 km.

Find the circumference, C, of Earth by multiplying the radius by 2π.

$C = 2\pi r$
$C = 2(3.14)(6318.14 \text{ km})$
$C = 39\,677.9 \text{ km}$

Find the speed, s, of the waves in kilometres per second by multiplying the circumference by 7.

$s = 7(39\,677.9)$
$s = 277\,745.38 \text{ km/s}$

The radio waves travel at a speed of 277 745.38 km/s. Convert this speed to kilometres per hour.

1 h = (60 min/h)(60 s/min) = 3600 s

Let x represent the distance the radio waves travel in 1 h or 3600 s.

Set up a proportion:

$$\frac{277\,745.38 \text{ km}}{1 \text{ sec}} = \frac{x \text{ km}}{3600 \text{ sec}}$$
$$x = 999\,883\,358.1$$

So, the speed of the radio transmission is 999 883 358.1 km/h.

1.2 Imperial Measurement

6. Example estimate: 8″ by 10″; actual measurement: $8\frac{1}{4}$″ by $10\frac{5}{16}$″

7. 3.04 in./h

8. Determine if the ratio $\frac{4}{6}$ is equivalent to the ratio $\frac{16}{20}$. Since the ratios are not equivalent, an enlargement of this size would result in distortion or omission. Any ratio equivalent to $\frac{4}{6}$, such as $\frac{16}{24}$ or $\frac{20}{30}$, would work. To obtain an equivalent ratio, multiply the numerator and the denominator of $\frac{4}{6}$ by the same number.

9. a) Seven platforms, assuming that there is a platform at the top of the tower; 203 rungs, assuming that 29 rungs are needed between each platform

b) 228 steps; 30 steps are needed to reach each of 7 platforms (29 ladder rungs plus 1 step onto each platform) and three steps need to be taken across each of the 6 platforms below the top (18 steps); Assume that no steps are taken across the platform at the top of the tower.

10. a) Since the walls are 10 feet high, the 4′ by 10′ sheets would be the most suitable.

b) Find the perimeter, P, of the room:
$P = 2l + 2w$
$P = 2(20') + 2(15')$
$P = 70'$
The perimeter of the room is 70′.

Since the width of each sheet of drywall is 4′, divide 70 by 4: $\frac{70}{4} = 17.5$. So, 17.5 sheets are needed for the walls.

The ceiling is 20′ by 15′, so for calculating the number of sheets that are 4′ by 10′, assume that the ceiling is 20′ by 16′. Then 2(4) or 8 sheets would be needed for the ceiling.

Add the number of sheets needed for the walls and ceiling, and subtract $2\left(\frac{1}{3}\right)$ or $\frac{2}{3}$ of a sheet for the two doors, and subtract $\frac{1}{4}$ sheet for the one window: $17.5 + 8 - \frac{2}{3} - \frac{1}{4} = 24\frac{7}{12}$ or 24.583 sheets.

Finally, find 5% of 24.583 and add to 24.583. Then, round to the next highest number of whole sheets: (5%)(24.583) = 1.229. So, 24.583 + 1.229 = 25.812 or 26 sheets are needed.

1.3 Converting Between SI and Imperial Systems

11. a) 98.48 m
b) 62.76 mph
c) 899 ft

12. a) 205.4 km/h **b)** 127.7 mph

13. a) Answers may vary.
b) Matt (439 km versus 365.2 km for Bethany)

14. a) 1 h 43 min
b) 2099.7 m; 6888.9 ft

15. Convert 6318.1387 km to miles.

Let x represent the radius of Earth, in miles.

Set up a proportion:

$$1 \text{ mi} = 1.609 \text{ km}$$

$$\frac{1 \text{ mi}}{1.609 \text{ km}} = \frac{x \text{ mi}}{6318.1387 \text{ km}}$$

$$x = 3926.749$$

The radius of Earth is 3926.749 mi.

If the shuttle orbits Earth once in 1 h at the rate of 25 500 mph, the distance covered is 25 500 mi, which is represented as the circumference of the larger circle in the diagram. Find the radius, r, of a circle with circumference 25 500 mi.

$$C = 2\pi r$$

$$r = \frac{C}{2\pi}$$

$$r = \frac{25\,500}{2(3.14)}$$

$$r = 4060.51$$

The radius of the shuttle's orbit is 4060.51 mi.

To find the shuttle orbit's distance above Earth, subtract the radius of Earth from 4060.51 mi.: 4060.51 mi − 3926.749 mi. = 133.76 mi.

Convert 133.76 mi to kilometres.

1 mi = 1.609 km

Set up a proportion.

Let x represent the number of kilometres above Earth at which the shuttle is orbiting.

$$\frac{1 \text{ mi}}{1.609 \text{ km}} = \frac{133.76 \text{ mi}}{x \text{ km}}$$

$$x = 215.22$$

The shuttle is orbiting 133.76 mi or 215.22 km above Earth.

16. **a)** 357
b) 180 cm
c) 574.4
d) 70.866 in.
e) Example: A length of 1 in. is approximately 2.5 cm. Dividing 180 cm by 2.5 is equivalent to dividing 360 cm by 5. The answer is 72 in., which is a reasonable approximation of the calculated length.

Chapter 1 Cumulative Review

1. Estimates:
a) 13 cm **b)** 16 cm

2. The perimeter of the figure in part a) is 13.2 cm, or 5.2 in. The perimeter of the figure in part b) is 17.3 cm, or 6.48 in. Inches are an appropriate imperial unit to measure the perimeter of figures of this size.

3. **a)** 1.52 mm **b)** 450 ft
c) 74.98 km **d)** 22.23 cm

4. **a)** 3.1 cm
b) $1\frac{7}{32}$ in.
c) Examples: erasers, magnets, buttons

5. **a)** approximate; 626 ft $\frac{1}{5}$ in. is equal to 190.809 88 m
b) 1 cm : 41.48 m

6. **a)** 3.12 cm; Example: eraser
b) Estimate: $1\frac{1}{4}$ in.
c) $3.12 \text{ cm}\left(\frac{1''}{2.54 \text{ cm}}\right) \approx 1.228$ in.

7. 5959 m = 19 551 ft; 6050 m = 19 849 ft; 300 m = 984 ft

8. **a)** 1 : 2 500 000
b) 25
c) Estimate: 72.5 km

9. **a)** No. The ratio of the photograph's width to length is 2 : 3. The ratio of the frame's width to length is 3 : 4. Because the ratios are not equal, the photograph cannot be enlarged proportionally to fit the frame without cropping.
b) 10″ by 15″

10. 7.96 cm

11. **a)** $101\frac{1}{4}$ sq ft

b) 68

c) Assume that Jeremy cannot buy a fraction of a laminate.
The area of each laminate is $\left(4\frac{1}{2}\text{ ft}\right)\left(4\frac{1}{2}\text{ ft}\right) = 1.5\text{ ft}^2$. To cover the floor, Jeremy needs 68 pieces of laminate.
The area of the total laminate is (68 pieces)(1.5 ft^2/piece) = 102 ft^2.
Therefore, it will cost (102 ft^2)($4.59/$\text{ft}^2$) = $468.18 to cover the room.

12. **a)** The Grand Canyon is deeper by approximately 828.8 m.

b) Methods may vary.

13. **a)** $23\frac{1}{2}''$, to the nearest quarter of an inch

b) Example: The length of the larger semicircle is approximately $\frac{(3.14)(20)}{2} \approx$ 30 cm. The total length of the smaller semicircle and the length of the two ends is approximately the same as the perimeter of the larger semicircle. Therefore the perimeter of the figure is approximately 60 cm. A length of 1 in. is approximately 2.5 cm. Dividing 60 cm by 2.5 is equivalent to dividing 240 cm by 10. The answer is 24 in., which is a reasonable approximation of the calculated length.

Chapter 1 Extend It Further

1. C
2. C
3. B
4. A
5. D
6. **a)** 26 mi 386 yd
   b) 42 195 m or 138 441 ft
7. 5
8. approximately 14.2 yd
9. George is taller by 3.8 mm.
10. 3 ft 2.5 in.
11. cost before tax: $51.60

Chapter 2 Surface Area and Volume

2.1 Units of Area and Volume

1. **a)** 154.84 **b)** 0.46
c) 0.08 **d)** 32.29

2. **a)** Example: 25 cm by 20 cm; 50 000
b) Example: 3 ft by 5 ft; 13 935.5

3. **a)** 16 387.1 cm^3 **b)** 690 233.1 cm^3

4. **a)** 0.03
b) Convert the dimensions to inches.
1 cm ≈ 0.3937 in.
[25(0.3937)][16(0.3937)][7(0.3937)]
= (9.8425)(6.2992)(2.7559)
= 170.865 458 3
≈ 170.87 $in.^3$

5. 1.3 m^3

6. **a)** 7.8 m^2 **b)** 1 can

7. $135.48

8. 817.5 m^2

9. 8.75 ft^3

10. **a)** Convert the dimensions of the room to metres. Since 1 yd = 0.9144 m, 1 ft = $\frac{0.9144}{3}$ = 0.3048 m.
Use proportional reasoning to convert 6 m into feet and 10 m into feet.
$\frac{l}{6} = \frac{1}{0.3048}$
$l = \frac{6}{0.3048}$
$l = 19.685$
6 m is approximately 19.685 ft.
$\frac{w}{10} = \frac{1}{0.3048}$
$w = \frac{10}{0.3048}$
$w = 32.8084$
10 m is approximately 32.8084 ft.
Calculate area in square feet:
$A = lw$
$A = (19.685)(32.8084)$
$A = 645.833\,354\ldots$
To the nearest tenth, the area is approximately 645.8 ft^2.

b) Convert 4 in. to feet. Since 12 in. = 1 ft, $\frac{4}{12} = \frac{1}{3}$ ft.
The area of each strip is given by:
$A = lw$
$A = (4)\left(\frac{1}{3}\right)$
$A = 1.\overline{3}$
The area of each strip is approximately 1.3 ft^2.

c) The manager needs 12% more than the area of the room. That is 1.12 times the area of the room:
(1.12)(645.833 354... = 723.333 356 48...
Since each strip has an area of $1.\overline{3}$ ft^2, divide $\frac{723.333\,356\,48}{1.3}$ = 542.5 strips.
Since it is not possible to buy part of a strip, the manager should buy 543 strips of hardwood.

11. 203 km^2

12. **a)** 3 cm **b)** 9 in. by 9 in.

13. **a)** 122 cm **b)** 4 ft

14. The radius of the barrel is $\frac{23.5}{2}$ in. or 11.75 in. To convert inches to centimetres, multiply the measurement by $\frac{2.54 \text{ cm}}{1 \text{ in.}}$
Determine the volume of the barrel in cubic centimetres:
$V = \pi r^2 h$
$V = \pi\left[\left(\frac{11.75}{1}\right)\left(\frac{2.54}{1}\right)\right]^2\left(\frac{34}{1}\right)\left(\frac{2.54}{1}\right)$
$V = 241\,660.501\,724$
To express in cubic metres, divide by 1 000 000 to obtain 0.24 m^3.
The volume of the barrel is approximately 0.24 m^3.

15. a) $V = lwh$

$V = \left(\frac{19}{12}\right)\left(\frac{11}{12}\right)\left(\frac{34}{12}\right)$

$V = 4.112\ 268\ 2$

$V \approx 4.1$

Each bag holds about 4.1 ft^2.

b) 1 yd = 3 ft;

1 yd^3 = 3 ft × 3 ft × 3 ft = 27 ft^3

The 10-yd^3 dumpster will hold (10)(27) = 270 ft^3. The 15-yd^3 dumpster will hold (15)(27) = 405 ft^3. If each volunteer collects 4.1 ft^3 of litter, that is a total of (80)(4.1) = 328 ft^2. The 10-yd^3 dumpster is too small. Amy should rent the 15-yd^3 dumpster.

16. a) 0.5 mi; 0.8 km **b)** 0.6 km^2
c) 1.5 mi; 2.4 km **d)** 9 times as large
e) 3 times as long

17. a) 101 277 000 ft^2 **b)** 9 408 941 m^2
c) 941 ha

18. Example: **a)** I prefer to measure rooms in imperial units.

b) Consider a room with dimensions 12 ft by 10 ft. To convert the dimensions to metres, recall that 1 ft = 0.3048 m. Multiply (12)(0.3048) = 3.6576 and (10)(0.3048) = 3.048. A room that is 12 ft by 10 ft is approximately 3.7 m by 3 m.

c) For a quick estimate, it is reasonable to use 1 ft ≈ 0.3 m.

19. Example: **a)** I prefer to measure my electronic equipment using SI units.

b) Consider a computer screen with dimensions 40 cm by 35 cm. To convert the dimensions to inches, recall that 1 cm = 0.3937 in.
Multiply (40)(0.3937) = 15.748 and (35)(0.3937) = 13.7795. A computer screen that measures 40 cm by 35 cm is approximately 15.7 in. by 13.8 in.

c) For a quick estimate, it is reasonable to use 1 cm ≈ 0.4 in.

2.2 Surface Area

1. a) 3232 cm^2 **b)** 27.9 m^2
c) 2827.43 cm^2 **d)** 753.98 $in.^2$
e) 6.99 m^2

2. a) 600 $in.^2$ **b)** 13 273.23 cm^2
c) 3242.12 cm^2 **d)** 3.14 ft^2

3. 5 in.

4. 3689 ft^2

5. a) Since the diameter is 1.2 m, the radius is 0.6 m. Substitute values into the formula for surface area of a cylinder:

$$SA = 2\pi r^2 + 2\pi rh$$
$$4 = 2\pi(0.6)^2 + 2\pi(0.6)h$$
$$4 = 0.72\pi + 1.2\pi h$$
$$4 - 0.72\pi = 1.2\pi h$$
$$\frac{4 - 0.72\pi}{1.2\pi} = h$$
$$0.461\,032\,95\ldots = h$$

The height of the cylinder is approximately 0.46 m.

b) 2.59 in. **c)** 1.47 cm
d) 22.1 ft

6. a) 6872.23 cm^2

b) The base of the composite object is a right prism with no top.
Calculate the surface area of the prism:

$SA_{prism} = lw + 2lh + 2wh$

$SA_{prism} = (10)(18) + 2(10)(38) + 2(18)(38)$

$SA_{prism} = 2308$

The top of the composite object is a right pyramid with no base.
Calculate the surface area of the right pyramid:

$SA_{pyramid} = 2\left[\frac{1}{2}(10)(15)\right] + 2\left[\frac{1}{2}(18)(13)\right]$

$SA_{pyramid} = 384$

The combined surface area is 2308 + 384 = 2692. The total surface area of the composite object is 2692 m^2.

7. a) 16 596 mm^2 **b)** 15 936 mm^2

8. 509 904 364 km^2

9. a) 1.7 m **b)** 5.5 m^2
c) 4.1 m^2

10. 25 cm

11. 6300 cm^2

12. 104.7 ft^2

13. 36 cm

14. Use the circumference of the base to determine the radius.

$C = 2\pi r$

$r = \frac{C}{2\pi}$

$r = \frac{12}{2\pi}$

$r = \frac{6}{\pi}$

Use the Pythagorean relationship to determine the slant height of the cone.

$s^2 = r^2 + h^2$

$s^2 = \left(\frac{6}{\pi}\right)^2 + 6^2$

$s = \sqrt{\left(\frac{6}{\pi}\right)^2 + 6^2}$

$s = 6.296\,631\,05...$

Calculate the surface area of the cone:

$SA = \pi r^2 + \pi rs$

$SA = \pi\left(\frac{6}{\pi}\right)^2 + \pi\left(\frac{6}{\pi}\right)(6.296\,631\,05...)^2$

$SA = 49.2$

The surface area of the mandrel is approximately 49.2 in.^{2}.

15. a) 3.2 m **b)** $l = \sqrt{\frac{SA}{6}}$

16. a) 3.2 ft **b)** 2.3 ft

c) No. Construction requires some cutting, so some material will be unusable or unavailable. The surface area of a manufactured object will be less than the surface area of the sheet of aluminum.

17. a) 7.3 m **b)** 117 m^2

18. a) $SA = \frac{1}{2}\pi d^2 + \pi dh$

b) $SA = \frac{C^2}{2\pi} + Ch$

c) Answers will vary. Example:
Suppose a homeowner wants to paint a rain barrel. It is easier to determine the diameter of the barrel than the radius, since it is difficult to locate the centre of the barrel. The homeowner would use the formula in part a).
Suppose an arborist needs to wrap the trunk of a tree to protect it from pests. Since it is clearly undesirable to cut the tree to measure its diameter or radius, the arborist would measure the circumference and use the formula in part b).

2.3 Volume

1. a) 4647.12 in.^{3} **b)** 41.47 m^3 **c)** 2572.44 cm^3 **d)** 753.98 ft^3 **e)** 132 383.33 mm^3

2. a) 400 in.^{3} **b)** 57 255.53 mm^3

3. a) 8.51 in.

b)

$$\begin{aligned} V &= \tfrac{4}{3}\pi r^3 \\ 36\pi &= \tfrac{4}{3}\pi r^3 \\ (3)(36\pi) &= 4\pi r^3 \\ 108\pi &= 4\pi r^3 \\ \frac{108\pi}{4\pi} &= \frac{4\pi r^3}{4\pi} \\ 27 &= r^3 \\ 3 &= r \end{aligned}$$

The sphere has radius 3 m.

c) 11.88 m **d)** 2.8 ft

4. a) 18 847.99 cm^3 **b)** 35 116.72 cm^3

5. a) 28 013.33 cm^3 **b)** 21 205.75 cm^3

6. 1 082 696 932 430 km^3 or 1.08×10^{12} km^3

7. a) 94.2 cm^3; This cup meets the standard.

b) 157.1 cm^3; This cup does not meet the standard, as it is too large.

8. a) 5575.3 in.^{3} **b)** 948.1 cm^3 **c)** 192 666.7 cm^3 **d)** 0.7 m^3

9. a) 225.8 cm^3 **b)** 1 mL = 1 cm^3

10. To determine the volume, you need to know the dimensions of the base. The triangle formed by the height of the pyramid, the slant height of a face, and half the length of the base is a right triangle. Use the Pythagorean relationship. Let x represent half the length of the base of the pyramid:

$$\begin{aligned} x^2 + 24^2 &= 25^2 \\ x^2 &= 25^2 - 24^2 \\ x^2 &= 49 \\ x &= 7 \end{aligned}$$

Since 7 cm represents half the base, the base of the pyramid is 14 cm by 14 cm. Substitute into the formula for the volume of a pyramid:

$V = \frac{1}{3}lwh$

$V = \frac{1}{3}(14)(14)(24)$

$V = 1568$

The volume of the right pyramid is 1568 cm^3.

11. 3.6 cm; This is the minimum radius. If the height of the cylinder decreases, the radius will need to increase.

12. **a)** 3.7 m **b)** 4.2 cm
c) 30 cm or 0.3 m

13. 21.4 ft

14. **a)** 196.3 cm^3 **b)** The can is too small.
c)
$$V = \pi r^2 h$$
$$250 = \pi(2.5)^2 h$$
$$\frac{250}{6.25\pi} = h$$
$$12.74 \approx h$$
Check by substituting $h = 12.74$ in the formula:
$$V = \pi r^2 h$$
$$V = \pi(2.5)^2(12.74)$$
$$V \approx 250.1$$

15. **a)** 4 cm **b)** 4.6 cm
c) 6.2 cm
d) (12.2 cm)(12.2 cm) = 148.84 cm^2

16. 36 077 533.3 ft^3

17. Since the bead is half a sphere, modify the formula for the volume of a sphere:
$$V = \frac{1}{2}\left(\frac{4}{3}\pi r^3\right)$$
$$V = \frac{2}{3}\pi r^3$$
$$V = \frac{2}{3}\pi\left(\frac{1.85}{2}\right)^3$$
$$V \approx 1.657\ 615\ 5...$$
The volume of the bead is approximately 1.7 cm^3.

18. **a)** 9.5 cm **b)** 7.5 cm
c) cylinder: 457.1 cm^2; prism 500 cm^2
d) Example: Since both containers meet the requirements for capacity, I recommend the cylinder as it uses less material, and therefore, may be less costly to manufacture.

19. 7743.36 cm^3

20. **a)** 6 units × 6 units × 6 units
b) $r = 3$ units

21. The volume will increase more than the surface area. Many students may incorrectly predict that both the surface area and the volume will double. By creating an example, they should discover that such a prediction is incorrect. Example: A sphere has radius 5 cm. The original volume is about 523.6 cm^3. The original surface area is about 314.2 cm^2. If the radius is doubled to 10, the new volume is 4188.8 cm^3 and the new surface area is 1256.6 cm^2. In both cases, the volume and surface area more than doubled. In fact, the volume increased by approximately 8 times. The surface area increased by approximately 4 times. Therefore, when the dimensions of an object are doubled, the volume changes more the surface area does.

Chapter 2 Review

2.1 Units of Area and Volume

1. **a)** 603.22 cm^2 **b)** 3.88 ft^2

2. **a)** 0.13 m^3 **b)** 1608.8 cm^3

3. 10.49 ft^2

4. 1 $yd^3 \approx 0.76$ m^3, so 1 yd^3 should cost about (0.76)(62) = 47.12. One cubic yard should cost about \$47.12 but the supplier is charging \$50 instead. This means that \$62 per cubic metre is a better price.

2.2 Surface Area

5. **a)** 170.43 m^2 **b)** 301.59 cm^2
c) 226.98 $in.^2$ **d)** 60 ft^2

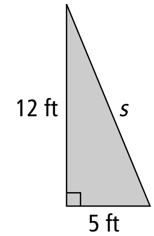
6. **a)** $r = 5.98$ in. **b)** $s = 9.43$ cm
c) $s = 1.18$ ft **d)** $h = 5.92$ m

7. Area of floor: (8)(10) = 80
Area of walls: (2)(8)(7) + (2)(10)(7) = 252
$$\text{Area of roof: } 2\left(\frac{1}{2}(8)(5.4)\right) + 2\left(\frac{1}{2}(10)(4.5)\right) = 88.2$$
Since the shed does not have a ceiling, it is not necessary to find the area of the base of the pyramid, which is also the top of the prism. The total surface area is 420.2 ft^2.

8. 4750.09 $in.^2$ or 32.99 ft^2

9. \$88.77

10. **a)** Example:



b) $r = 5$ ft; $s = 13$ ft **c)** 282.74 ft^2

2.3 Volume

11. a) 7.07 ft^3 or 12 214.51 $in.^3$ **b)** 5.33 m^3
c) 0.52 m^3 **d)** 796.39 cm^3

12. a) 25.98 m **b)** 4.98 cm
c) 6 in. **d)** 6 ft

13. a) 233.33 ft^3
b) 233.33 $ft^3 \approx 6.61\ m^3$
$$\frac{233.33}{35} = 6.666\,574\,14... \approx 6.67$$
Mike's estimate is fairly accurate.

14. a) Determine the volume of the bin:
$V = \pi r^2 h$
$V = \pi\left(\frac{1.25}{2}\right)^2(1.1)$
$V \approx 1.349\,903\ldots$
There is approximately 1.35 m^3 of compost in a full bin.

b) Determine the area of the garden in square metres:
$A = lw$
$$A = \left[\left(\frac{12\text{ ft}}{1}\right)\left(\frac{0.3048\text{ m}}{1\text{ ft}}\right)\right]\left[\left(\frac{20\text{ ft}}{1}\right)\left(\frac{0.3048\text{ m}}{1\text{ ft}}\right)\right]$$
$A = 22.296\,729\ldots$
The area of the garden is approximately 22.3 m^2.
Consider the compost in the garden to occupy a rectangular prism with base 22.3 m^2 and volume 1.35 m^3. Rearrange the formula $V = Bh$ and solve:
$h = \frac{V}{B}$
$h \approx \frac{1.349\,903}{22.296\,729}$
$h \approx 0.060\,542\,6$
The height of the compost is approximately 0.06 m. This is equivalent to approximately 6 cm.
Convert this depth to inches:
$$\left(\frac{0.060\,542\,6}{1}\right)\left(\frac{1\text{ in.}}{2.54\text{ cm}}\right) = 2.383\,568\ldots$$
The compost will be approximately 2.4 in. deep.

15. 502.65 cm^3

16. a) Example: The height will need to double. Example: When the height is 20 cm, the capacity is 1005.31 cm^3, so the prediction was correct.
b) Example: The diameter will need to double. Example: When the diameter is 16 cm, the radius is 8 cm and the capacity is 2010.62 cm^3, so the prediction was incorrect.

17. a) 169.65 ft^3 **b)** $94.25

Chapters 1–2 Cumulative Review

1. a) 800 000 mm^2 **b)** 97.98 cm^2

2. a) Example: Using an eraser width as a referent for 35 mm, the curve of the O could be about 2 eraser widths.
b) Using a pen as a referent for 15 cm, the curve of the O could be about 2 pen widths.

3. a) Use a piece of string and lay it along the shape of the letter that you drew, and then measure the string.

4. a) 2.17 m^3 **b)** 399.5 $in.^3$

5. Answers will vary. Students should list the most commonly used conversions.

6. a) 49 mm = 4.9 cm **b)** 9.4 mm = 0.94 cm

7. 53.25 ft^2

8. 1.43 m by 2.85 m

9. a) $\frac{4}{3}\pi(6.2)^3 = 998.3\ cm^3$
b) $\frac{(1.5)(0.7)(2)}{3} = 0.7\ m^3$
c) $\frac{1}{3}\pi(4^2)(7) = 117.3\ mm^3$

10. $3\frac{3}{16}$ in.; Example: width of a library card

11. a) 433.5 $in.^2$ **b)** 784 cm^2
c) 78.5 ft^2

12. a) 3 yd **b)** 5.5 mi
c) 4550 in.

13. a) $s = 1.58$ ft **b)** $s = 103.75$ cm
c) $r = 2.12$ m

14. a) 17 m^2 **b)** 389 tiles

15. 21.06 cm

16. 271.04 km

17. 3.39 cm^3

Chapter 2 Extend It Further

1. A
2. D

Volume of one scoop of ice cream:

$V = \frac{4}{3}\pi r^3$
$= \frac{4}{3}\pi(2)^3$
$= 33.5103...$

The volume of one scoop is approximately 33.5 cm^3.

Since there are two scoops, the total volume is twice this amount or approximately 67 cm^3.

The volume of ice cream remains the same when it is placed in the cup.

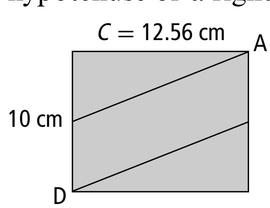
Solve the equation:

$\pi r^2 h = 67$
$\pi(3)^2 h = 67$
$9\pi h = 67$
$h = \frac{67}{9\pi}$
$h = 2.4$

The ice cream raised the height of the juice by 2.4 cm to a new height of 10 + 2.4 = 12.4 cm.

3. A

When unfolded, the curve is made up of two separate lines. Each line is the hypotenuse of a right triangle.



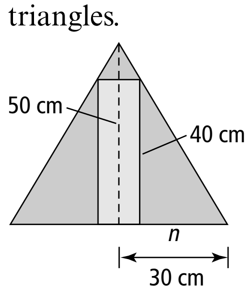
The circumference is 3.14(4) = 12.56 cm.

Each hypotenuse is $\sqrt{(12.56)^2 + 5^2} =$ 13.52 cm.

The curve is 2(13.52) or 27.04 cm long.

4. B

From the side view, there are two similar triangles.



That is, $\frac{50}{40} = \frac{30}{n}$ or $n = 24$ cm.

This gives the radius of the cylinder as $30 - 24 = 6$ cm.

Determine the lateral surface area of the cylinder:

$SA = \pi dh$
$SA = \pi(12)(40)$
$SA = 480\pi \text{ cm}^2$

5. Volume of hemisphere:

$V = \frac{1}{2}\left(\frac{4}{3}\pi r^3\right)$
$V = \frac{2}{3}\pi r^3$

Volume of cylinder:

$V = \pi r^2 h$
$V = \frac{2}{3}\pi r^3 + \pi r^2 h$

Since the hemisphere has $\frac{1}{6}$ the capacity of the test tube:

$\frac{2}{3}\pi r^3 = \frac{1}{6}\left(\frac{2}{3}\pi r^3 + \pi r^2 h\right)$
$4\pi r^3 = \frac{2}{3}\pi r^3 + \pi r^2 h$
$12\pi r^3 = 2\pi r^3 + 3\pi r^2 h$
$10\pi r^3 = 3\pi r^2 h$
$10r^3 = 3r^2 h$
$10r = 3h$
$r = \frac{3}{10}h$
$r:h = 3:10$

6. Volumes of the cone, cylinder, and hemisphere:

$V_{cone} = \frac{1}{3}\pi r^2 h$
$V_{cylinder} = \pi r^2 h$
$V_{hemisphere} = \frac{1}{2}\left(\frac{4}{3}\pi r^3\right)$
$= \frac{2}{3}\pi r^3$

Equate the volumes of the cylinder and hemisphere:

$\pi r^2 h_{cylinder} = \frac{2}{3}\pi r^3$
$h_{cylinder} = \frac{2}{3}r$

Equate the volumes of the cone and hemisphere:

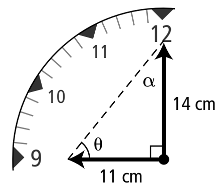
$\frac{1}{3}\pi r^2 h_{cone} = \frac{2}{3}\pi r^3$
$\pi r^2 h_{cone} = 2\pi r^3$
$h_{cone} = 2r$

Therefore, the ratio of heights $x:y:z$ is $2:\frac{2}{3}:1$. To write this ratio using natural numbers, multiply each term in the ratio by 3 to get $6:2:3$.

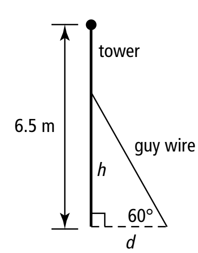
Chapter 3 Right Triangle Trigonometry

3.1 The Tangent Ratio

1. **a)** c
   b) a
   c) b
2. **a)** $\tan A = \frac{a}{b}$ **b)** $\tan B = \frac{b}{a}$
3. **a)** 0.83
   b) 1.26
   c) 18
4. 5.31 m
5. **a)** $\tan X = \frac{\text{opposite}}{\text{adjacent}}$
   $\tan X = \frac{1.85}{1.6}$
   $\tan X = 1.15625$
   Use the inverse function on a calculator to apply the tangent ratio in reverse:
   $\tan X = 1.15625$
   $X = \tan^{-1}(1.15625)$
   $X = 49.1446\ldots°$
   $\angle X$ is 49.1°, to the nearest tenth of a degree.
   b) $\tan Y = \frac{\text{opposite}}{\text{adjacent}}$
   $\tan Y = \frac{1.6}{1.85}$
   $\tan Y = 0.86486$
   Use the inverse function on a calculator to apply the tangent ratio in reverse:
   $\tan Y = 0.86486$
   $Y = \tan^{-1}(0.86486)$
   $Y = 40.8552\ldots°$
   $\angle Y$ is 40.9°, to the nearest tenth of a degree.
6. $\angle A = 52°$; $\angle B = 38°$; $c = 4.06$ m; Side c, which is opposite the right angle, is the hypotenuse. Because the lengths of the other two sides (a and b) are known, the length of side c can be determined by substituting the values for a and b in the equation $a^2 + b^2 = c^2$ and solving for c.
7. 293 cm
8. **a)** 12.9 m
   b) 14.8°
9. 3.59 m
10. 200 cm, or 2 m
11. Organize the information and sketch a diagram to illustrate the problem.



   a) Form the tangent ratio for $\angle\alpha$ from the diagram.
   $\tan \alpha = \frac{11}{14}$
   $\alpha = \tan^{-1}\left(\frac{11}{14}\right)$
   $\alpha = 38.2°$
   The angle formed between the line and the minute hand is 38.2°.
   b) Form the tangent ratio for $\angle\theta$.
   $\tan \theta = \frac{14}{11}$
   $\theta = \tan^{-1}\left(\frac{14}{11}\right)$
   $\theta = 51.8°$
   The angle between the line and the hour hand is 51.8°.
12. 359 m
13. The plane travelled 13 186 m.
14. **a)** 6.1 m **b)** 7.6 m
15. 24.3°
16. **a)** Organize the information and sketch a diagram to illustrate the problem.



   First, find the value of h, the height in metres up the pole where the wires should be attached.
   $6.5 \text{ m} \times \frac{2}{3} = 4.33 \text{ m}$

Next, use a tangent ratio to find the distance, d, in metres, that each wire should extend from the base of the tower.

$\tan 60° = \frac{4.33}{d}$

$d = \frac{4.33}{\tan 60°}$

$d = 2.5$ m

Since Ramon needs 2.5 m *on each side* of the tower, the available width of 4.2 m is not enough.

b) Since the available width is 4.2 m, the maximum value of d is $\frac{4.2 \text{ m}}{2}$, or 2.1 m.

To find the corresponding value of h when d equals 2.1 m, use a tangent ratio:

$\tan 60° = \frac{h}{2.1}$

$(2.1) \tan 60° = h$

$3.64 \text{ m} = h$

Since h represents only two thirds of the tower's height, the maximum possible tower height is

$3.64 \times \frac{3}{2} = 5.46$ m

17. a) $a = 2b$ or $a = \frac{b}{2}$; $b = 2a$ or $b = \frac{a}{2}$

b) $a = \frac{b}{2}$ or $a = 2b$; $b = \frac{a}{2}$ or $b = 2a$

c) The values or ratios in parts a) and b) are the same. This is because the values are simply switched from numerator to denominator, or vice versa.

3.2 The Sine and Cosine Ratios

1. a) $\sin A = \frac{a}{c}$ **b)** $\cos A = \frac{b}{c}$

c) $\sin B = \frac{b}{c}$ **d)** $\cos B = \frac{a}{c}$

2. a) $\cos A = \frac{12}{17}$ **b)** $\sin A = \frac{10}{15}$

c) $\sin B = \frac{1.9}{2.4}$ **d)** $\cos B = \frac{2.6}{3.9}$

e) $a = \frac{75}{6} = \frac{25}{2}$ **f)** $a = \frac{9}{3} = 3$

3. a) $\angle R = 48.4°$ **b)** $\angle S = 41.6°$

4. a) 54.3° **b)** 56.7°
c) 12.6° **d)** 87.2°

5. a) $x = 1.85$ cm **b)** $x = 4.39$ m

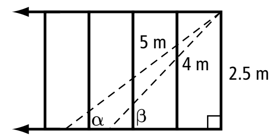
6. a) $z = 72.48$ mm **b)** $z = 9.70$ m

7. The angle is 61° and the backing piece must have a height of 155 mm.

8. a) 6.3 ft **b)** 54.9°

9. 34 m

10. First, label the given diagram.



Then, form appropriate ratios:

$\sin \alpha = \frac{2.5 \text{ m}}{5 \text{ m}}$ $\sin \beta = \frac{2.5 \text{ m}}{4 \text{ m}}$

Solve for the angles:

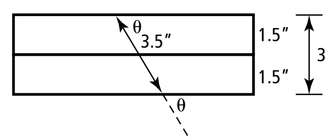
$\alpha = \sin^{-1}\left(\frac{2.5}{5}\right)$ $\beta = \sin^{-1}\left(\frac{2.5}{4}\right)$

$\alpha = 30°$ $\beta = 39°$

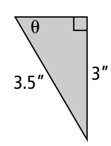
The 5-m rod forms an angle of 30° with the floor. The 4-m rod forms an angle of 39° with the floor.

11. The boat ramp must be 4.8 m in length.

12. First, modify and label the given diagram.



Then, create a simplified diagram.



Select the appropriate trigonometric ratio and solve for θ:

$\sin \theta = \frac{3}{3.5}$

$\theta = \sin^{-1}\left(\frac{3}{3.5}\right)$

$\theta = 59°$

The screws should be driven in at an angle of 59° or less to prevent the points from sticking through.

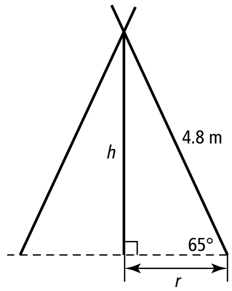
13. a) The water gun can spray the middle 7.2 m of the opposite side.

b) 2.8 m (1.4 m at each end)

c) 7.8 m

14. CD =14.7 cm

15. Consider the teepee as a cone.



Use a ratio to find the radius of the base.

$\cos 65° = \frac{r}{4.8 \text{ m}}$

$(4.8 \text{ m}) \times \cos 65° = r$

$2.03 \text{ m} = r$

Since the radius is one half of the diameter, multiply the value by 2:

diameter = 2 × radius

diameter = 2 × 2.03 m

diameter = 4.06 m, or 4.1 m, to the nearest tenth of a metre

The diameter of the teepee is 4.1 m.

16. a)

θ	tan θ	sin θ	cos θ
15°	0.2679	0.2588	0.9659
30°	0.5774	0.5	0.8660
45°	1	0.7071	0.7071
60°	1.7321	0.8660	0.5
75°	3.7321	0.9659	0.2588

b) As the values of the tangent and sine increase, the value of the cosine decreases.

c) The sine and cosine generate the same values, but in the opposite order.

3.3 Solving Right Triangles

1. a) ∠B = 23°; $a = 5.2$; $c = 5.6$

b) ∠B = 42°; $b = 12.9$; $c = 19.2$

c) ∠Z = 49.0°; ∠Y = 41.0°; $x = 2.3$

d) Use the Pythagorean theorem to calculate the length, x, of side YZ:

$(YZ)^2 = (XY)^2 + (XZ)^2$

$x^2 = (1.75)^2 + (1.52)^2$

$x^2 = 3.0625 + 2.3104$

$x^2 = 5.3729$

$x = \sqrt{5.3729}$

$x = 2.317\ldots$, or 2.3 units, to the nearest tenth of a unit

2. a) ∠A, ∠C

b) ∠B, ∠D

c) ∠A = ∠B, ∠C = ∠D

3. a) Both are correct. The name of the angle changes when the point of view changes.

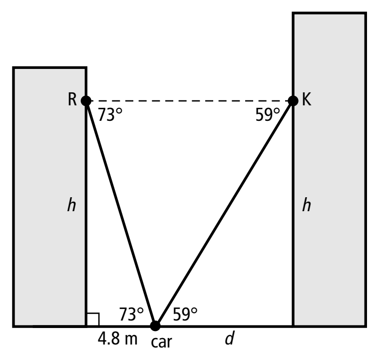
b) The angle of elevation from one point to a second point is equal to the angle of depression from the second point to the first point.

4. a) ∠C = 48°; ∠B = 52°; ∠D = 42°; $b = 18.3$; $c = 23.2$; $x = 20.3$

b) ∠X = 27°; ∠Z = 61°; $x = 2.6$; $y = 5.4$; $z = 5.3$

5. a) 42.1 cm **b)** 54.9°

6. Sketch and label a diagram with the given information to illustrate the problem.



Note that the angles of depression to the car equal the angles of elevation from the car.

Use an appropriate ratio to find h first:

$\tan 73° = \frac{h}{4.8 \text{ m}}$

$(4.8 \text{ m}) \times \tan 73° = h$

$15.7 \text{ m} = h$

This is the same h as for Kenneth's window.

Now we find d:

$\tan 59° = \frac{15.7 \text{ m}}{d}$

$d = \frac{15.7 \text{ m}}{\tan 59°}$

$d = 9.43$ m.

Add the two horizontal distances:

4.8 m + 9.43 m = 14.23 m, or 14.2 m, to the nearest tenth of a metre

The distance between the two windows is 14.2 m.

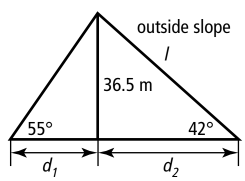
7. 8.6 m

8. **a)** 202 m
b) 714 m
c) 436 m

9. **a)** 98 m **b)** 50°

10. **a)** No, the diagonal length across the bottom of the box is only 118.5 cm, which is 1.5 cm less than the length of the cane.
b) Yes, the diagonal distance across opposite corners is 121.8 cm, which is greater than the length of the cane. Therefore, the lid can be closed.

11. Sketch a modified diagram and label it with the given information to illustrate the problem.



a) Width of dike = $d_1 + d_2$

Find d_1:

$\tan 55° = \dfrac{36.5 \text{ m}}{d_1}$

$d_1 = \dfrac{36.5 \text{ m}}{\tan 55°}$

$d_1 = 25.56$ m

Find d_2:

$\tan 42° = \dfrac{36.5 \text{ m}}{d_2}$

$d_2 = \dfrac{36.5 \text{ m}}{\tan 42°}$

$d_2 = 40.54$ m

Width = 25.56 m + 40.54 m = 66.1 m
The width of the dike is 66.1 m.

b) The length of the mesh is the hypotenuse of the outside triangle:

$\sin 42° = \dfrac{36.5 \text{ m}}{\ell}$

$\ell = \dfrac{36.5 \text{ m}}{\sin 42°}$

$\ell = 54.5$ m

The mesh needs to be 54.5 m long.

c) Let the height be 39 m. Then, solve as in part a):

$d_1 = \dfrac{39 \text{ m}}{\tan 55°}$

$d_1 = 27.31$ m

$d_2 = \dfrac{39 \text{ m}}{\tan 42°}$

$d_2 = 43.31$ m

Width = 27.31 m + 43.31 m = 70.6 m
The width at the base must be 70.6 m.

d) Let the height equal 31 m. Then, solve as in part a):

$d_1 = \dfrac{31 \text{ m}}{\tan 55°}$

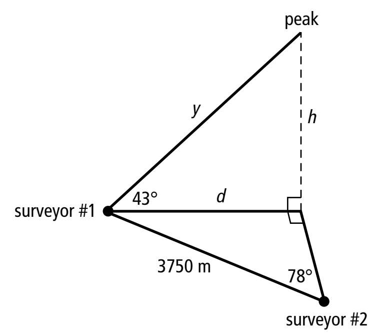
$d_1 = 21.71$ m

$d_2 = \dfrac{31 \text{ m}}{\tan 42°}$

$d_2 = 34.43$ m

Width = 21.71 m + 34.43 m = 56.14 m
The student-engineer is not correct. The base of the dike needs to be 56.1 m wide, not 54.8 m.

12. Sketch a simplified diagram to illustrate the problem, converting all distances to metres.



a) Find the distance d, in metres, from surveyor #1 to a point directly under the peak:

$\sin 78° = \dfrac{d}{3750 \text{ m}}$

$(3750 \text{ m}) \times \sin 78° = d$

$3668 \text{ m} = d$

Now, use this distance in the other triangle to find h:

$\tan 43° = \dfrac{h}{3668 \text{ m}}$

$(3668 \text{ m}) \times \tan 43° = h$

$3420 \text{ m} = h$

The mountain is 3420 m high.

b) Find the hypotenuse, y, of the second triangle:

$\cos 43° = \dfrac{3668 \text{ m}}{y}$

$y = \dfrac{3668 \text{ m}}{\cos 43°}$

$y = 5015$ m

The cable needs to be 5015 m long.

c) Use trigonometric ratios as in part a) to determine the distance, in metres, of each of d and h. Then, use the Pythagorean theorem to determine the distance y, in metres:
$y^2 = d^2 + h^2$
$y^2 = (3668)^2 + (3420)^2$
$y^2 = 13\,454\,224 + 11\,696\,400$
$y^2 = 25\,150\,624$
$y = \sqrt{25\,150\,624}$
$y = 5015.03\ldots$, or 5015 m, to the nearest metre

Chapter 3 Review
3.1 The Tangent Ratio

1. a) x
   b) z
   c) y
2. a) $\tan Y = \frac{y}{z}$ b) $\tan Z = \frac{z}{y}$
3. 30.7 cm
4. ∠B is the smallest angle: 39.75°
5. 2.34 m
6. 30.56 m

3.2 The Sine and Cosine Ratios

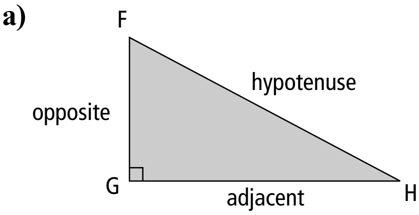
7. a) $\sin A = \frac{a}{c}$
   b) $\cos A = \frac{b}{c}$
   c) $\sin B = \frac{b}{c}$
   d) $\cos B = \frac{a}{c}$
8. a) $b = 4.69$ b) $b = 3.59$
9. 2.39 m
10. 5.49 m
11. a) 8.5° b) 53.4 ft

3.3 Solving Right Triangles

12. a) ∠B = 73°; a = 3.7 cm; b = 12.0 cm
    b) ∠Y = 41°; x = 81.1 m; z = 107.5 m
    c) ∠L = 41.8°; ∠M = 48.2°; m = 5.4 mm
    d) ∠D = 57.4°; ∠E = 32.6°; f = 7.6
    e) ∠X = 63.3°; ∠Y = 26.7°; x = 22.8
13. a) 87 cm b) 34°
14. 701 m
15. One goalie is at a distance of 22 m. The second goalie is at a distance of 78 m.
16. a) 233.2 m
    b) 223.6 m
    c) 63.4°

Chapters 1–3 Cumulative Review

1. a) Example: 12 cm
   b) 11.4 cm
   c) 3.82 cm^2
2. 448 ft^2
3. a)

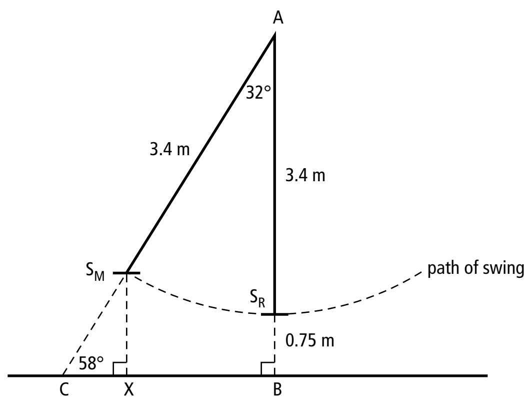


   b) $\tan H = \frac{FG}{GH}$; $\sin H = \frac{FG}{FH}$; $\cos H = \frac{GH}{FH}$
4. a) slant height = 1.11 m
   b) slant height = 37.00 cm
   c) radius = 6.15 mm
5. a) 76°
   b) 62°
   c) 53°
6. a) $1\frac{5}{16}$ in.; 3.33 cm
   b) 2.64 cm; 1.04 in.
7. 1152.3 cm^2
8. a) 9650.97 ft^3 b) 279.8 cm^3
   c) 192 ft^3 d) 998.31 cm^3
   e) 169.65 in.^{3} f) 60 m^3
9. a) radius = 0.89 m
   b) height = 7.41 cm
   c) side length = 4.03 m
   d) radius = 9.39 cm
   e) radius = 0.62 in.
   f) height = 3.00 ft
10. a) ∠A = 25.8°; ∠C = 64.2°; a = 1.3 m
    b) ∠A = 48.0°; a = 74.4 cm; c = 100.1 cm
11. a) 2041.92 m b) 820.26 m
12. a) 66.6 m^3; 333 000 m^3
    b) 0.59 truckloads; 2950 truckloads
    c) 621 125 m^2
13. a) 1 : 12 500 000
    b) 317.5 km
    c) Example: approximately 179 mi
    d) approximately 62 mi

Chapter 3 Extend It Further

1. A

2. C; Sketch and label a diagram with the given information to illustrate the problem.



In the diagram, S_R represents the position of the swing at rest. S_M represents the position of the swing at its highest point. At this point, as the diagram illustrates, the swing reaches a maximum angle of 32° with the vertical. The line S_MX represents the maximum height of the swing above the ground.

To calculate the length of S_MX, first determine the length of the line segment S_MC. The length of that segment is equal to the length of the line AC (the hypotenuse of right ΔABC) minus the length of the swing. Use the cosine ratio to determine the length of AC:

$$\cos 32° = \frac{\text{adjacent}}{\text{hypotenuse}}$$

$$\cos 32° = \frac{4.15\text{ m}}{AC}$$

$$0.84804 = \frac{4.15\text{ m}}{AC}$$

$$AC = 4.8936\text{ m}$$

The length of line segment $S_MC = 4.8936\text{ m} - 3.4\text{ m} = 1.4936\text{ m}$

In ΔS_MXC, $\angle C = 58°$. Use the sine ratio to determine the length of S_MX:

$$\sin 58° = \frac{\text{opposite}}{\text{hypotenuse}}$$

$$\sin 58° = \frac{S_MX}{1.4936\text{ m}}$$

$$0.84804 = \frac{S_MX}{1.4936\text{ m}}$$

$$S_MX = 1.2666\text{ m}$$

The maximum height of the swing above the ground is 1.2666 m. Therefore, the best answer is C: 1.27 m.

3. B

4. vertically = 0.28 m; horizontally = 0.48 m. The two distances are different as the two ends of the ladder are travelling at different speeds.

5. AC = 15.3 cm; BD = 12.9 cm

6. **a)** 108° **b)** 80.9 cm

7. 76 507 cm^3

Unit 1 Review

1. C

2. B

3. B

4. A

5. B

6. C

7. B

8. D

9. B

10. C

11. B

12. B

13. B

14. C

15. B

16. C

17. $3\frac{1}{4}''$

18. 30.5 mm

19. 90 in.

20. 166.4 cm^2

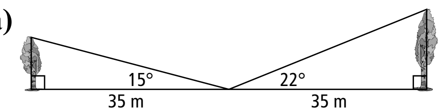
21. 26 m

22. 11 ft

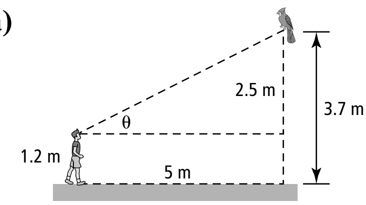
23. 25.7 yd^3

24. 128.9°

25. a) r = 12.7 cm, h = 30.5 cm
b) 1316.0 cm^2
c) 5148.9 cm^3

26. a)


b) tangent ratio
c) 4.8 m

27. a)


b) 26.6°

28. a) 6.7 ft
b) 449.0 ft3
c) 17.9 ft

29. a) $1\frac{5}{8}$ in.
b) 4.6 in.^{2}
c) 0.5 in.^{3}

30. a) Answers may vary.
b) outer radius = 6.35 cm,
inner radius = 1.91 cm
c) 1170 cm^3

31. a) Use the Pythagorean theorem to determine the length of side BC. Triangle ABC is a right triangle (the sum of the angles is 180°). Use the tangent ratio to find the length of side AB.
b) 1.7 m

Chapter 4 Exponents and Radicals

4.1 Square Roots and Cube Roots

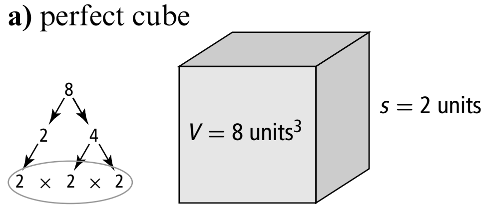
1. **a)** 81 **b)** 225
c) −625 **d)** $\frac{4}{9}$
e) $\frac{-25}{8}$ **f)** $\left(\frac{36}{49}\right)$

2. **a)** 729 **b)** −27
c) −216 **d)** 8
e) $\frac{-1}{3}$ **f)** $\frac{125}{343}$

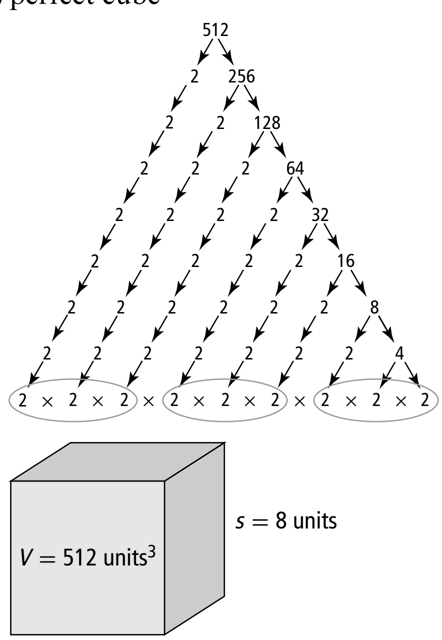
3. **a)** 5 **b)** 14
c) 28 **d)** 2
e) $\frac{2}{3}$ **f)** $\frac{4}{7}$
g) $\frac{1}{3}$ **h)** $6x$
i) $\frac{7a}{13b}$

4. **a)** 2 **b)** 3
c) 12 **d)** 20
e) 3 **f)** $\frac{3}{5}$
g) $\frac{2}{7}$ **h)** $5y$
i) $9a$

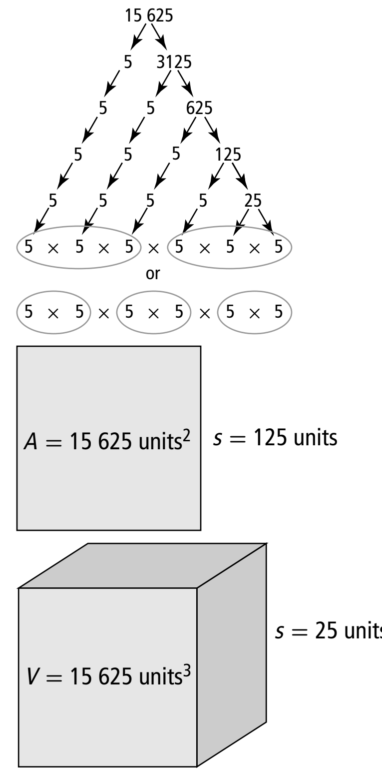
5. **a)** perfect cube



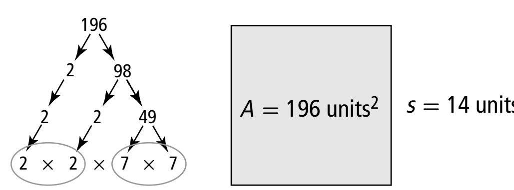
b) perfect cube



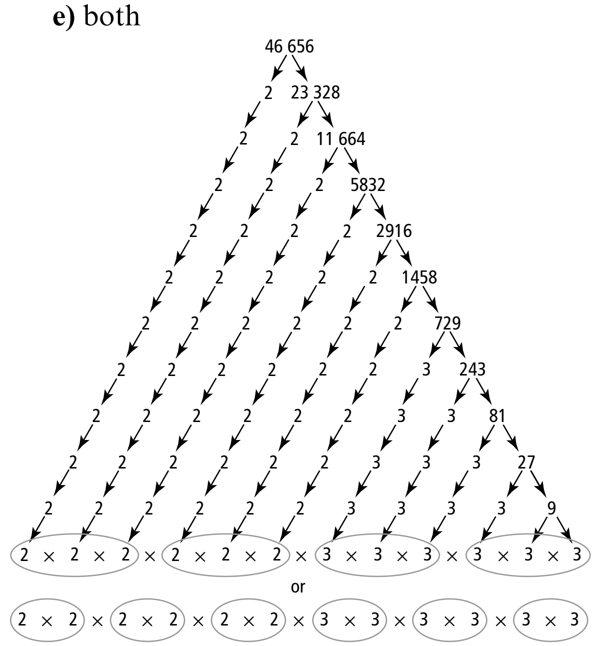
c) both

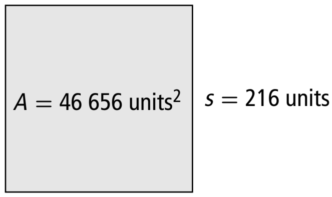


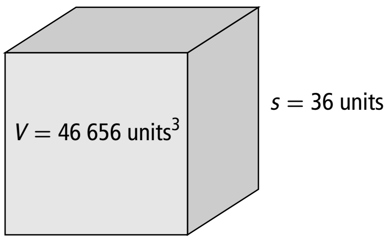
d) perfect square



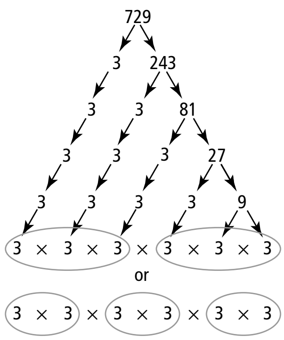
e) both

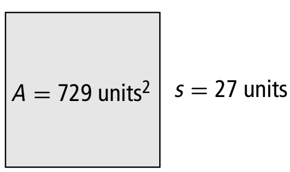


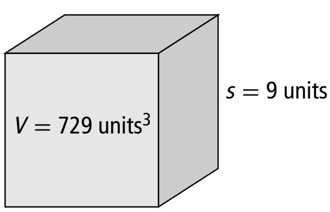




f) both







6. **a)** perfect square **b)** perfect square **c)** both **d)** perfect square **e)** both **f)** neither

7. **a)** perfect square **b)** perfect cube **c)** perfect cube **d)** perfect square **e)** perfect square **f)** neither

8. **a)** 17 **b)** 23 **c)** 14 **d)** 22 **e)** 31 **f)** 27

9. The storage container will measure 1.4 m by 1.4 m by 1.4 m (or 140 cm by 140 cm by 140 cm).

10. The side length of the patio is 23 ft.

11.
$$\begin{aligned} V &= s^3 \\ 2146.2 &= s^3 \\ \sqrt[3]{2146.2} &= s \\ 12.899\,02\ldots &= s \end{aligned}$$
The edge length of the cube would be approximately 12.9 cm.

12. 24 ft

13. 12.5 ft

14. 6 m × 6 m × 6 m

15. 1331 mm^3

16. approximately 6.2 m

17. 9 m by 9 m by 9 m

18. 16 cm

19. **a)** $y = 60$ **b)** $y = 192$

20. **a)** $x = 6$ **b)** $x = 23$

21. Volume of the tank in cubic inches:
$$\begin{aligned} 1\text{ ft}^3 &= (12\text{ in.})(12\text{ in.})(12\text{ in.}) \\ &= 1728\text{ in.}^3 \\ 54\text{ ft}^3 &= (54)(1728) \\ &= 93\,312 \end{aligned}$$
The volume of the tank is equal to 93 312 in.^3
Volume of one balloon:
$$V = \frac{4}{3}\pi r^3$$
$$V = \frac{4}{3}\pi(6)^3$$
$$V = 288\pi$$
$$V = 904.778\,761\ldots$$
The volume of one balloon is approximately 904.78 in.^3
Number of balloons inflated per full tank:
$$\frac{\text{volume of tank}}{\text{volume of balloon}} = \frac{93\,312}{904.778\,761\ldots}$$
$$V = 103.13\ldots$$
A full tank will inflate approximately 103 balloons.

22. 575 cm^2

23. a)

$\sqrt{25}$	5
$\sqrt{2.5}$	1.581…
$\sqrt{0.25}$	0.5
$\sqrt{0.025}$	0.158…
$\sqrt{0.0025}$	0.05
$\sqrt{0.00025}$	0.015…

b)

$\sqrt{81}$	9
$\sqrt{8.1}$	2.846…
$\sqrt{0.81}$	0.9
$\sqrt{0.081}$	0.284…
$\sqrt{0.0081}$	0.09
$\sqrt{0.00081}$	0.028…

c) Answers may vary. Look for the idea that a perfect decimal square exists if it has an even number of zeros before the perfect square number.

24. The expression $\sqrt{-25}$ is not a perfect square because when you multiply two positive or two negative numbers the answer is always positive. The expression $\sqrt[3]{-27}$ is a perfect cube because when you multiply three negative numbers, such as (−3)(−3)(−3), the answer is negative. Therefore, it is possible to have a negative perfect cube.

25. a) When you double the side lengths of a square, the area increases by a factor of 2^2 or 4. Example:
$A = s^2$
$= (2s)^2$
$= 4s^2$
When you triple the side lengths, the area increases by a factor of 3^2 or 9. Example:
$A = s^2$
$= (3s)^2$
$= 9s^2$

b) When you double the edge lengths of a cube, the volume increases by a factor of 2^3 or 8. Example:
$V = s^3$
$= (2s)^3$
$= 8s^3$
When you triple the edge lengths, the volume increases by a factor of 3^3 or 27. Example:
$V = s^3$
$= (3s)^3$
$= 27s^3$

4.2 Integral Exponents

1. a) $\frac{1}{4^2}$ b) $\frac{3}{x^3}$
c) $\frac{1}{(5x)^2}$ or $\frac{1}{25x^2}$ d) $\frac{6}{a^3b^2}$
e) $\frac{-5}{a^4}$ f) $\frac{-4a^4}{b^5}$
g) $\left(\frac{3}{2}\right)^3$ h) $-3x^2y^4$
i) $\frac{6}{a^3b^4}$

2. No. Shelby's answer is incorrect. The correct answer is $\frac{16x^{10}}{y^6}$.

3. a) 0.3644 b) −0.125
c) 0.0625 d) −1
e) 4096 f) 2.8477

4. a) $\frac{a^4}{b^5}$ b) $\frac{-2b^2}{a^3}$
c) p^{12} d) $3s^{10}$
e) $\frac{x^8}{6^2}$ f) t^{16}
g) $\frac{1}{n^4}$ h) $\frac{y^6}{x^2}$

5. a) $(6)^{-3}(6) = 6^{-3+1}$
$= 6^{-2}$
$= \frac{1}{6^2}$

b) $\frac{(-2)^{-6}}{(-2)^{-3}} = (-2)^{-6-(-3)}$
$= (-2)^{-3}$
$= \frac{1}{(-2)^3}$

c) $\frac{3^3}{3^{-2}} = 3^{3-(-2)}$
$= 3^5$

d) $\left(\frac{4^0}{4^{-2}}\right)^2 = (4^{0-(-2)})^2$
$= (4^2)^2$
$= 4^4$

e) $(6^{-4})^2 = 6^{(-4)(2)}$
$= 6^{-8}$
$= \frac{1}{6^8}$

f) $-(3^4)^{-3} = -(3)^{(4)(-3)}$
$= -(3)^{-12}$
$= \frac{-1}{(3)^{12}}$

g) $[(2^4)(2^{-7})]^{-3} = [(2)^{4+(-7)}]^{-3}$
$= [(2)^{-3}]^{-3}$
$= 2^{(-3)(-3)}$
$= 2^9$

h) $\left(\frac{3^3}{4^3}\right)^{-2} = \frac{(3)^{(3)(-2)}}{(4)^{(3)(-2)}}$
$= \frac{3^{-6}}{4^{-6}}$
$= \frac{4^6}{3^6}$

i) $(4a^{-3})^{-2} = (4)^{-2}a^{(-3)(-2)}$
$= (4)^{-2}a^6$
$= \frac{a^6}{4^2}$

j) $-3[(2^4)(2^{-3})]^{-2} = -3[(2)^{4+(-3)}]^{-2}$
$= -3[(2)^1]^{-2}$
$= -3(2)^{-2}$
$= \frac{-3}{2^2}$

6. **a)** 27 200 cm^2 **b)** 7 130 316 800 cm^2

7. approximately 1638 caribou

8. **a)** 3200 bacteria **b)** 6 710 886 400 bacteria **c)** 50 bacteria

9. $\left[\left((2^{-1})^2\right)^3\right]^{-1} = \left[\left(\left(\frac{1}{2}\right)^2\right)^3\right]^{-1}$
$= \left[\left(\frac{1}{4}\right)^3\right]^{-1}$
$= \left[\frac{1}{64}\right]^{-1}$
$= 64$

Or, some students may evaluate as $2^6 = 64$.

10. No. Kevin is incorrect. Example: Since the bases are not the same, you cannot add the exponents. When simplified, the expression $(2^3)(3^2) = (8)(9) = 72$. The power $6^5 = 7776$.

11. **a)** 25 g **b)** 800 g

12. **a)** $d = \frac{1}{2}gt^2$
$= \frac{1}{2}(9.8)(12.4^2)$
$= (4.9)(153.76)$
$= 753.424$
The penny falls from a height of approximately 753.4 m.

b) $d = \frac{1}{2}gt^2$
$28.5 = \frac{1}{2}(9.8)t^2$
$28.5 = (4.9)t^2$
$\frac{28.5}{4.9} = t^2$
$t^2 = 5.816\,326\,5\ldots$
$t = \sqrt{5.816\,326\,5}$
$t = 2.411\,706\,1\ldots$
It takes approximately 2.4 s for the penny to fall.

c) $d = \frac{1}{2}gt^2$
$248 = \frac{1}{2}(9.8)t^2$
$248 = (4.9)t^2$
$\frac{248}{4.9} = t^2$
$t^2 = 50.612\,244\ldots$
$t = \sqrt{50.612\,244\ldots}$
$t = 7.114\,228\,2\ldots$
It takes approximately 7.1 s for the penny to fall.

13. **a)** approximately 7.6×10^9 or 7.6 billion people
b) approximately 8.3×10^9 or 8.3 billion people

14. **a)** approximately 3.65×10^7 or 36.5 million people
b) approximately 3.75×10^7 or 37.5 million people

15. **a)** $A = 0.01(2)^3 = 0.08$ After 3 years, the payment will be \$0.08.
$A = 0.01(2)^{10} = 10.24$ After 10 years, the payment will be \$10.24.
$A = 0.01(2)^{25} = 335\,544.32$. After 25 years, the payment will be \$335 544 32.

b) Accept any reasonable justification. Examples:
- I would accept the double the money offer because it is worth more over time.
- I would accept the cash prize because it is immediate and I have few financial resources at the present time.

c) Years 0–10 total = \$20.47; years 11–20 total = \$20 951.04; years 21–25 total = \$650 117.12. The total value over 25 years is \$671 088.63.

16. a) 21.5 g **b)** approximately 1.34 g
c) approximately 0.34 g

17. a) $x = -4$ **b)** $x = 6$
c) $x = \frac{2}{3}$ **d)** $x = 3$

18. a) approximately 1.05 g
b) approximately 0.22 g

19. Yes. Example: When you multiply the exponents within each expression, both are equal to 2^{24}.

20.
$$\begin{aligned} 2^x + 2^x + 2^x + 2^x &= 256 \\ 2^x(1 + 1 + 1 + 1) &= 256 \\ 2^x &= \frac{256}{4} \\ 2^x &= 64 \\ 2^x &= 2^6 \\ x &= 6 \end{aligned}$$
or
$$\begin{aligned} 2^x + 2^x + 2^x + 2^x &= 256 \\ 2^x(4) &= 256 \\ 2^x(2^2) &= 256 \\ 2^{x+2} &= 2^8 \\ x + 2 &= 8 \\ x &= 6 \end{aligned}$$

21. For $2^2 + 2^3 + 2^4$, use the order of operations to evaluate each power and then add the resulting values: $4 + 8 + 16 = 28$. For $(2^2)(2^3)(2^4)$, since the powers have a common base, you can multiply by adding the exponents : $2^9 = 512$.

22. Example: calculating student enrollment at schools in the community.

a) You would use a positive exponent to predict enrollment in future years beyond the current year.

b) You would use a negative exponent to calculate student enrollment in years before the current year.

4.3 Rational Exponents

1. a) $a^{\frac{15}{2}}$ **b)** $y^{\frac{5}{6}}$
c) $x^{0.9}$ or $x^{\frac{9}{10}}$ **d)** $a^{0.6}$
e) x^{-4} or $\frac{1}{x^4}$ **f)** 9
g) $\frac{-4x^{\frac{1}{12}}}{3}$ **h)** $-10a^{\frac{11}{10}}$
i) $4a^{1.5}$ or $4a^{\frac{3}{2}}$

2. a) $\frac{1}{a^{\frac{5}{4}}}$ **b)** $\frac{1}{4}$
c) $y^{\frac{2}{3}}$ **d)** $\frac{1}{a^{\frac{7}{8}}}$
e) $a^{1.5}b^3$ or $a^{\frac{3}{2}}b^3$ **f)** $\frac{64x^{\frac{9}{4}}}{125}$
g) $\frac{3y^{\frac{2}{3}}}{2x^{\frac{3}{2}}}$ **h)** $\frac{3x^{\frac{1}{6}}}{5y^{\frac{3}{20}}}$

3. a)
$$\begin{aligned} \left(x^{\frac{2}{3}}\right)^q &= x^{\frac{4}{3}} \\ x^{\frac{2q}{3}} &= x^{\frac{4}{3}} \\ \frac{2q}{3} &= \frac{4}{3} \\ 2q &= 4 \\ q &= 2 \\ \left(x^{\frac{2}{3}}\right)^2 &= x^{\frac{4}{3}} \end{aligned}$$

b)
$$\begin{aligned} \left(x^{\frac{-2}{3}}\right)(x^q) &= x^{\frac{-1}{6}} \\ x^{\frac{-2}{3}+q} &= x^{\frac{-1}{6}} \\ \frac{-2}{3} + q &= \frac{-1}{6} \\ q &= \frac{-1}{6} + \frac{2}{3} \\ q &= \frac{-1}{6} + \frac{4}{6} \\ q &= \frac{3}{6} = \frac{1}{2} \\ \left(x^{\frac{-2}{3}}\right)\left(x^{\frac{1}{2}}\right) &= x^{\frac{-1}{6}} \end{aligned}$$

c) $\dfrac{y^{\frac{2}{3}}}{y^{q}} = y^{\frac{11}{12}}$

$y^{\frac{2}{3} - q} = y^{\frac{11}{12}}$

$\frac{2}{3} - q = \frac{11}{12}$

$-q = \frac{11}{12} - \frac{2}{3}$

$-q = \frac{11}{12} - \frac{8}{12}$

$-q = \frac{3}{12}$

$q = \frac{-3}{12}$

$q = \frac{-1}{4}$

$\dfrac{y^{\frac{2}{3}}}{y^{\frac{-1}{4}}} = y^{\frac{11}{12}}$

d) $(27x^2)^{\frac{1}{3}}(qx^2)^{\frac{-1}{2}} = \dfrac{3}{2x^{\frac{1}{3}}}$

$\left(3x^{\frac{2}{3}}\right)\left(\dfrac{x^{-1}}{q^{\frac{1}{2}}}\right) = \dfrac{3}{2x^{\frac{1}{3}}}$

$\dfrac{3x^{\frac{2}{3}+(-1)}}{q^{\frac{1}{2}}} = \dfrac{3}{2x^{\frac{1}{3}}}$

$\dfrac{3x^{\frac{2}{3}+\left(\frac{-3}{3}\right)}}{q^{\frac{1}{2}}} = \dfrac{3}{2x^{\frac{1}{3}}}$

$\dfrac{3x^{\frac{-1}{3}}}{q^{\frac{1}{2}}} = \dfrac{3}{2x^{\frac{1}{3}}}$

$\dfrac{3}{q^{\frac{1}{2}}x^{\frac{1}{3}}} = \dfrac{3}{2x^{\frac{1}{3}}}$

$q^{\frac{1}{2}} = 2$

$\sqrt{q} = 2$

$q = 4$

$(27x^2)^{\frac{1}{3}}(4x^2)^{\frac{-1}{2}} = \dfrac{3}{2x^{\frac{1}{3}}}$

e) $(5^q)(-3^{-q}) = \dfrac{-125}{27}$

$\left(\dfrac{5^q}{-3^q}\right) = \dfrac{-125}{27}$

$\left(\dfrac{5}{-3}\right)^q = \dfrac{-125}{27}$

$\left(\dfrac{5}{-3}\right)^q = \left(\dfrac{-5^3}{3^3}\right)$

$\left(\dfrac{5}{-3}\right)^q = \left(\dfrac{-5}{3}\right)^3$

$q = 3$

$(5^3)(-3^{-3}) = \dfrac{-125}{27}$

4. a) 8 b) 9
c) $\frac{1}{32}$ d) $\frac{343}{27}$
e) $\dfrac{25x^{\frac{4}{3}}}{4y^2}$ f) 5

5. a) 0.037 b) 512
c) 52.1959 d) 11.0553
e) 0.037 f) 6.3227

6. a) 863 trout b) 1409 trout
c) 911 trout d) 1264 trout

7. a) Error: A common denominator is needed to subtract exponents.

$\dfrac{a^{\frac{2}{3}}}{a^{\frac{1}{4}}} = a^{\frac{2}{3} - \frac{1}{4}}$

$= a^{\frac{8}{12} - \frac{3}{12}}$

$= a^{\frac{5}{12}}$

b) Errors: The negative exponent needs to be converted to a positive exponent. The expression $16^{0.5}$ is equal to 4, not 8.

$\left(16y^{-6}\right)^{-0.5} = (16)^{-0.5}(y^{-6})^{-0.5}$

$= \dfrac{1}{16^{0.5}}y^{(-6)(-0.5)}$

$= \dfrac{1}{4}y^3$

8. a) \$1651.05 b) \$1624.86

9. a) 1.5 represents the growth rate; 1000 represents the starting population
b) approximately 2646 bacteria
c) approximately 614 bacteria

10. a) 35.600 million people
b) 33.155 million people

11. a) $A = 28(0.5)^{\frac{t}{20}}$

$= 28(0.5)^{\frac{45}{20}}$

$= 5.886\,274\ldots$

After 45 min, approximately 5.89 g remain.

b) $A = 28(0.5)^{\frac{t}{20}}$

$= 28(0.5)^6$

$= 0.4375$

After 2 h, approximately 0.44 g remain.

c) $A = 28(0.5)^{\frac{t}{20}}$

$= 28(0.5)^{\frac{195}{20}}$

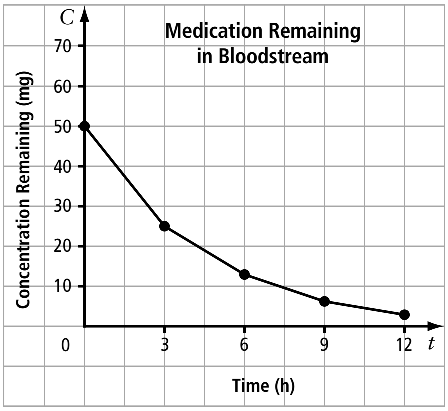
$= 0.032\,58$

After $3\frac{1}{4}$ h, approximately 0.03 g remain.

12. a)

Time (t)	0	3	6	9	12
Concentration (C)	50	25	12.5	6.25	3.125

b)



c) $t = 24$ h **d)** $A = 0.003\,05$ mg

13. 81.92 g

14. a) \$3432.14 **b)** \$759.57

15.
$$4^{\frac{1}{2}} + 4^{\frac{1}{2}} + 4^{\frac{1}{2}} + 4^{\frac{1}{2}} = 4^x$$
$$4^{\frac{1}{2}}(1 + 1 + 1 + 1) = 4^x$$
$$4^{\frac{1}{2}}(4) = 4^x$$
$$4^{\frac{1}{2}+1} = 4^x$$
$$4^{\frac{1}{2}+\frac{2}{2}} = 4^x$$
$$4^{\frac{3}{2}} = 4^x$$
$$x = \frac{3}{2}$$

4.4 Irrational Numbers

1. a) $(\sqrt[3]{5})^2$ **b)** $(\sqrt[4]{8})^3$
c) $(\sqrt[5]{6})^3$ **d)** $\sqrt{81}$
e) $\frac{1}{9^{\frac{5}{3}}} = \left[\left(\frac{1}{9}\right)^{\frac{1}{3}}\right]^5 = \left(\sqrt[3]{\frac{1}{9}}\right)^5$
f) $\sqrt[4]{x^3}$ **g)** $(\sqrt[3]{a})^2$
h) $\left(\sqrt[3]{\frac{x}{y}}\right)^2$

2. a) $3^{\frac{3}{4}}$ **b)** $(5t)^{\frac{4}{3}}$
c) $x^{\frac{2}{3}}$ **d)** $\left(\frac{a^2}{b^3}\right)^{\frac{1}{5}}$ or $\frac{a^{\frac{2}{5}}}{b^{\frac{3}{5}}}$
e) $y^{\frac{5}{6}}$ **f)** $2^{\frac{3}{a}}$

3. a) 0.5 **b)** 4
c) 10.3923 **d)** 1.25
e) 4.5861 **f)** 0.7274

4. a) $4\sqrt{5} = \sqrt{(4^2)}\sqrt{5}$
$= \sqrt{(16)(5)}$
$= \sqrt{80}$
b) $\sqrt{36}$
c) $\sqrt{325}$ **d)** $\sqrt{384.4}$
e) $\sqrt{174.24}$ **f)** $\sqrt{\frac{10}{25}}$ or $\sqrt{\frac{2}{5}}$

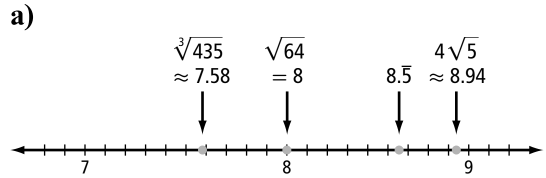
5. a) $\sqrt[3]{135}$ **b)** $\sqrt[3]{1029}$
c) $\sqrt[3]{750}$ **d)** $\sqrt[4]{112}$
e) $\sqrt[3]{\frac{5}{8}}$ **f)** $\sqrt[4]{50.625}$

6. a) $4\sqrt{2}$ **b)** $2\sqrt{11}$
c) $3\sqrt{10}$ **d)** $4\sqrt{5}$
e) $6\sqrt{10}$ **f)** $5\sqrt{19}$

7. a) $2\sqrt[3]{6}$ **b)** $2\sqrt[3]{15}$
c) $3\sqrt[3]{12}$ **d)** $2\sqrt[4]{3}$
e) $3\sqrt[4]{5}$ **f)** $2\sqrt[4]{13}$

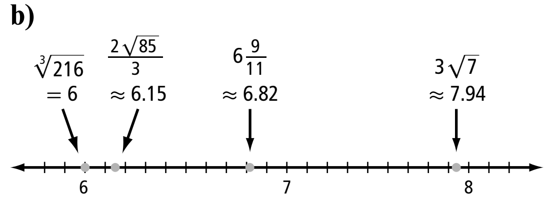
8. a) $0.\overline{7}$, $\frac{3}{4}$, $0.5\sqrt{2}$, $\sqrt{0.49}$; $0.5\sqrt{2}$ is an irrational number.
b) $\sqrt[3]{0.343}$, $\frac{2}{3}$, 0.62, $\sqrt{0.38}$; $\sqrt{0.38}$ is an irrational number.

9. a)



$\sqrt[3]{435}$ and $4\sqrt{5}$ are irrational numbers.

b)



$\frac{2\sqrt{85}}{3}$ and $3\sqrt{7}$ are irrational numbers.

10. approximately 10.093 cm

11. approximately 16.54 cm

12.
$$V = s^3$$
$$(1.3)(10^9) = s^3$$
$$\sqrt[3]{(1.3)(10^9)} = s$$
$$1091 = s$$
The edge length of a cube that contained Earth's estimated total volume of water would be approximately 1091 km.

13. a) approximately 3.16 cm
b) approximately 7.68 cm

14. 2.72 s

15. approximately 86 cm

16. a) solution B: 0.15 M
b) solution A: 0.73 M

17. a) approximately 110 m
b) approximately 38 013.3 m^2

18.
$$\begin{aligned} SA &= 2\pi\left[h\left(\sqrt{\frac{V}{\pi h}}\right) + \left(\frac{V}{\pi h}\right)\right] \\ &= 2\pi\left[26\left(\sqrt{\frac{26\,465}{26\pi}}\right) + \left(\frac{26\,465}{26\pi}\right)\right] \\ &= 2\pi[26(18.000\,076) + (324.002\,736)] \\ &= 2\pi[468.001\,976 + 324.002\,736] \\ &= 2\pi[792.004\,712] \\ &= 4976.312\,37 \end{aligned}$$

The surface area of the cylinder is 4976 m^2.

19. a) 2 **b)** 5

c)
$$\begin{aligned} \sqrt{4 + \sqrt{19 + \sqrt{36}}} &= \sqrt{4 + \sqrt{19 + 6}} \\ &= \sqrt{4 + \sqrt{25}} \\ &= \sqrt{4 + 5} \\ &= \sqrt{9} \\ &= 3 \end{aligned}$$

d)
$$\begin{aligned} \sqrt[4]{13 + \sqrt[3]{22 + \sqrt[3]{125}}} &= \sqrt[4]{13 + \sqrt[3]{22 + 5}} \\ &= \sqrt[4]{13 + \sqrt[3]{27}} \\ &= \sqrt[4]{13 + 3} \\ &= \sqrt[4]{16} \\ &= 2 \end{aligned}$$

20. a)
$$\begin{aligned} \sqrt[3]{\sqrt{7}} &= (\sqrt{7})^{\frac{1}{3}} \\ &= \left(7^{\frac{1}{2}}\right)^{\frac{1}{3}} \\ &= 7^{\frac{1}{6}} \end{aligned}$$

b)
$$\begin{aligned} \sqrt[4]{\sqrt[3]{5^2}} &= \left(\sqrt[3]{5^2}\right)^{\frac{1}{4}} \\ &= \left[(5^2)^{\frac{1}{3}}\right]^{\frac{1}{4}} \\ &= 5^{(2)\left(\frac{1}{3}\right)\left(\frac{1}{4}\right)} \\ &= 5^{\frac{1}{6}} \end{aligned}$$

c) $\left(\frac{1}{8}\right)^{\frac{1}{10}}$ **d)** $\left(\frac{2}{5}\right)^{\frac{1}{2}}$

21. The expression $\sqrt[4]{x^3}$ does not have a solution when x is negative. It is not possible to determine the even root of a negative number. Example: The expression $\sqrt[4]{x^3} = \sqrt[4]{(-3)^3} = \sqrt[4]{-27}$ has no solution.

22. The expression $\sqrt[3]{x^4}$ always has a solution because when you raise a negative number to an even exponent, the result is always a positive number and then it is possible to take the cube root of the positive number.

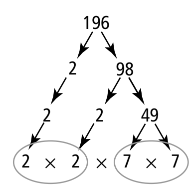
23. a) Example: For all non-perfect squares, the calculator screen shows 9 decimals.
b) Yes. Example: The square root of each non-perfect square is an irrational number since it cannot be expressed as a terminating or a repeating decimal.

Chapter 4 Review

4.1 Square Roots and Cube Roots

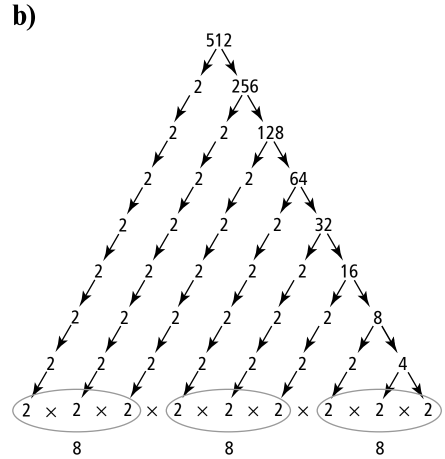
1. a) perfect square **b)** perfect cube
c) perfect square **d)** perfect cube
e) perfect square **f)** both

2. a)



There is one group of 2 and one group of 7.
Therefore, the square root of 196 is (2)(7) = 14.

b)



There are three equal groups of 2s.
Therefore, the cube root of 512 is (2)(2)(2) = 8.

3. **a)** 16 **b)** 13 **c)** 30

4. 19 cm by 19 cm

5. **a)** Area of floor = 81 ft^2
Area of one tile: Convert from inches to feet: 6 in. = 0.5 ft
Area of tile in feet: $(0.5)^2 = 0.25$ ft^2
Divide the area of the floor by the area of the tile to determine the number of tiles needed:
$\frac{\text{area of floor}}{\text{area of tile}} = \frac{81}{0.25} = 324$
She will need 324 tiles.
b) $324 \times 1.38 = 447.12$ The tiles will cost \$447.12.

4.2 Integral Exponents

6. **a)** $\frac{1}{a^6}$ **b)** $(3.5)^7$
c) $\left(\frac{b^2}{b^{-5}}\right)^2 = \frac{b^{(2)(2)}}{b^{(-5)(2)}}$
$= \frac{b^4}{b^{-10}}$
$= b^{4-(-10)}$
$= b^{4+10}$
$= b^{14}$

7. **a)** $\frac{1}{81}$ or 0.012 **b)** 2.097
c) 3933.798

8. **a)** approximately 11.56 g
b) approximately 0.045 g
c) approximately 11 840 g

9. **a)** 146 475 moose
b) 158 925 moose
c) 202 993 moose

10. **a)** approximately 331 177 moose
b) approximately 64 783 moose

4.3 Rational Exponents

11. **a)** As a fraction:
$(5^{-0.5})^{\frac{3}{4}} = \left(5^{\frac{-1}{2}}\right)^{\frac{3}{4}}$
$= 5^{\left(\frac{-1}{2}\right)\left(\frac{3}{4}\right)}$
$= 5^{\frac{-3}{8}}$
$= \frac{1}{5^{\frac{3}{8}}}$

As a decimal:
$(5^{-0.5})^{\frac{3}{4}} = (5^{-0.5})^{0.75}$
$= 5^{(-0.5)(0.75)}$
$= 5^{-0.375}$
$= \frac{1}{5^{0.375}}$

b) As a fraction:
$\frac{2.8^{0.4}}{2.8^{\frac{-1}{2}}} = \frac{2.8^{\frac{4}{10}}}{2.8^{\frac{-1}{2}}}$
$= 2.8^{\frac{4}{10}-\frac{-1}{2}}$
$= 2.8^{\frac{4}{10}+\frac{5}{10}}$
$= 2.8^{\frac{9}{10}}$

As a decimal:
$\frac{2.8^{0.4}}{2.8^{\frac{-1}{2}}} = \frac{2.8^{0.4}}{2.8^{-0.5}}$
$= 2.8^{0.4-(-0.5)}$
$= 2.8^{0.4+0.5}$
$= 2.8^{0.9}$

c) $(27x^{-2})^{\frac{-2}{3}} = (27)^{\frac{-2}{3}}(x^{-2})^{\frac{-2}{3}}$
$= \left(\frac{1}{27^{\frac{2}{3}}}\right)\left(x^{(-2)\left(\frac{-2}{3}\right)}\right)$
$= \left(\frac{1}{\sqrt[3]{27^2}}\right)\left(x^{\frac{4}{3}}\right)$
$= \left(\frac{1}{3^2}\right)\left(x^{\frac{4}{3}}\right)$
$= \frac{x^{\frac{4}{3}}}{9}$

12. $(27x)^{\frac{-1}{3}}(9x)^{\frac{1}{2}} = \frac{3x^{\frac{1}{2}}}{3x^{\frac{1}{3}}}$, not $243x^{\left(\frac{-1}{3}+\frac{1}{2}\right)}$.
The correct answer is $x^{\frac{1}{6}}$.

13. **a)** $\frac{8^{\frac{5}{3}}}{4^2} = \frac{(2^3)^{\frac{5}{3}}}{(2^2)^2}$
$= \frac{2^{(3)\left(\frac{5}{3}\right)}}{2^{(2)(2)}}$
$= \frac{2^5}{2^4}$
$= 2^{5-4}$
$= 2$

b) $\dfrac{125^{\frac{2}{3}}}{5^{-1}} = \dfrac{(5^3)^{\frac{2}{3}}}{5^{-1}}$

$= \dfrac{5^{(3)\left(\frac{2}{3}\right)}}{5^{-1}}$

$= 5^{2-(-1)}$

$= 5^3$

$= 125$

c) $\dfrac{9^{\frac{3}{2}}}{27^{\frac{1}{3}}} = \dfrac{(3^2)^{\frac{3}{2}}}{(3^3)^{\frac{1}{3}}}$

$= \dfrac{3^3}{3}$

$= 3^{3-1}$

$= 3^2$

$= 9$

d) $\dfrac{8^{\frac{2}{3}}}{32^{\frac{4}{5}}} = \dfrac{(2^3)^{\frac{2}{3}}}{(2^5)^{\frac{4}{5}}}$

$= \dfrac{2^{(3)\left(\frac{2}{3}\right)}}{2^{(5)\left(\frac{4}{5}\right)}}$

$= \dfrac{2^2}{2^4}$

$= 2^{2-4}$

$= 2^{-2}$

$= \dfrac{1}{2^2}$

$= \dfrac{1}{4}$

14. a) 15.5816 **b)** 0.0917
c) 9.8821 **d)** 19.5313

15. \$1651.05

16. approximately \$525.28

17. 0.706 mg

4.4 Irrational Numbers

18. a) $\sqrt[5]{x^2}$ **b)** $\left(\sqrt[5]{16s^3}\right)^3$
c) $\left(\sqrt[4]{\dfrac{a^5}{7}}\right)^3$ **d)** $\sqrt[3]{\dfrac{1}{5a^4}}$

19. a) $x^{\frac{5}{2}}$ **b)** $5^{\frac{1}{2}}$
c) $4x^{\frac{3}{5}}$ **d)** $(4y)^{\frac{4}{3}}$

20. a) $\sqrt{112}$ **b)** $\sqrt{180}$
c) $3\sqrt[3]{2} = \sqrt[3]{(3^3)}\sqrt[3]{2}$

$= \sqrt[3]{(3^3)(2)}$

$= \sqrt[3]{(27)(2)}$

$= \sqrt[3]{54}$

d) $\sqrt[3]{-375}$

21. a) $6\sqrt{7}$ **b)** $4\sqrt[3]{6}$
c) $2\sqrt[4]{3}$ **d)** $3\sqrt[3]{15}$

22. a) Irrational numbers: $\dfrac{4\sqrt{5}}{2}$; Order: $\sqrt[3]{216}$, $\dfrac{4\sqrt{5}}{2}$, $\sqrt{0.25}$, $0.2\overline{3}$
b) Irrational numbers: $\sqrt[3]{32}$; Order: $\dfrac{3\sqrt{25}}{4}$, $\sqrt[3]{32}$, $\sqrt{0.81}$, $0.\overline{49}$

23. a) approximately 68 607.17 cm^3
b) approximately 4.5 cm

Chapters 1–4 Cumulative Review

1. 10 cm

2. a) 92 500 mm^2 **b)** 0.0097 m^2
c) 74 322.432 cm^2

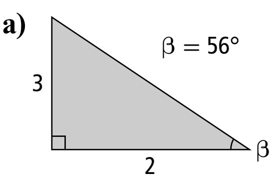
3. a) perfect cube **b)** both
c) perfect cube **d)** perfect square
e) neither

4. a) hypotenuse : ZX; adjacent side: ZY; opposite side: XY
b) hypotenuse: ST; adjacent side: SR; opposite side: RT
c) hypotenuse: ML; adjacent side: MN; opposite side: LN

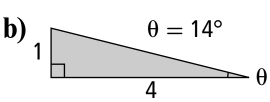
5. a) $2\frac{13}{16}$ in.; 7.1 cm **b)** 3.52 cm; 1.4 in.

6. 17.76 lb; 6 bags

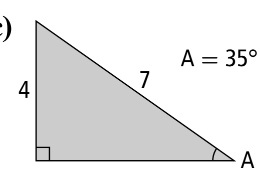
7. a)



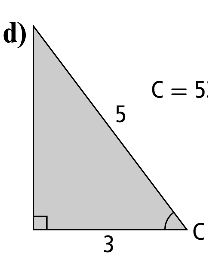
b)



c)



d)



8. 13 cm × 13 cm × 13 cm

9. **a)** 3845.31 mm^2 **b)** 4300.84 cm^2
   c) 421 ft^2

10. **a)** 107.11 m
    b) He is closer to the building. He is now 89.38 m from the building instead of 107.11 m.

11. **a)** 0.0000 **b)** 0.3875
    c) 0.3090 **d)** 0.5317

12. **a)** $\frac{1}{x^{15}}$ **b)** b^8
    c) $\frac{1}{(-5.6)^5}$

13. **a)** 1 : 3 **b)** 53.1 rotations
    c) 560.2 rotations

14. **a)** 0.99 kg **b)** 0.42 kg

15. **a)** $x \approx 9.1$ units; $y \approx 4.2$ units
    b) $x \approx 8.3$ units; $y \approx 10.9$ units
    c) $\angle B = 25°$; $\angle C = 65°$; CB ≈ 16.6 units

16. **a)** 10.13 cm **b)** 9.2 in.
    c) 1.02 yd

17. **a)** 13.9666 **b)** −0.5946
    c) 0.0001 **d)** 3.6742

18. **a)** 511 185 932.5 km^2
    b) 37 936 694.79 km^2
    c) 1347.47%

19. **a)** $14\frac{3}{4}$ in. **b)** $2\frac{3}{4}$ yd
    c) 28.4 mi **d)** 42 240 ft

20. 8 cm × 8 cm × 8 cm

21. 20.8°

22. **a)** $3\sqrt{6}$ **b)** $16\sqrt{2}$
    c) $3\sqrt[3]{5}$ **d)** $2\sqrt[4]{9}$

23. **a)** $\sqrt[7]{x^2}$ **b)** $\sqrt[5]{13t^4}$
    c) $\sqrt{\frac{h^2}{12}}$

Chapter 4 Extend It Further

1. B
2. C
3. D
4. D
5. C
6. C

7. $$\begin{aligned}(\sqrt{5})(\sqrt[3]{7}) &= \left(5^{\frac{1}{2}}\right)\left(7^{\frac{1}{3}}\right)\\ &= \left(5^{\frac{3}{6}}\right)\left(7^{\frac{2}{6}}\right)\\ &= [(5^3)\,(7^2)]^{\frac{1}{6}}\\ &= 6125^{\frac{1}{6}}\end{aligned}$$

8. No. Let $a = \sqrt{3}$ and $b = \sqrt{2}$. It follows that $a^b = (\sqrt{3})^{\sqrt{2}}$, which could be irrational. Then, consider $\left[(\sqrt{3})^{\sqrt{2}}\right]^{\sqrt{2}} = (\sqrt{3})^2 = 3$, which is rational.

9. $$\begin{aligned}\frac{3^{n+2} - 3^{n+1}}{3^{n+3}} &= \frac{9(3^n) - 3(3^n)}{27(3^n)}\\ &= \frac{6}{27}\\ &= \frac{2}{9}\end{aligned}$$

10. $\sqrt[3]{2} = 1.2599$ or 26%

11. **a)** 64 **b)** −64
    c) $n > 0$ **d)** 64
    e) −64

12. n must be a perfect square. Only perfect squares have square roots.

13. $t = \frac{-3}{4}$

14. $\frac{1}{2009}$

15. 6: The factors of 32 are 1, 2, 4, 8, 16, and 32. Each gives a different solution. They are $(2^1)^{32} = (2^{32})^1 = (2^2)^{16} = (2^{16})^2 = (2^4)^8 = (2^8)^4$.

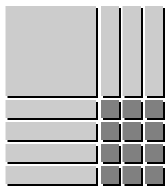
16. $$\begin{aligned}A &= P(1 + i)^n\\ (12\,500.00 + 878.29) &= 12\,500.00\,(1 + i)^{\frac{33}{12}}\\ 13\,378.29 &= 12\,500.00(1 + i)^{2.75}\\ \frac{13\,378.29}{12\,500.00} &= \frac{12\,500.00(1 + i)^{2.75}}{12\,500.00}\\ 1.070\,263\,2 &= (1 + i)^{2.75}\\ \sqrt[2.75]{1.070\,263\,2} &= (1 + i)\\ 1.024\,999\,968 &= (1 + i)\\ 1.024\,999\,968 - 1 &= i\\ 0.024\,999\,968 &= i\\ i &= 2.5\%\end{aligned}$$

Chapter 5 Polynomials

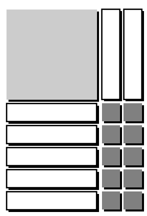
5.1 Multiplying Polynomials

1. **a)** $3x^2 - 5x + 2$; $(3x - 2)(x - 1)$
b) $2x^2 + x - 6$; $(2x - 3)(x + 2)$

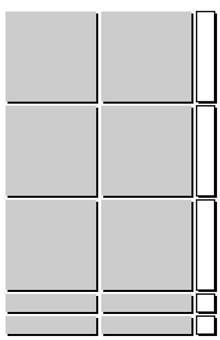
2. **a)**



b)

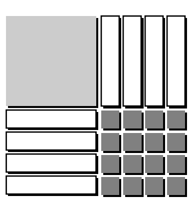


c)

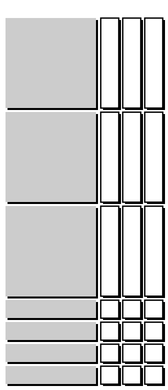


d)

e)



f)



3. **a)** $2x^2 - 4x - 16$
b) $t^2 + 9t + 20$
c) $6w^2 - 23w - 18$
d) $z^2 - 4$
e) $a^2 + 2ab + b^2$
f) $30e^2 + 25e - 5$

4. **a)** E **b)** H
c) A **d)** G
e) B **f)** C
g) D **h)** F

5. **a)** A **b)** D
c) C **d)** B
e) B **f)** A

6. **a)** $2d^3 + 11d^2 + 13d - 6$
b) $4s^3 - 41s^2 + 41s + 5$
c) $5k^3 - k^2 + 7k$
d) $3c^3 + 18c^2 + 45c + 42$
e) $10y^4 + 8y^3 - 32y^2 + 6y$
f) $(r^2 - 5r - 3)(3r^2 - 4r - 5)$
$= r^2(3r^2 - 4r - 5) - 5r(3r^2 - 4r - 5)$
$-3(3r^2 - 4r - 5)$
$= 3r^4 - 4r^3 - 5r^2 - 15r^3 + 20r^2 + 25r$
$- 9r^2 + 12r + 15$
$= 3r^4 - 4r^3 - 15r^3 - 5r^2 - 9r^2 + 20r^2$
$+ 25r + 12r + 15$
$= 3r^4 - 19r^3 + 6r^2 + 37r + 15$

7. **a)** $120y^3 - 68y^2 - 144y - 36$
b) $8a^2 - 25a + 47$
c) $12d^2 - 32de - 15e^2$
d) $9n^2 - 4n + 58$
e) $6w^4 - 13w^3 - 15w^2 - 26w - 24$
f) $2(4t + 5s)(2t - 3s) - (5t - s)$
$= 2[4t(2t - 3s) + 5s(2t - 3s)] - 5t + s$
$= 2[8t^2 - 12st + 10st - 15s^2] - 5t + s$
$= 2[8t^2 - 2st - 15s^2] - 5t + s$
$= 16t^2 - 4st - 30s^2 - 5t + s$
$= 16t^2 - 5t - 4st + s - 30s^2$

8. **a)** $8a^2 + 5a + 1$
b) $4b^2 + 6b + 21$
c) $5x^2 - 5xy + 5y^2$
d) $23a^2 - 68ac - 28c^2$
e) $2x^4 - x^3 - 4x^2 + 17x - 12$
f) $12b^2 - 18bd - 5d^2$

9. **a)** Step 2;
$28t^2 - 33t - 7$
b) Step 3;
$2xy^2 + x^2y + xy - 3x$

10. a) The dimensions of the deck and the pool are $(x + 4)$ by $(x + 4)$.
The area of the deck and pool is
$(x + 4) \times (x + 4) = (x + 4)^2$.
$(x + 4)^2 = x(x + 4) + 4(x + 4)$
$= x^2 + 4x + 4x + 16$
$= x^2 + 8x + 16$.

b) The area of the pool is 49 m^2. If $x^2 = 49$, then $x = \sqrt{49} = 7$.
The area of pool and deck is
$x^2 + 8x + 16$.
Using the value for x, the total area is
$(7)^2 + 8(7) + 16 = 49 + 56 + 16 = 121$.
Thus, the area of the deck and the pool is 121 m^2.

11. a) $A(5x + 6)(2x + 4) = 10x^2 + 32x + 24$
b) 920 in.^{2}

12. a) $A = x^2 + 8x + 12$
b) The area of the diamond is one half the area of the rectangle.

13. a) $(5x - 2)(2x + 1)$
b) $(x - 1)(x + 3)$
c) $(5x - 2)(2x + 1) - (x - 1)(x + 3)$, $9x^2 - x + 1$

14. a) length: $30 - 2x$; width: $20 - 2x$; height: x
b) $x(30 - 2x)(20 - 2x)$
c) $600x - 100x^2 + 4x^3$

15. a) 4 cm × 5 cm × 6 cm = 120 cm^3
b) $V = n(n + 1)(n + 2)$
c) One way:
10 cm × 11 cm × 12 cm = 1320 cm^3
Another way:
$V = n(n + 1)(n + 2)$
$V = n^3 + 3n^2 + 2n$
$V = (10)^3 + 3(10)^2 + 2(10)$
$V = 1000 + 300 + 20$
$V = 1320$ cm^3

16. a) The square of the middle number is 4 greater than the product of the first and third numbers.
b) $(x - 2)$ and $(x + 2)$
c) $(x - 2)(x + 2) = x(x + 2) - 2(x + 2)$
$(x - 2)(x + 2) = x^2 + 2x - 2x - 4$
$(x - 2)(x + 2) = x^2 - 4$
$x^2 = (x - 2)(x + 2) + 4$

17. a)

Table A	
Numbers	Total
6, 7	42
7, 8	56
8, 9	72
9, 10	90
10, 11	110

Table B				
Numbers			Total	
5	25	15	2	42
6	36	18	2	56
7	49	21	2	72
8	64	24	2	90
9	81	27	2	110

b) $(n + 1)(n + 2) = n^2 + 3n + 2$

18. a) $(n + 3)(n + 2) - n(n + 1)$
b) $4n + 6$
c) $12 - 2 = 10$, $4(1) + 6 = 10$; $20 - 6 = 14$, $4(2) + 6 = 14$; $30 - 12 = 18$, $4(3) + 6 = 18$; $42 - 20 = 22$; $4(4) + 6 = 22$

5.2 Common Factors

1. a) 10: 1, 2, 5, 10; 15: 1, 3, 5, 15; GCF: 5
b) 24: 1, 2, 3, 4, 6, 8, 12, 24; 36: 1, 2, 3, 4, 6, 9, 12, 18, 36; GCF: 12
c) 16: 1, 2, 4, 8, 16; 48: 1, 2, 3, 4, 6, 8, 12, 16, 24, 48; GCF: 16
d) 40: 1, 2, 4, 5, 8, 10, 20, 40; 60: 1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30, 60; GCF: 20
e) 18: 1, 2, 3, 6, 9, 18; 45: 1, 3, 5, 9, 15, 45; GCF: 9
f) 14: 1, 2, 7, 14; 24: 1, 2, 3, 4, 6, 8, 12, 24; GCF: 2

2. a) $6x^2 = (2)(3)(x)(x)$;
$12x = (2)(2)(3)(x)$
b) $20c^2d^3 = (2)(2)(5)(c)(c)(d)(d)(d)$;
$30cd^2 = (2)(3)(5)(c)(d)(d)$
c) $4b^2c^3 = (2)(2)(b)(b)(c)(c)(c)$;
$6bc^2 = (2)(3)(b)(c)(c)$
d) $18xy^2z = (2)(3)(3)(x)(y)(y)(z)$;
$24x^2y^3z^2 = (2)(2)(2)(3)(x)(x)(y)(y)(y)(z)(z)$
e) $5m^3n = (5)(m)(m)(m)(n)$;
$20mn^2 = (2)(2)(5)(m)(n)(n)$

3. **a)** 2, 3, x; GCF: $(2)(3)(x) = 6x$
b) 2, 5, c, d; GCF: $(2)(5)(c)(d)(d) = 10cd^2$
c) 2, b, c; GCF: $(2)(b)(c)(c) = 2bc^2$
d) 2, 3, x, y, z;
GCF: $(2)(3)(x)(y)(y)(z) = 6xy^2z$
e) 5, m, n; GCF: $(5)(m)(n) = 5mn$

4. **a)** 7 **b)** $-5n$
c) 1 **d)** $4fg^2$
e) $-15de$ **f)** $9j^2k$

5. **a)** 80 **b)** 120
c) $18x$ **d)** $12t^3$
e) $2ab$ **f)** $504c^3d^2e^3$

6. **a)** $6(s + 5)$ **b)** $4(t + 7)$
c) $5(a - 1)$ **d)** $4r(4r - 3)$
e) $7x(y + 2y - 7z)$ **f)** $3(c^3 - 3c^2 - 9d^2)$

7. **a)** $3w - 1$ **b)** $2a^2$
c) $x^2y - 5x$ **d)** $g + 2$
e) $5xy$ **f)** $2r$

8. **a)** $(x - 6)$ **b)** $(a + 3)$
c) $(d - 9)$ **d)** $ab(b + 2)$
e) $x(x + 2)$ **f)** $2m(n - 1)$

9. **a)** $(s + 5)(s - 2)$ **b)** $(r - 7)(r - 4)$
c) $(g + 6)(g + 9)$ **d)** $(p + 3)(p + 4)$
e) $(b - 3)(b - 7)$ **f)** $(r - 3)(r + 2s)$

10. **a)** To find the largest number of centrepieces, identify the GCF of 36, 48, and 60.
The factors of 36 are 1, 2, 3, 4, 6, 9, 12, 18, and 36.
The factors of 48 are 1, 2, 3, 4, 6, 8, 12, 16, 24, and 48.
The factors of 60 are 1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30, and 60.
The GCF is 12, so that factor represents the largest number of centrepieces.
To determine how many of each type of flower per centrepiece, divide the number of each flower by 12:
$\frac{36}{12} = 3$, $\frac{48}{12} = 4$, $\frac{60}{12} = 5$
Each centrepiece will contain three roses, four daffodils, and five tulips.
b) The cost of each centrepiece will be the unit cost of each flower multiplied by the number of each flower added together:
$3 \times \$2.50 + 4 \times \$1.70 + 5 \times \$1.50 = \$21.80$
Therefore, the cost of each centrepiece is \$21.80.

11. **a)** no; $6(2x - 1)$ **b)** no; $-10w(w + 1)$
c) yes **d)** no; $(x + 3)(x + 2y)$
e) yes **f)** yes

12. Examples:
a) $4x^2 + 8x$
b) $6r^2s^2 + 9rs$
c) $10m^2n^2 + 15m^3n^3$
d) $a^3b^3 + 2a^2b^2 + 3ab$
e) $4c^4d^4 + 6c^3d^3 + 8c^2d^2$
f) $2e^4 + 6e^3 + 8e^2 + 4e$
g) $ac + 4a - bc - 4b$

13. **a)** 4 by $(x - 1)$; $4(x - 1) = 4x - 4$
b) $(x - 2)$ by $(x + 3)$;
$$(x - 2)(x + 3) = x^2 + 3x - 2x - 6 = x^2 + x - 6$$
c) $(2x - 3)$ by $(x + 2)$;
$$(2x - 3)(x + 2) = 2x^2 + 4x - 3x - 6 = 4x^2 + x - 6$$

14. **a)** The length is $t - 3 - 3 = t - 6$ and the width is $s - 3 - 3 = s - 6$.
b) Substituting 10 cm for t, and 8 cm for s, the dimensions are $(10 - 6)$ by $(8 - 6)$ or 4 by 2. So, the area is 4 cm × 2 cm = 8 cm^2.
Multiplying the binomials to find the area first, and then substituting, is another way to find the area:
$$\begin{aligned}(t - 6)(s - 6) &= ts - 6t - 6s + 36\\ &= (10)(8) - (6)(10) - (6)(8) + 36\\ &= 80 - 60 - 48 + 36\\ &= 8 \text{ cm}^2\end{aligned}$$

15. **a)** 6" by 3"
b) 3" by 3" (22 servings)

16. 30 and 90, 45 and 60. The only other number with a GCF of 15 less than 30 is 15. The other number has to be greater than 100, because 90 is already close to 100.

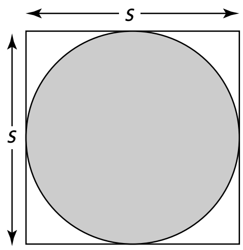
17. 5

18. **a)** $A = \pi r^2 + \pi(r + 3)^2 + \pi(r + 6)^2$;
Other algebraic expressions are possible, depending on which radius is assigned the value of r; examples:
$A = \pi r^2 + \pi(r - 3)^2 + \pi(r + 3)^2$ or
$A = \pi r^2 + \pi(r - 3)^2 + \pi(r - 6)^2$
b) $A = 3\pi(r^2 + 6r + 15)$

19. $8x^5 - 16x^3 + 24x$

20. 1948 and 2922

21. a)



b) $A = \pi\left(\frac{s}{2}\right)^2 = \frac{\pi s^2}{4}$

c) $A = s^2 - \frac{\pi s^2}{4}$;

$A = s^2\left(1 - \frac{\pi}{4}\right)$

22. a) 3 s

b) $15t - 5t^2 = 5t(3 - t)$. The product equals 0 when $t = 0$ or when $t = 3$. Because the ball is at its initial height when the product is 0, it can be seen that the ball will be at the same height when $t = 3$. Thus, factoring simplifies the process used to calculate the answer in part a).

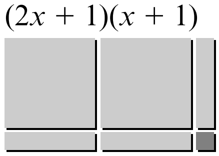
23. a) $5x$

b) The width is 10 cm, the length is 15 cm and the volume is 900 cm^3.

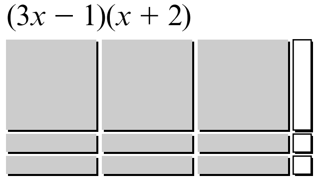
5.3 Factoring Trinomials

1. a) $x^2 + 5x + 6$; $x + 2$ by $x + 3$
b) $x^2 - 9$; $x - 3$ by $x + 3$
c) $x^2 - 3x - 4$; $x - 4$ by $x + 1$
d) $x^2 - x - 6$; $x - 3$ by $x + 2$

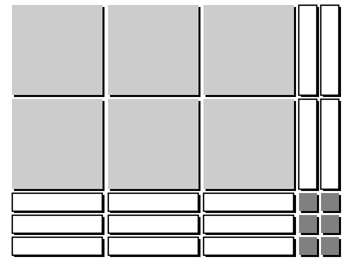
2. a) $(2x + 1)(x + 1)$



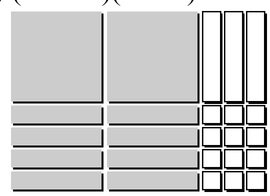
b) $(3x - 1)(x + 2)$



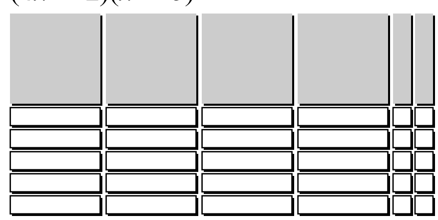
c) $(3x - 2)(2x - 3)$



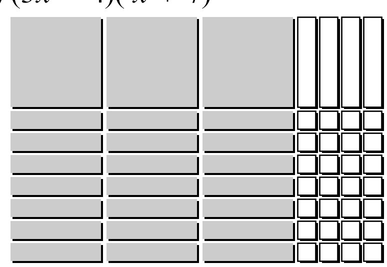
d) $(2x - 3)(x + 4)$



e) $(4x + 2)(x - 5)$



f) $(3x - 4)(x + 7)$



3. a) 2, 6 **b)** not possible
c) -4, 1 **d)** -8, -3
e) -2, 21 **f)** not possible

4. a) $(y + 6)(y + 2)$ **b)** $(x + 3)(x + 7)$
c) $(a - 10)(a - 9)$ **d)** not possible
e) $(m - 7n)(m + 6n)$ **f)** $(b + 2)(b + 17)$

5. a) $(g - 4)(g - 6)$ **b)** $(n - 2)(n - 13)$
c) $(c - 8)(c - 7)$ **d)** $(s - 2t)(s - 5t)$
e) not possible **f)** $(3v - 2)(v + 1)$

6. a) $(2r + 7)(r + 2)$ **b)** $(2l + 3)(l + 4)$
c) $(3w + 6)(w + 1)$ **d)** not possible
e) $(y + 3z)(y + 2z)$ **f)** $(3a + 4)(4a + 1)$

7. a) $(2f - 3)(f + 5)$ **b)** $(r - 10)(r + 11)$
c) not possible **d)** $(5m - n)(2m - 3n)$
e) not possible **f)** $(3g - 2f)(3g - f)$
g) $2(l + 3)(3l + 7)$ **h)** $(5a - 7)(a - 9)$

8. Examples:
a) 5, 7, −5, −7
b) 2, 14, −2, −14
c) 9, 11, 19, −9, −11, −19
d) 5, 13, −5, −13

9. Examples:
a) −5, 5, −1, 1
b) −9, 9, −6, 6
c) −57, 57, −30, 30, −18, 18, −15, 15
d) −19, 19, −1, 1, −8, 8

10. Examples:
a) There are four sets of two integers with the product of −10: −1 and 10, 1 and −10, −2 and 5, and 2 and −5. Possible values of p are the sums of each set: −1 + 10, 1 + −10, −2 + 5, and 2 + −5. So, the possible values of p are 9, −9, 3, and −3.
b) −4, 4
c) 9, 15
d) 12, 36

11. **a)** 12 **b)** 28
c) 7 **d)** −12
e) 21 **f)** 6

12. **a)** width = $2x - 6$; length = $3x + 8$
b) 18 yards by 44 yards

13. **a)** $A = x^2 + 11x + 24 = (x + 8)(x + 3)$;
width: $x + 3 = (12) + 3 = 15$ cm;
length: $x + 8 = (12) + 8 = 20$ cm
b) $A = 8x^2 + 6x - 2 =)(2x + 2)\,(4x - 1)$;
width: $2x + 2 = 2(12) + 2 = 26$ cm;
length: $4x - 1 = 4(12) - 1$
$= 48 - 1$
$= 47$ cm
c) $A = x^2 + 3x - 10 = (x - 2)(x + 5)$;
width: $x - 2 = (12) - 2 = 10$ cm;
length: $x + 5 = (12) + 5 = 17$ cm

14. **a)** $(-6t - 3)(t - 5)$
b) 27 ft

15. **a)** $h = (x + 6)$, $b = (x + 7)$;
$h = 24$ cm, $b = 25$ cm
b) $h = (2x + 3)$, $b = (3x - 1)$;
$h = 39$ cm, $b = 53$ cm

16. 7 by 1 and 6 by 4

17. 14

18. **a)** square
b) 16 and 36 are squares.
c) $(4s - 6)(4s - 6) = (4s - 6)^2$

19. **a)** square
b) $(x + 3)(x + 3)$
c) The area of the second figure is four times the area of the original square, meaning that the side dimension is doubled: $2(x + 3) = 2x + 6$.

20. Example: In trinomials such as $n^2 - 20n - 44$, one needs to find two numbers whose sum is −20 and whose product is −44. The important thing to notice to make a connection between the two types of trinomials is that the product −44 comes from multiplying the coefficient for n, which is 1, by the final term in the trinomial. For trinomials such as $6n^2 + 13n - 5$, one must ask what two numbers have a product of −30 (because 6 × −5 = −30) and a sum of 13. These two numbers are used to break up the middle term. Then, factoring by grouping completes the process.

21. **a)** 5, 6
b) $(x + m)(x + n)$
$= x^2 + nx + mx + mn$
$= x^2 + (n + m)x + mn$
c) 30, 13
d) $(ax + m)(x + n)$
$= ax^2 + anx + mx + mn$
$= ax^2 + (an + m)x + mn$

22. **a)** x by $2x - 5$ by $3x + 1$
b) dimensions: 5 cm by 5 cm by 16 cm;
volume: 400 cm^3

5.4 Factoring Special Trinomials

1. **a)** $(x - 2)^2$ **b)** $(x + 3)^2$
c) $(x + 2)(x - 2)$ **d)** $(3x - 2)^2$

2. **a)** $x^2 - 25$ **b)** $9r^2 - 16$
c) $5w^2 - 180$ **d)** $4b^2 - 49c^2$
e) $16x^2 - 36y^2$ **f)** $2x^2y - 18y$

3. **a)** $y^2 + 10y + 25$
b) $9d^2 + 12d + 4$
c) $16m^2 - 40mp + 25p^2$
d) $2e^2 - 24ef + 72f^2$
e) $12z^2 - 48z + 48$
f) $4x^2 - 12xy + 9y^2$

4. a) $n^2 - 10n + 25 = (n - 5)^2$
b) $r^2 - s^2 = (r + s)(r - s)$
c) $9c^2 - 16d^2 = (3c - 4d)(3c + 4d)$
d) $4s^2 + 24s + 36 = (2s + 6)^2$
e) $4x^2 + 8x + 4 = (2x + 2)^2$
f) $(4x - 2)^2 = 16x^2 - 16x + 4$

5. a) $(a + 10)(a - 10)$
b) $(t + 7)(t - 7)$
c) not possible
d) $(8 + h)(8 - h)$
e) $2(5g + 6h)(5g - 6h)$
f) $3(3p^2 - 5r^2)$
g) not possible
h) $2(6g + 4h)(6g - 4h)$

6. a) $(y + 6)^2$
b) $(x - 3)^2$
c) $2(z + 3)^2$
d) not possible
e) $-4(b^2 + 12b - 36)$
f) $(3s + 8)^2$
g) $(5n - 11)^2$
h) not possible

7. a) $16(d + 2e)(d - 2e)$
b) $3(3m + 4)(3m - 4)$
c) $-2(k + 6)^2$
d) $3c(c^2 + 17c + 49)$
e) $25(2a + b)(2a - b)$
f) $st(s - 9)^2$
g) $(9g^2 + 4)(3g + 2)(3g - 2)$
h) $3l(2m + n)^2$

8. a) $(2a - b)(2a + b)$
b) $(3x + 1)^2$
c) $9(24 - y^2)$
d) $d^2 - 4e^2 = (d + 2e)(d - 2e)$
e) $(7 - h)^2$

9. a) $-2, 2$ **b)** $-24, 24$
c) $-60, 60$ **d)** $-48, 48$

10. a) $3x^2 + 24x + 48 = 3(x^2 + 8x + 16)$
$= 3(x + 4)^2$
b) $3(x + 4) = 3x + 12$; The dimensions are $x + 4$ by $3x + 12$.
c) Since $x = 5$, the width is $(5) + 4 = 9$ cm and the length is $3(5) + 12 = 27$ cm.
d) Area $= 9 \times 27 = 243$ cm^2; check: $3(5)^2 + 24(5) + 48 = 3(25) + 120 + 48 = 243$

11. a) $16^2 - 4^2 = (16 + 4)(16 - 4) = (20)(12)$
$= 240$
b) $7^2 - 27^2 = (7 + 27)(7 - 27)$
$= (34)(-20) = -680$
c) $45^2 - 15^2 = (45 + 15)(45 - 15)$
$= (60)(30) = 1800$
d) $113^2 - 13^2 = (113 + 13)(113 - 13)$
$= (126)(100) = 12\,600$

12. a) Area $= \pi(r + 5)^2 - \pi(r + 3)^2 + \pi r^2$
b) Area $= \pi(r^2 + 4r + 16)$
c) Area $= 28\pi = 28(3.14) = 87.9$ cm^2

13. $2r(r - 1)^2(r + 1)^2$; solution:
$2r^5 - 4r^3 + 2r = 2r(r^4 - 2r^2 + 1)$
$= 2r(r^2 - 1)^2$
$= 2r(r^2 - 1)(r^2 - 1)$
$= 2r(r + 1)(r - 1)(r + 1)(r - 1)$
$= 2r(r - 1)^2(r + 1)^2$

14. $(x + 2y)$, $(x - 2y)$, and $(xy - 4)$

15. a) 391, 775
b) $(x - 3)(x + 3) = x(x - 3) + 3(x - 3)$
$(x - 3)(x + 3) = x^2 - 3x + 3x - 9$
$(x - 3)(x + 3) = x^2 - 9$
$x^2 = (x - 3)(x + 3) + 9$

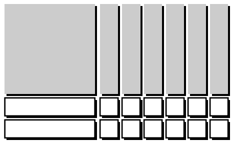
16. $9b^2 - 12b$

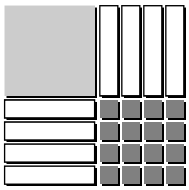
17. a) $A = \pi r^2$
b) $A = \pi(r + 3)^2 = \pi(r^2 + 6r + 9)$
$= \pi r^2 + 6\pi r + 9\pi$
c) Area of walkway = (area of walkway + area of garden) − area of garden
Area of walkway $= (\pi r^2 + 6\pi r + 9\pi) - \pi r^2 = 6\pi r + 9\pi = 3\pi(2r + 3)$
d) $3\pi[2(8) + 3] = 3\pi(19) = 179.1$ m

18. a) 144, 143, 169, 168, 196, 195, $15^2 = 225$, $14 \times 16 = 224$
b) The product of the factors that are 1 less and 1 more than the squared number is 1 less than the product of the squared number, the difference of squares equation.
c) $(n - 1)(n + 1) = n^2 - 1$

19. a) 600 cm^2
b) The difference between $a^2 + b^2$ and $(a + b)^2$ is $2ab$. So, the difference between $15^2 + 20^2$ and $(15 + 20)^2$ is $2(15 \times 20)$ which equals 600.

Chapter 5 Review

1. a) 

   b) 

2. a) $a^2 + 12a + 35$
   b) $y^2 - 64$
   c) $10v^2 + 32vw + 24w^2$
   d) $4c^2 - 1$
   e) $-2r^2 + 18s^2$
   f) $-g^2 - 8gh - 16h^2$

3. a) $r^3 - 3r^2 - 36r - 32$
   b) $-48p^3 + 121p^2 + 185p$; solution:
   $3p(4p - 5)(p - 7) - 5p(6p + 2)(2p - 8)$
   $= 3p[4p(p - 7) - 5(p - 7)] - 5p[6p(2p - 8) + 2(2p - 8)]$
   $= 3p(4p^2 - 28p - 5p + 35) - 5p(12p^2 - 48p + 4p - 16)$
   $= 12p^3 - 84p^2 - 15p^2 + 105p - 60p^3 + 240p^2 - 20p^2 + 80p$
   $= (12 - 60)p^3 + (-84 - 15 + 240)p^2 + (105 + 80)p$
   $= -48p^3 + 121p^2 + 185p$

4. $2a^2 + 5ab + 2a - 2b + 2b^2$; solution:
   From the diagram it can be seen that the area of the figure is equal to the area of the original square less the area of the rectangular shape that is removed.
   Area of square $= (2a + b)^2$
   $= 2a(2a + b) + b(2a + b)$
   $= 4a^2 + 2ab + 2ab + b^2$
   $= 4a^2 + 4ab + b^2$
   Area of rectangular shape
   $= (a - b)(2a + b - 2)$
   $= a(2a + b - 2) - b(2a + b - 2)$
   $= 2a^2 + ab - 2a - 2ab - b^2 + 2b$
   $= 2a^2 - ab - 2a + 2b - b^2$
   Area of figure $= (4a^2 + 4ab + b^2) - (2a^2 - ab - 2a + 2b - b^2)$
   $= 4a^2 + 4ab + b^2 - 2a^2 + ab + 2a - 2b + b^2$
   $= 2a^2 + 5ab + 2a - 2b + 2b^2$

5. $2x^2 - 30x + 100$

6. a) 15 b) 28
   c) 18 d) $2d$
   e) $17ab$ f) $5rst$

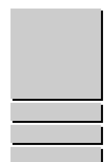
7. a) 75 b) 128

8. a) 9 b) 13
   c) $4ab$ d) $12xy^2z$
   e) m^3n^5

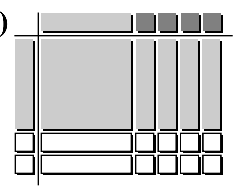
9. a) $2x(x + 2)$

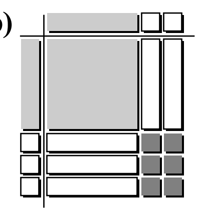
   

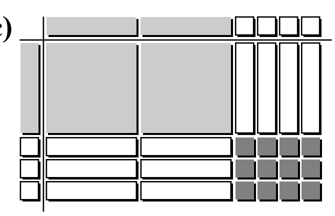
   b) $x(x + 3)$

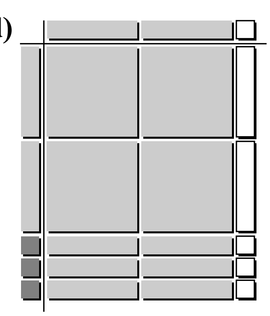
   

10. $a^2 + 2ab + 3a + 2b - 2$

11. a) 

    b) 

    c) 

    d) 

12. a) $(x - 4)(x - 2)$
b) $(x - 5)(x + 4)$
c) $(3x + 1)(3x - 5)$
d) not possible
e) $-3(x - 3)(2x - 9)$
f) $-2x(2x + 1)(3x - 2)$

13. x, $x + 1$, $x - 3$; 5 cm by 6 cm by 2 cm

14. a) $9x^2 - 42x + 49 = (3x - 7)^2$, so the side length of the field is $3x - 7$ and the perimeter is $4(3x - 7) = 12x - 28$.
b) The length of the fence that borders the field is $12(20) - 28 = 212$ m. The length of each side is $3(20) - 7 = 53$ m. So the length of the diagonal section is $\sqrt{53^2 + 53^2} \doteq 75$ m. The total length of the fence is $212 + 75 = 287$ m.

15. a) $(s + 8)(s - 8)$ **b)** $(d + 11)(d - 11)$
c) $(2h + 5)(2h - 5)$ **d)** $9(n + 3)(n - 3)$
e) $4(6 - b)(6 + b)$ **f)** $2c(7 - 3d)(7 + 3d)$

16. a) $(b + 7)^2$ **b)** $(12 + w)^2$
c) $(4 - 3g)^2$ **d)** $(8s - 13t)^2$

17. a) $(9 - x)(9 + x)$
b) $10y(x^2 + 1)(x - 1)(x +1)$
c) $(3x +5)(3x + 5)$
d) $4(2x + 5y)(2x - 5y)$
e) $(x^2 - 8)(x^2 - 8)$
f) $-2y(2x + 3)(2x + 3)$

18. a) -36 should be 36.
b) There needs to be a *difference* of squares.
c) $3y^2$ needs to be $9y^2$.
d) 40 is not a square. The value should be 49.

Chapters 1–5 Cumulative Review

1. $C = 1\frac{5}{16}$; $D = 3\frac{1}{8}$; $CD = 1\frac{13}{16}$

2. a) 18 000 mm^2 **b)** 30.94 m^2
c) 522.58 cm^2

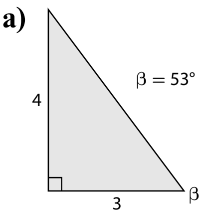
3. RS = 9; $XY = \frac{9}{4}$; $ZX = \frac{15}{4}$

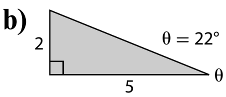
4. a) 13 **b)** 12
c) $\frac{8}{3}$ **d)** $14x$

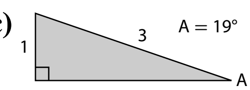
5. a) $x^2 + 6x + 8$
b) $b^2 - 9$
c) $y^2 - 64$
d) $8a^2 + 2ab - 21b^2$
e) $-100x^2 - 120xy - 36y^2$
f) $-x^2 + y^2$

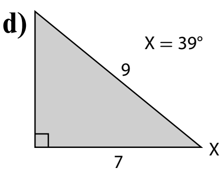
6. 0.486; Example: diameter of a pen

7. The new shed has the larger floor area. It is 23.5% larger.

8. a)


b)


c)


d)


9. a) $\frac{-216}{x^{18}}$ **b)** $\frac{1}{400b^4}$
c) $\frac{1}{25}$ **d)** 6480

10. 125.66 cm; 543.36 cm^2

11. a) 2258.57 m^3 **b)** 41 547.56 in^3
c) 15 828.08 mm^3 **d)** 26 521.85 cm^3

12. a) 0.8660 **b)** 0.6613
c) 1 **d)** 0.7071
e) 3.0777

13. a) -4 **b)** $-\frac{17}{5}$
c) $\frac{1}{2}$

14. a) $2(x + 5)$ **b)** $z(7 + 8z)$
c) $a^3(q + r + s)$ **d)** $4mn(m^4 - 3n^2)$

15. a) 352.5 ft^2 **b)** 3 cans
c) \$107.85

16. 17.6 m

17. a) the population, in millions, of BC in 2001
b) 5 158 947
c) 3 667 300

18. a) $(x + 9)(x - 3)$ **b)** $-2(x + 6)(x - 3)$
c) $-2(2x - 1)(x - 7)$ **d)** not possible
e) $x(x - 7)(x + 1)$

19. a) 9.12 cm **b)** 9.17 in.

20. a) $\angle C = 38°$; AB = 4.14 km; AC = 6.73 km
b) DF = 20; $\angle D = 53.13°$; $\angle F = 36.87°$

21. a) $4^{\frac{5}{3}}$ **b)** $(xt)^{\frac{3}{2}}$
c) $-2a^{\frac{-5}{6}}$

22. a) 366.6 km **b)** 22.86 m

23. 6.44 cm

24. 128.67 m

25. a) $10\sqrt{2}$ **b)** $15\sqrt{7}$
c) $4\sqrt[3]{2}$ **d)** $2\sqrt[4]{5}$

26. a) 12 or −12; $(x + 6)^2$ or $(x - 6)^2$
b) 36 or −36; $(2x + 9)^2$ or $(2x - 9)^2$

Extend It Further

1. B

2. B

3. A

4. C

5. A

6. −17, $2x - 3$

7.
$$(2m)^2 = 4m^2$$
$$(m^2 - 1)^2 = m^4 - 2m^2 + 1$$
$$(m^2 + 1)^2 = (m^2 - 1)^2 + (2m)^2$$

8.
$$\frac{2^{20} - 2^{16} + 15}{2^{16} + 1} = \frac{2^{16}(2^4 - 1) + 15}{2^{16} + 1} = \frac{15\cancel{(2^{16} + 1)}}{\cancel{2^{16} + 1}} = 15$$

9.
$$\frac{x^2 - y^2}{(x + y)^2} = \frac{(x + y)(x - y)}{(x + y)(x + y)} = \frac{(x - y)}{(x + y)}$$

10. $a^2 - 6a + 9 = (a - 3)^2$ and $9 - a^2 = -(a^2 - 9) = -(a - 3)(a + 3)$; GCF = $(a - 3)$ and LCM = $(a + 3)(a - 3)^2$.

11. $\frac{a^2}{a - 1}$;
solution:
$$\frac{1 + a}{1 - \frac{1}{a^2}} = \frac{1 + a}{\frac{a^2 - 1}{a^2}}$$
$$= (1 + a)\left(\frac{a^2}{a^2 - 1}\right)$$
$$= \cancel{(1 + a)}\left(\frac{a^2}{\cancel{(a + 1)}(a - 1)}\right)$$
$$= \frac{a^2}{a - 1}$$

12. $\sqrt{14} + \sqrt{12}$; solution:
$(\sqrt{14} + \sqrt{12})^2 = 14 + 2\sqrt{168} + 12$
$(\sqrt{15} + \sqrt{11})^2 = 15 + 2\sqrt{165} + 11$

13. A = −4, B = 25

14. −2010, $(4321)(4319) - (4320)^2$ is of the form $(x + 1)(x - 1) - x^2 = -1$

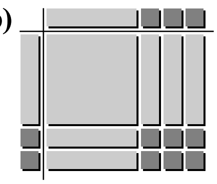
15. 4

16. 600

17. −1, 1, 2009

Unit 2 Review

1. C
2. B
3. B
4. B
5. C
6. D
7. A
8. B
9. D
10. B
11. B
12. C
13. C
14. B
15. B
16. A
17. 3
18. $\sqrt[5]{4}$, $\sqrt[4]{5}$, $\sqrt[3]{12}$, $\sqrt{12}$
19. 16
20. 14 896 cm^2
21. 16
22. 4
23. 8
24. −1
25. 22
26. 0.5 or $\frac{1}{2}$
27. a) −6, 6; $(x + 3)^2$; $(x - 3)^2$
b) −24, 24; $(x + 12)^2$; $(x - 12)^2$
c) −64, 64; $(4d + 8)^2$; $(4d - 8)^2$
d) −140, 140; $(7r + 10)^2$; $(7r - 10)^2$
28. Examples: 19, 23, 47, 33, 91
29. 14
30. $12k$, where $k = 1, 2, 3, 4$ ...
31. $2x - 1$
32. a) 508 212
b) 13 569 264
c) No; Example: At the rate of growth that the equation models, the number of subscribers would exceed the total population of the world (approximately 7 billion) within 7 months.

33. a) $5a$ and −3 were not distributed properly into binomials.
b) $20a^2 + 23a - 21$
c) Each side of the equation should equal 105.
34. a) $(x + 4)^2$ **b)** $(x + 3)(x + 5)$
c) $3(y + 2)(y - 4)$ **d)** $(b - 7)(2a - 5)$
e) $(x - 11)(x + 11)$ **f)** $4(4x - 7y)(4x + 7y)$
35. a) $(x + 3)$ and $(x + 2)$
b)

c) $x^2 + 5x + 6$
36. a) $8k^3 - 12k^2 + 6k - 1$
b) $7k^3 - 15k^2 + 3k - 2$
37. $5x^2 + 15x + 11$
38. a) No
b) −1, 0, 1 or −2, −1, 0
39. $2r(r - 1)^2(r + 1)^2$
40. a) $(20x + 3)(x - 5)$
b) length = 803 m; width = 35 m
41. a) Find the greatest common factor. In this case, GCF = $6a$.
b) $6a(2b - c)(7b - c)$
42. a) Yes
b) No. They are factored, but not factored in the simplest form.
c) $9x^2 - 9$
$= 9(x^2 - 1)$
$= 9(x + 1)(x - 1)$
$16m^2 - 64$
$= 16(m^2 - 4)$
$= 16(m - 2)(m + 2)$
$36d^2 - 100$
$= 4(9d^2 - 25)$
$= 4(3d + 5)(3d - 5)$
d) If it is possible to remove a common factor with a result that a difference of squares still exists, then that needs to be done first, before continuing with the factoring process.
43. a) Example: $3y^2 + 6y - 12$
b) c must be a multiple of 3

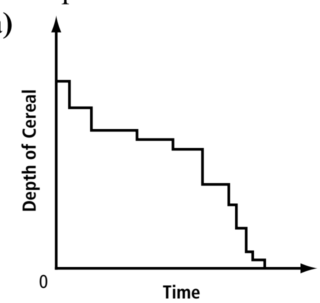
Chapter 6 Linear Relations and Functions

6.1 Graphs of Relations

1. Examples:
   a) a straight line starting at the origin and rising gently to the right
   b) a straight line starting at a point on the distance axis (y-axis) above the origin and descending rapidly to the right to the time axis (x-axis)
   c) a curved line starting at the origin and rising to the right quickly at first and then becoming less and less steep, but always moving further from the time axis
   d) a straight horizontal line quite high above the time axis
   e) an inverted V, starting at the origin, with the first segment steeper than the second
   f) a straight line starting at the origin and rising to the right, and then becoming a horizontal line leading to the right side of the graph

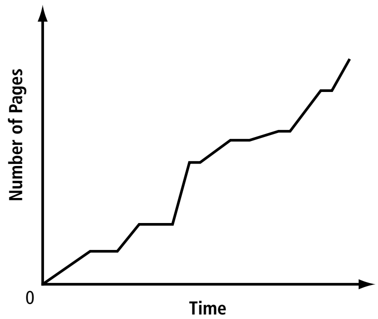
2. Examples:
   a) Graph A: the lines are straight (suggesting constant rate of change), have the same steepness, and are increasing; Graph B: the lines are straight and have the same steepness; Graph C: the lines are straight, start at the same point on the vertical axis, and are increasing; Graph D: the lines start at the same point on the vertical axis and are increasing
   b) Graph A: each line starts at a different point on the vertical axis; Graph B: each line starts at a different point on the vertical axis and one line is increasing, while the other is decreasing; Graph C: the lines have different steepness; Graph D: one line is straight (suggesting constant rate of change) while the other is curved (suggesting a decreasing rate of change)
   c) Graph A: The cost to rent DVDs versus the number of DVDs rented. The upper line includes a membership fee and the lower one has no extra fee. The costs of individual DVD rentals are the same for both lines.; Graph B: The increasing line could represent the number of pages read in a book versus time. The decreasing line, then, is the number of pages left to read.; Graph C: The steeper line could represent the cost of removing computer viruses versus the time taken to do the job. The less steep line could represent the same scenario, but at a lower hourly rate.; Graph D: The straight line could represent the height of a jet after takeoff versus time. The curved line could be the height of a smaller, less powerful, private plane.

3. Examples:
   a)



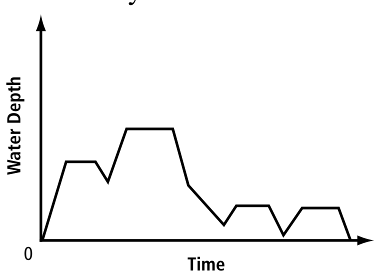
The height of each "step" on the graph illustrates the amount that the cereal goes down with each spoonful. The width of each step is the time between mouthfuls. This graph suggests that the eater starts of at a leisurely pace, perhaps while reading the paper. However, the size of spoonful increases and the time between mouthfuls decreases as if the eater has suddenly realized that the school bus is coming. The point at the x-axis is where the cereal is gone.

b)



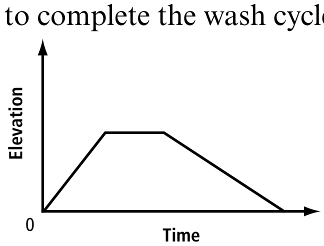
The number of pages read over time changes with the pace of reading. The steeper the slope, the faster the person is reading. At one point, where the slope is very steep the person may even be skimming the text. Where the slope is almost flat, the person is reading very slowly and carefully. The horizontal lines are places are periods where the reader may not even be reading.

c)



This graph shows that the water rises when the washing machine is turned on. The water reaches a particular height, where the clothes soak. The level of the water level dips as the more of the clothes slide into the water, absorbing some of it. At the end of the soaking cycle, more water is added to the tub and the water begins to agitate for a period of time. Then, all the water is drained and fresh water is added to rinse the clothes. This rinse cycle is repeated and then the water drains out to complete the wash cycle.

d)



This graph shows a quick elevation change as the airplane takes off. The plane then levels out. Notice that this is a short flight, so the plane is at cruising altitude for not much longer than it took to get to that elevation. The plane then begins a slower descent to its destination.

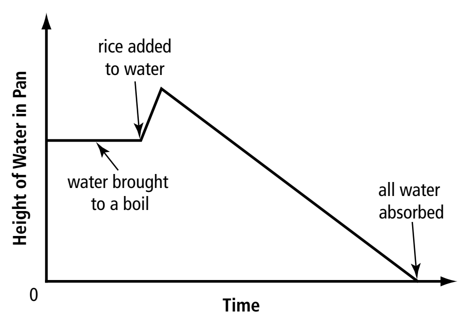
4. Examples:
Using line segments: (constant change theme)
- graphing water used each time a toilet is flushed
- buying grapes at a fixed price per kilogram

Using curves: (changing rate occurring)
- driving in traffic that is speeding up and slowing down
- elevation of a road through a mountain park

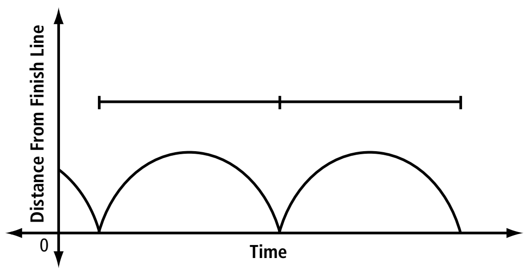
5. **a)** line segments and curves follow a similar path

b) The person graphing may have realized that the relation had more constant increases and decreases, which are best represented by line segments.

6.

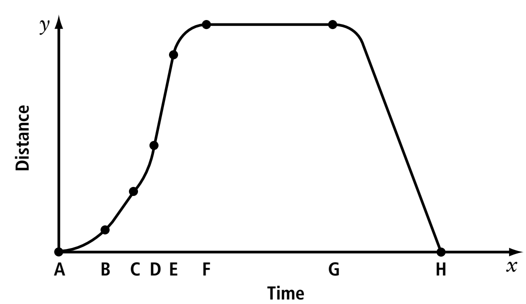


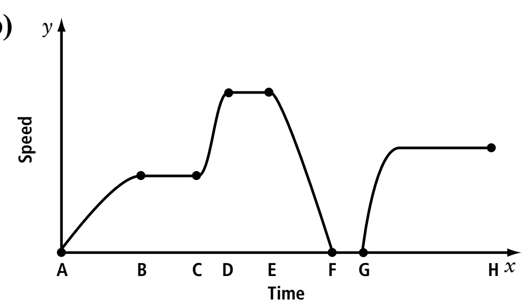
The height of the water rises sharply as the rice is added. This rise is not exactly vertical because it takes some time, even though it very little, to add the rice. As the rice absorbs the water and some evaporates, the water level decreases steadily. When the line reaches the x-axis, all the water has been absorbed and there is none left in the pan.

7. 

Example: The symmetry occurs because the skater moves away from and then returns to the finish line repeatedly and keeps the same pace. If the skater's pace varied, the distance between the points where the graph meets the x-axis would change.

8. **a)** Example: Section B to C should not be horizontal; it should be increasing, but not as steeply as in D to E. Section F to G should not be decreasing; it should be horizontal. Section G to H should not be decreasing to the left. If this were the case, the car would be in two different places at the same time between times A and G. Rather, it should decrease to the right with steepness between that in B to C and D to E.



b) 

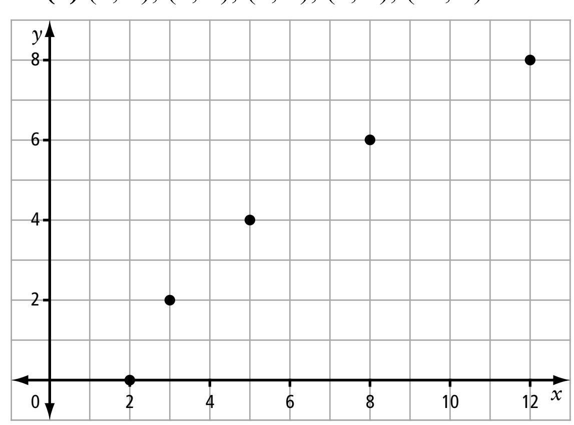
9. **a)** Example: The darker line is the revenue and the lighter line is cost. We know this because there are 0 revenues when 0 belts have been made and sold. Also, the dark line exceeds the lighter line after 500 belts. The distance between the lines is the profit. If the darker line represented cost, the company would lose money as it sold more belts, which does not make sense.
   b) \$4000.00
   c) 500
   d) \$9000.00
   e) \$4000.00
   f) \$4000.00
   g) \$18.00

10. Example: −40 °C = −40 °F; one degree F is smaller than one degree C; 0 °C = 32 °F (water freezes); 100 °C = 212 °F (water boils); as the temperature in C rises, so does the temperature in F; the F scale is positive from about −18° C to 0° C and beyond; doubling the temperature in C is less than doubling the corresponding temperatures in F.

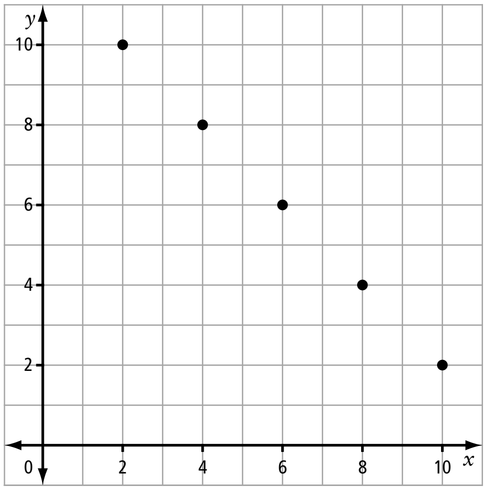
11. Example: Consumer income, competition between stores, scarceness of resource, input or cost of production prices.

6.2 Linear Relations

1. **(a)** (2, 0), (3, 2), (5, 4), (8, 6), (12, 8)



(b) (10, 2), (8, 4), (6, 6), (4, 8), (2, 10)



2. a) $C = 23p$

p	C
1	23
2	46
3	69
4	92

This relation is discrete because you cannot buy a part of a ticket.

b) $ab = 24$

a	b
2	12
2.5	9.6
3	8
3.5	6.857142857

This relation is continuous because you can choose any positive a-value and divide this number into 24 to find a b-value. If you only considered whole numbers, this relation would be discrete.

3. a) Non-linear; The number is always multiplied by one more than itself. $y = (x)(x + 1)$

b) Linear; The number is doubled, then increased by one. $y = 2x + 1$

c) Linear; The number is always subtracted from 3. $y = (3 - x)$

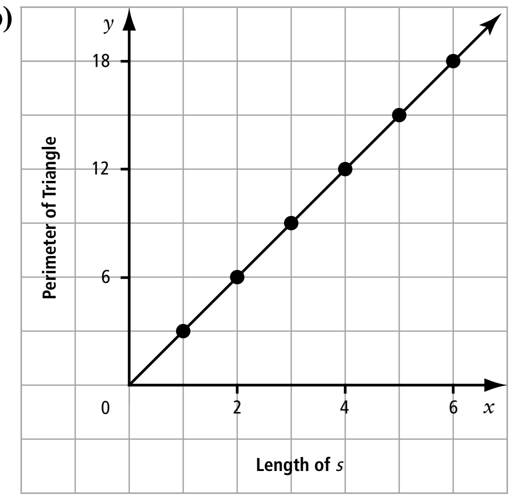
d) Linear; The number is always multiplied by negative one: $y = -x$.

4. a)

r	A
1	3.14
2	12.57
3	28.27
4	50.27

This is non-linear as there is no constant change in the values of A. The radius is independent; the area is dependent.

b)



This is linear as the perimeter is constantly three times the length of the side. The side length is independent, and perimeter is dependent.

c)

Polygon with n Sides	3	4	5	6
Number of Diagonals	0	2	5	9

This is non-linear as there is no constant change in the values of the numbers of diagonals. The number of sides in a polygon is the independent variable; the number of diagonals is the dependent variable.

5. a) linear **b)** linear
c) non-linear **d)** non-linear

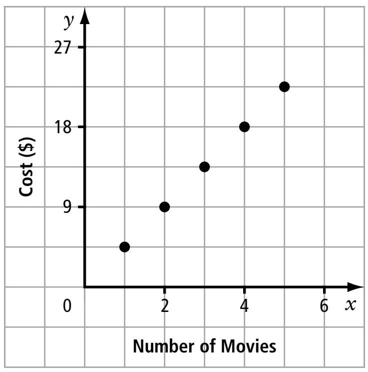
6. a) independent variable: number of movies; dependent variable: cost

b) The cost for renting one new release movie is \$4.50. The cost for renting two is \$9.00. The cost for renting three is \$13.50. The cost of renting four is \$18.00. The cost for renting five is \$22.50.

c) $C = \$4.50(m)$
d) (1, 4.50), (2, 9.00), (3, 13.50), (4, 18.00), (5, 22.50)
e)

Movies Rented	1	2	3	4	5
Cost ($)	4.50	9.00	13.50	18.00	22.50

f)



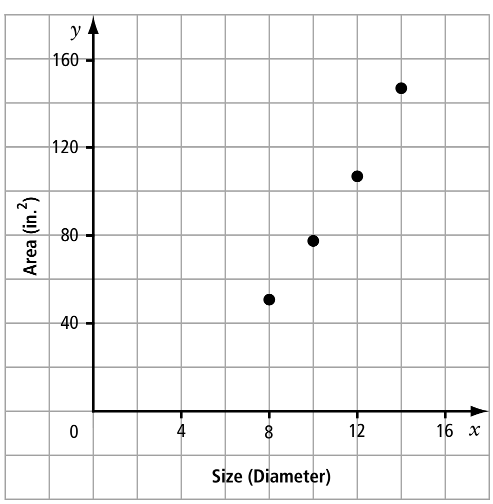
Plotting for zero does not make sense because people know that if they do not rent anything, the cost is $0.00.

g) Example: The table of values would be easiest for customers to understand.

7. a)

Size (Diameter)	Area of Pizza
8 in.	50.27 in.^{2}
10 in.	78.54 in.^{2}
12 in.	113.1 in.^{2}
14 in.	153.94 in.^{2}

b) diameter
c)



d) non-linear
e) discrete

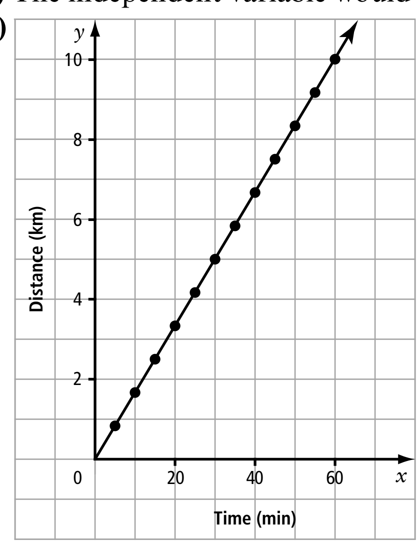
8. a) 4 in., 5 in., 6 in., 7 in.
b) 50 in.^{2}, 79 in.^{2}, 113 in.^{2}, 154 in.^{2}
c) $0.20
d) $15.80, $22.60, $30.80
e) Example: No. The price for the large pizzas is too high and may not compete well with the competition. Yes. He is charging the same rate for all the pizzas.
f) linear; discrete
g) non-linear

9. a) This would be a linear relation given a fixed or constant speed.
b)

Time (h)	1	2	3	4	5
Distance (km)	10	20	30	40	50

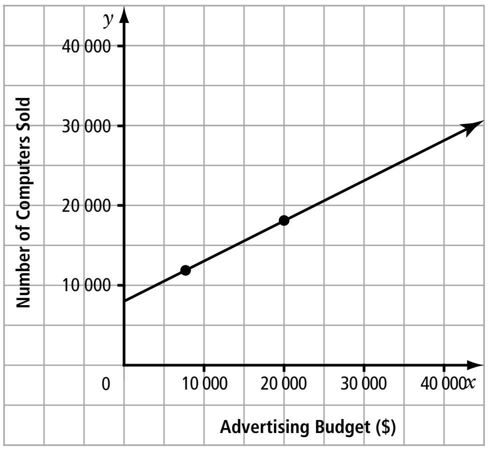
Distance (km)	Time (min)
1	6
2	12
3	18
4	24
5	30
6	36
7	42
8	48

The second table gives more realistic and detailed information to a reader. Distances of 40 or 50 km are unlikely for most joggers.
c) The independent variable would be time.
d)



e) The graph would be continuous because at any distance there would be a specific time.

10. a)



b) 28000
c) $26000
d) 8000

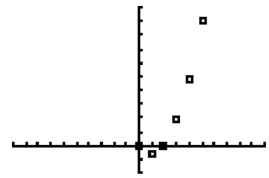
11. a) Answers will vary.
b) Answers will vary.
c) Either variable can be independent or dependent because you are measuring in centimetres for both.
d) linear
e) discrete, but in a population it would be continuous from the shortest arm/foot length to the longest

12. a) bags of flour, jugs of milk, single cans of soup, loaves of bread, packages of cookies
b) independent: number of items; dependent: cost
c) discrete.
d) Example: discrete; jars of pickles (even if bought by the case); continuous: roasts, which are priced per pound or kilogram
e) Items for which the price drops by a fraction if bought in multiples, such as 2 for a price, or 3 for a price.

13. $y = 3x\,(x - 2)$:

x	0	1	2	3	4	5
y	0	−3	0	9	24	45

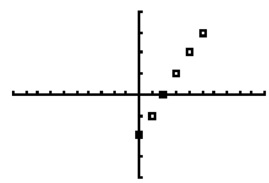
This equation is non-linear because the y-value does not change consistently with consistent change in the x-value.
The points on the graph are in the shape of a parabola so this is a non-linear function.



$y = 5(x - 2)$:

x	0	1	2	3	4	5
y	−10	−5	0	5	10	15

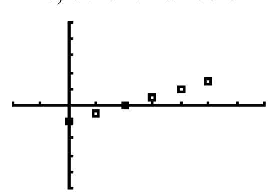
Each increase of 1 in the x-value results in an increase of 5 in the y-value. Since the y-value changes consistently with a consistent change in the x-value, this is a linear equation.
The points on the graph form a straight line, so the function is linear.



$y = \frac{(x - 2)}{2}$:

x	0	1	2	3	4	5
y	−1	−0.5	0	0.5	1	1.5

This equation is linear because the y-value changes consistently by 0.5 whenever the x-value increases by one.
The points on the graph form a straight line, so the function is linear.



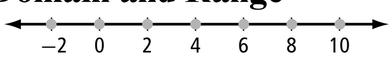
14. a) linear if the independent variable is of degree 1 and multiplied by a constant number
b) linear if both the independent and dependent values change at a constant rate
c) linear if both the independent and dependent values change at a constant rate
d) linear if all the points, whether discrete or continuous, form a line

e) Find at least 3 pairs of answers and see if there are regular changes between them. If so, it is linear.

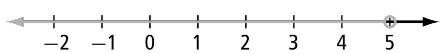
15. Example:
Look back at whether you had freedom to pick any numbers or values you wanted to for the independent variable. If you did, and you could choose numbers like fractions and decimals that work, it is continuous. If you are only allowed certain numbers, or only integers, then a discrete graph is best.

6.3 Domain and Range

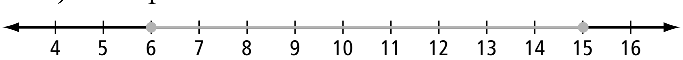
1. a)



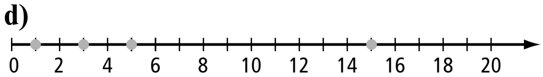
b)



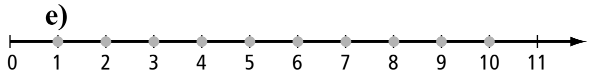
c) Example:



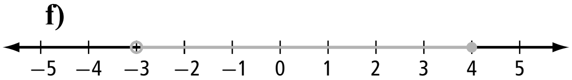
d)



e)



f)



2. a) D = {0, 1, 2, 3, 4};
R = {\$0.00, \$0.38, \$0.76, \$1.14, \$1.52}

b) D = {penny, nickel, dime, quarter, half dollar, loonie, twoonie}
R = {\$0.01, \$0.05, \$0.10, \$0.25, \$0.50, \$1.00, \$2.00}

c) D = {1, 2, 3, 4, 5, 6, 7, 8, 9, 10};
R = {1, 4, 9, 16, 25, 36, 49, 64, 81, 100}

d) D = {1, 2, 3, 4, 5, 6}
R = {\$35.00, \$70.00, \$105.00, \$140.00, \$175.00, \$210.00}

e) D = {0, 1, 2, 3, 4, 5, 6}
R = {\$0.00, \$1.50, \$3.00, \$4.50, \$6.00, \$7.50, 9.00}

3. a) D = $\{x \mid -4 < x \leq 5\}$ or $(-4, 5]$
R = $\{y \mid -2 \leq y < 2\}$ or $[-2, 2)$

b) D = $\{x \mid 0 \leq x \leq 4\}$ or $[0, 4]$
R = $\{y \mid 0 \leq y \leq 4\}$ or $[0, 4]$

c) D = $\{x \mid -3 \leq x \leq 6\}$ or $[-3, 6]$
R = $\{y \mid -4 \leq y \leq 5\}$ or $[-4, 5]$

d) D = $\{x \mid -6 \leq x \leq 0\}$ or $[-6, 0]$
R = $\{y \mid -8 \leq y \leq 0\}$ or $[-8, 0]$

e) D = $\{x \mid -3 \leq x \leq 5\}$ or $[-3, 5]$
R = $\{y \mid -3 \leq y \leq 7\}$ or $[-3, 7]$

f) D = $\{x \mid -6 \leq x \leq 1\}$ or $[-6, 1]$
R = $\{y \mid -4 \leq y \leq 7\}$ or $[-4, 7]$

4. a) The domain is the number of litres of fuel that might be purchased. Since the capacity of the fuel tank is 40 L, the domain is 0, if no fuel is purchased, to 40 L, if the tank is empty and then filled to capacity. In set notation, D = $\{x \mid 0 \leq x \leq 40\}$

b) The range is the possible cost incurred by purchasing gas and getting a car wash. The assumption is that the car wash will be purchased, regardless if any gasoline is purchased. So the lowest end of the range is \$8.00. If the tank is empty and is filled with 40 L of gas, C = 0.92(40) + 8.00, or 44.80. So, the range is \$8.00 to \$44.80, or R = $\{y \mid 8 \leq y \leq 44.80\}$

c) The cost is dependent on the number of litres of gasoline that is purchased, so n is the independent and C is the dependent variable.

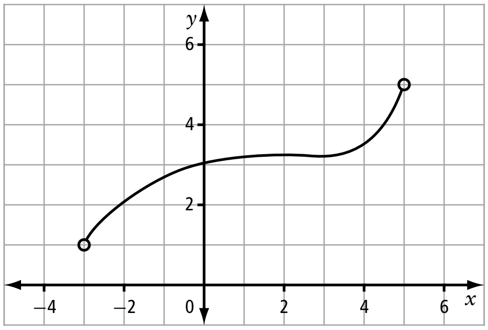
5. a) The lowest internal temperature in the table is for medium-rare beef, veal, and lamb at 63° C. The highest internal temperature is for whole poultry at 85° C. So, the range is from 63 to 85, or R = $\{T \mid 63 \leq T \leq 85\}$

b) It would be better to make a list of each temperature expectation. It would make a chef check carefully which temperature should be chosen.

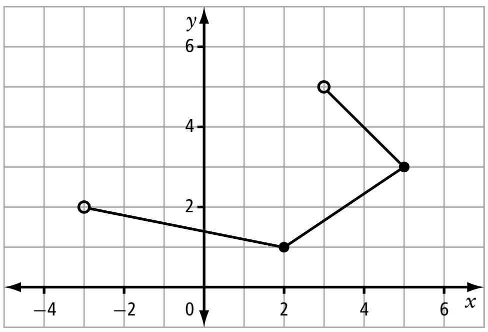
c) Each temperature depends on the type of food you are cooking. Some are very specific and a range of values will not work. This is especially true for poultry, which must have the highest temperature value of 85.

6. Example:

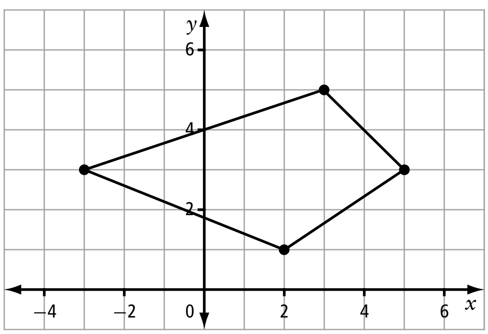
a)



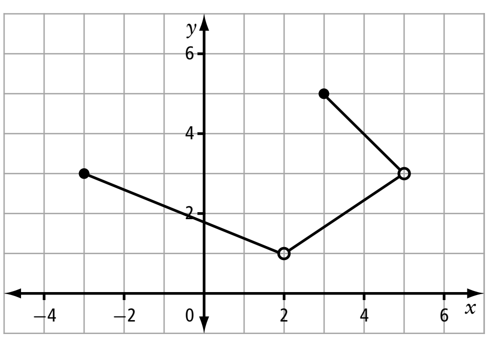
b)



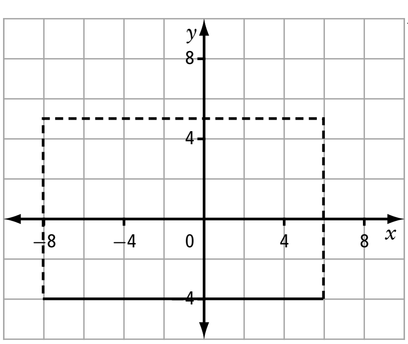
c)



d)



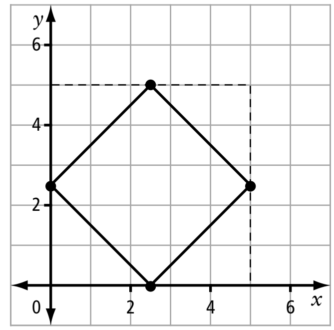
7.



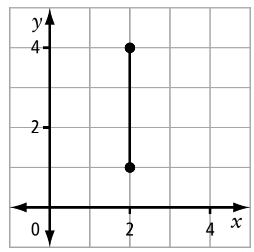
w

8. a ray

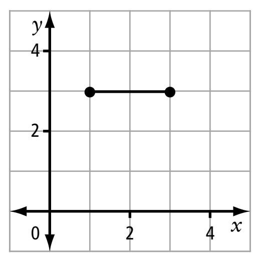
9. **a)** Example:



b) Example:



c) Example:



10. Example: A domain must be present for a relation to exist. It must have a minimum of one domain element matched with one range element

11. Example: A balloon being blown up: when empty it has no air in it, but it can get bigger and bigger and then pop when it gets to 20 cm

12. Example: Domains: player names, position on the team, team jersey number. Ranges: salary, game minutes, points scored

6.4 Functions

1. **a)** This is not a function because there are two ordered pairs with an x-value of 2, but with different y-values: 4 and 1. If you drew the vertical line, $x = 2$, the line would pass through two y-values proving that this is not a function.
   b) This is a function because each of the x-values is different and has only one corresponding y-value. You could draw a vertical line through each x-value, and it would intersect with only one y-value.
   c) This is not a function because each of the x-values, 1, 4, and 9, has two corresponding y-values. A vertical line drawn through any of these x-values would intersect two y-values.
   d) This is a function because each person has only one shoe size. If you were to plot these points on a graph, a vertical line could be drawn from any of the names and there would only be one corresponding shoe size (y-value).
   e) This is not a function because Anika has 3 different siblings.
   f) This is function because each of the x-values has one and only one corresponding y-value. In other words, you can draw a vertical line through any point on the graph, and it will not pass through any other point.
   g) This is not a function because if you draw a vertical line through any of these points, the line will pass through at least one other point.

2. $A(n) = 500(1 + 0.08)^n$

3. $W = 26p + 1200$

4. **a)** $z(-3) = 16$ **b)** $z(2) = 1$
   c) $a = 0$

5. **a)** $t(1) = 5$ **b)** $t(20) = 81$
   c) $n = 10$

6. **a)** The price, P, is dependent on the number of months you are a member, m. So, m is independent variable and it represents the number of months you are a member of the club.
   b) The cost of being a member for a year is equal to 12 months of monthly dues plus the \$55 initiation fee: $P(12) = 35(12) + 55$, or \$475.00.
   c) To find after how many months you will have spent \$1000, set P equal to 1000 and then solve for m:

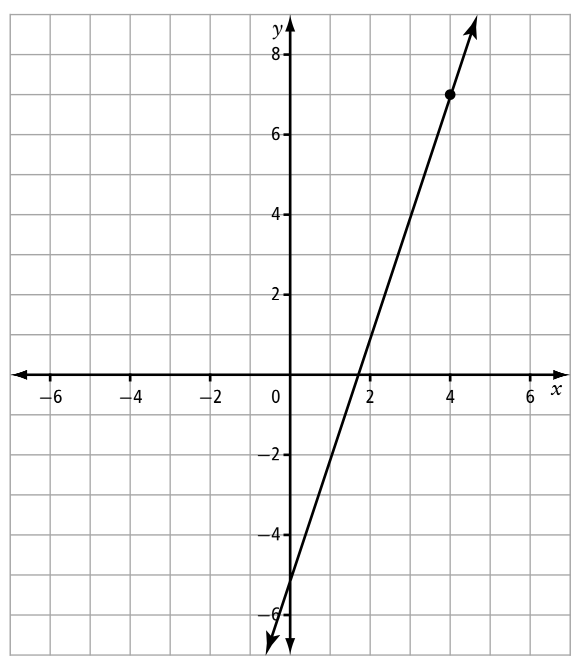
$$1000 = 35m + 55$$
$$1000 - 55 = 35m + 55 - 55$$
$$945 = 35m$$
$$\frac{945}{35} = \frac{35m}{35}$$
$$27 = m$$

   d) The competitor sells its membership by the week, so you must solve the equation for 52 weeks, which is equal to one year: $P(52) = 10(52) + 100$, or \$620.00. This option is more expensive than belonging to FITFIT.

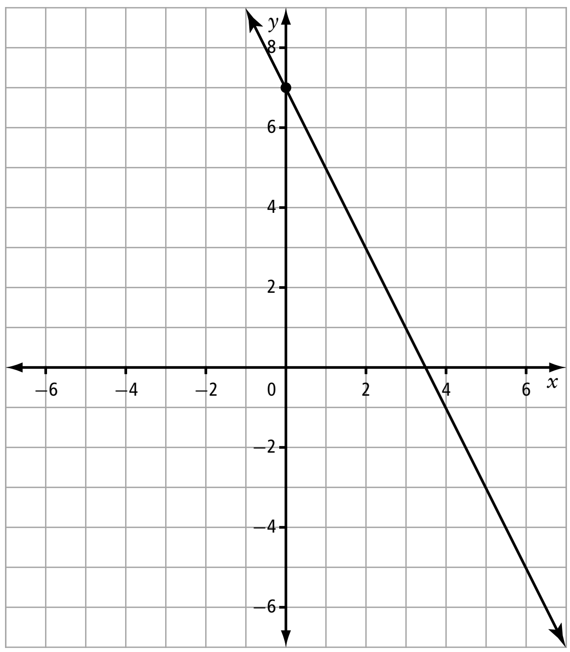
7. **a)** $f(5) = 9$ **b)** $f(5) = 1$
   c) $f(5) = 5$ **d)** $f(5) = -\frac{1}{2}$

8. **a)** $x = -3$ **b)** $x = 13$
   c) $x = -35$ **d)** $x = 63$

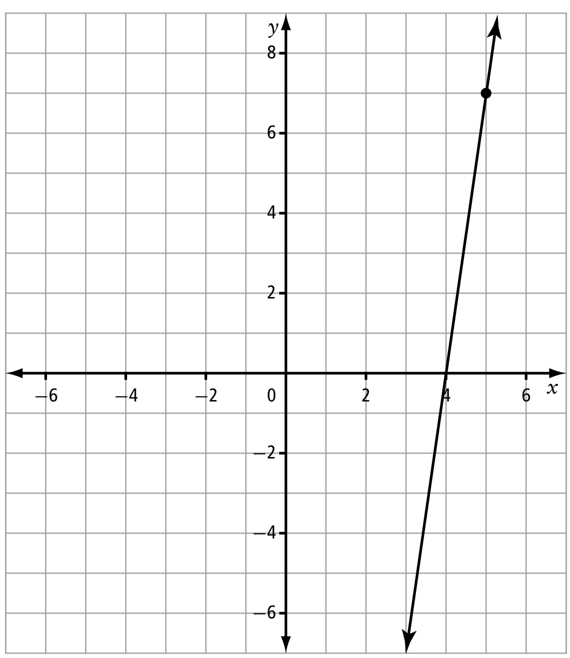
9. **a)** $x = 4$



b) $x = 0$



c) $x = 5$



10. a) $x = 6$ produces the prime number 7

b) $x = 9$ produces the multiple of 8 that is 16

c) $x = 38$ produces the number 103, which is larger than 100

d) $x = 3$ produces −2, the largest negative number in the function

11. $T(m) = (A)m + (B)$ would be $T(m) = (-4)m + (90)$, where $A = -4$ and $B = 90$

12. a) V0B 2P0 is the postal code for all of Yahk, BC. T0H 2P0 is the postal code for all of Meander River, AB. These are not functions. R2J 0A1 refers to only one address: 520 Lagimodiere Blvd, Winnipeg, MB (the Royal Canadian Mint). This postal code is a function. (Notice that this postal code returns two results when you search Canada Post's online database: one response in English and one in French. Therefore, you might also answer that this postal code is not a function within the context of the database because there are two records associated with it.)

b) Postal codes are usually specific to one street name and either even or odd street numbers. If you live in a rural setting or are the ONLY even or odd numbered house on a street, you may be unique. If your postal code is used only for you, then it is a function. If you share your postal code with other addresses, it is not a function.

6.5 Slope

1.

Positive Slope	Negative Slope	Zero Slope
AH GH FE BE	AB HE GF ED BC	HB DC

2. Slopes are: AB $= -\frac{1}{3}$; BC $= -\frac{2}{1}$; CD $= 0$; DE $= \frac{2}{1}$; EF $= -\frac{1}{3}$; FG $= 2$; GA $= -\frac{7}{2}$;

3. a) $m = +\frac{1}{2}$, less steep than a 45° line

b) $m = +\frac{8}{5}$, steeper than a 45° line

c) $m = -\frac{9}{4}$, steeper than a 45° line

d) $m = -\frac{1}{3}$, less steep than a 45° line

4. a) $m = -\frac{1}{2}$ **b)** $m = 0$

c) $m = \frac{3}{7}$ **d)** $m = \frac{5}{2}$

5.

Given Point A(x, y)	Slope	Next Point to the Right of A
(3, 5)	$-\frac{1}{2}$	(5, 4)
(3, 5)	$\frac{2}{3}$	(6, 7)
(−3, 7)	$\frac{3}{7}$	(4, 10)
(2, −5)	$-\frac{4}{1}$	(3, −9)
(0,−4)	$\frac{5}{4}$	(4, 1)

6. 10.08 m or approximately 10 m

7. $7.50: the amount of money she gives her mother each week

8. **a)** The slope is equal to $\frac{\text{vertical change}}{\text{horizontal change}}$, or $\frac{\text{rise}}{\text{run}}$. The slope on this road is 32% grade. So, $0.32 = \frac{130}{d}$, where d is the horizontal distance. Solving for d,

$$0.32 = \frac{130}{d}$$
$$d(0.32) = d\left(\frac{130}{d}\right)$$
$$d(0.32) = 130$$
$$\frac{d(0.32)}{(0.32)} = \frac{130}{0.32}$$
$$d = 406.25$$

The horizontal distance is approximately 406 m.

b) Expressed as rise over run, the slope of this road is $\frac{130}{406}$.

c) The actual road surface is approximately 426 m long.

9. 1.25 cm of hair growth per month

10. 3 cm

11. increase of 1925 people per year; in 2021, an increase of 28 878, or a population to 231 218

12. **a)** For both trips, the employee paid for 3 days of use. The only variable that changes to account for the change in cost is the number of kilometres driven. On the second trip, the cost of the car was $63.75 more and the number of additional kilometres driven was 255 more km. So, $255(d) = 63.75$, where d is the charge per kilometre:

$$255(d) = 63.75$$
$$\frac{255(d)}{255} = \frac{63.75}{255}$$
$$d = 0.25$$

The company charges $0.25/km.

b) The daily cost vehicle, C, is the number of kilometres × 0.25 plus the daily charge. In this case, the employee paid for 3 days for both trips. Since the daily charge does not change for each trip, so we can solve the equation $C = 0.25(d) + 3(r)$, where d is the number of kilometres driven and r is the daily rate. Solving for Trip A:

$$301.25 = 0.25(425) + 3(r)$$
$$301.25 = 106.25 + 3r$$
$$301.25 - 106.25 = 106.25 - 106.25 + 3(r)$$
$$195 = 3(r)$$
$$\frac{195}{3} = \frac{3(r)}{3}$$
$$65 = r$$

The daily fee for the car is $65.00.

c) If the company simply paid employees $0.50/km to use their own car, Trip A would have cost $212.50, while Trip B would cost $340.00. This means that paying the employee for the use of their car would be cheaper.

d) The cost for renting a car is the same as for using the employees car when the kilometres travelled is 780 km. The cost in both scenarios is $390.00. However, since the rental company charges less per kilometre, if the trip is more than 780 km long in a 3-day period, it becomes cheaper to rent.

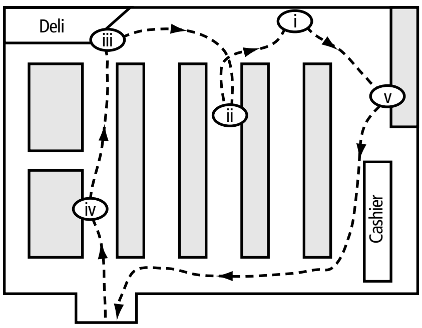
13. Example: If the slope definition were run over rise, when the line segments got steeper, the ratios would be getting smaller and smaller, rather than larger. Having the slope formula as rise over run makes these ratios increase in value as the actual line segments get steeper.

14. Example: The denominator is increasing quicker than the numerator, so the slope is getting increasingly smaller. However, since the numerator will never equal 0, no matter how small the slope gets, it will never be 0.

Chapter 6 Review

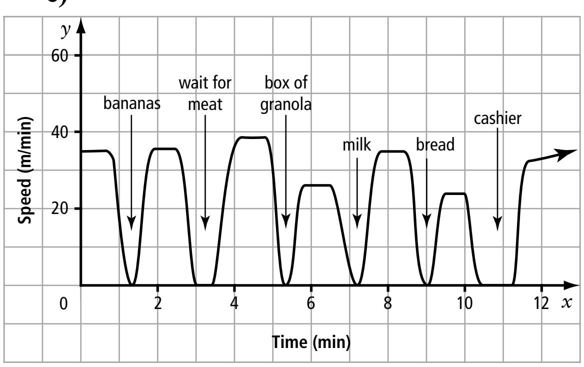
6.1 Graphs of Relations

1. **a)** items: **i)** bananas, **ii)** deli ham, **iii)** granola, **iv)** milk, **v)** bread



b) For speed, use either metres per minute or feet per minute. Time would best be measured in minutes.

c)



2. **a)** Example: mile 0 to approximately mile 3, the cyclist would face a long, steep climb and then would go downhill steeply for almost 2 miles; mile 15 to mile 20 might be a rolling portion of the ride, with short climbs and descents

b) Example: easiest portion: mile 23 to mile 28, where the riding is flat, with no elevation gain; most difficult: mile 0 to mile 8, where there are a series of steep climbs and descents

6.2 Linear Relations

3. **a)** Discrete. The number will always be a whole number. The numbers between have no meaning.

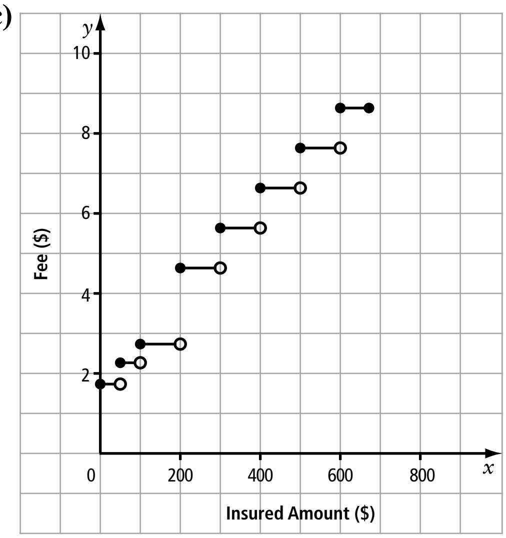
b) Continuous. Time increases constantly. The player could have any number of minutes and seconds.

c) Discrete. The number is always countable. Again, numbers between have no meaning.

4. **a)** fee charged = f (fee)
insured amount = v (value)
The insured amount would be the independent variable, as the fee depends on the value shipped.

b) Non-linear. The fees do not rise in a pattern. Some sections are linear, going up by \$1.00 for each \$100 increase in value; others don't change by that same amount.

c)



6.3 Domain and Range

5. **a)** D = {0, 3, 5}; R = {−7, 5, −4, 0, 11}

b) Factors of 10 are D = {1, 2, 5, 10}; Answers are R = {10, 5, 2, 1}

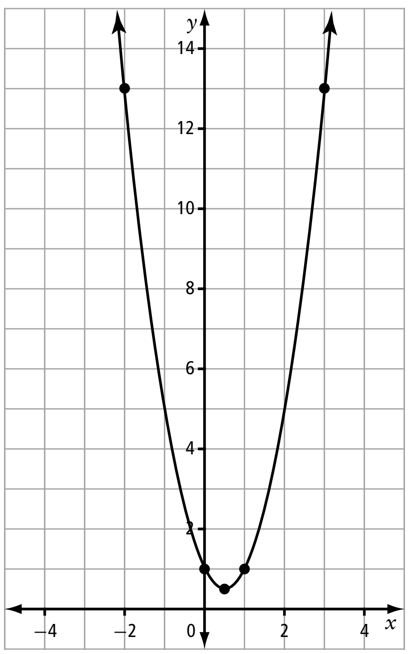
6.

Set Notation	Interval Notation
$\{x \mid 3 < x < 7\}$	(3, 7)
$\{x \mid -5 \le x \le 0\}$	[−5, 0]
$\{x \mid -13 < x \le 27\}$	(13, 27]
$\{x \mid x \le 5\}$	(−∞, 5]

7. **a)** D = $\{x \mid -5 \le x \le 1\}$;
R = $\{y \mid -4 \le y \le 1\}$
b) D = $\{x \mid 1 \le x < 6\}$;
R = $\{y \mid -5 < y < 1\}$

6.4 Functions

8. **a)** $f(0) = 1$
b) $f(-1) = 5$
c) $f(3) = 13$
d) Different domain values giving the same range value still defines a function. It is when the same input value produces 2 different outcomes that a relation is then not a function.
e)



It passes the vertical line text because a vertical line passes through only one point on the graph.

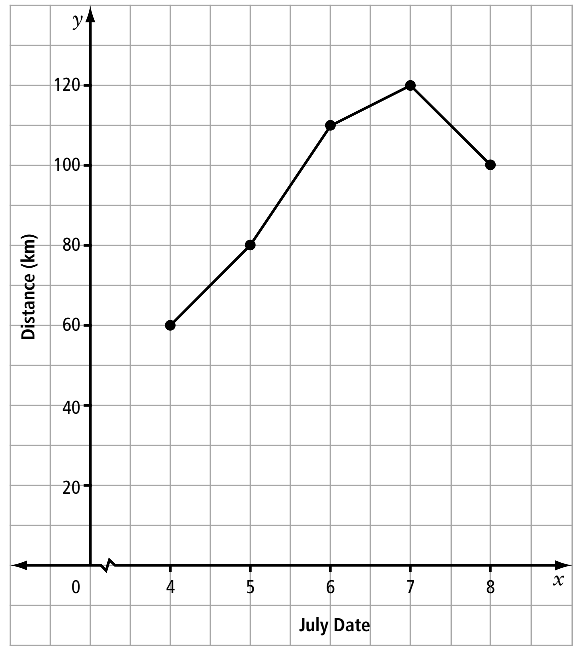
9. **a)** $V(s) = s^3$; $V(r) = (4/3)\pi r^3$.
b)

Side Length of Cube	Volume of Cube	Volume of Sphere Inside
10 cm	1000 cm^3	523.6 cm^3
20 cm	8000 cm^3	4188.8 cm^3
30 cm	27 000 cm^3	14 137 cm^3
40 cm	64 000 cm^3	33 510 cm^3

6.5 Slope

10. a) $-\frac{5}{9}$; negative **b)** $\frac{4}{3}$; positive
c) $-\frac{12}{1}$; negative

11. a)



b) The four slopes are $+\frac{20}{1}$, $+\frac{30}{1}$, $+\frac{10}{1}$, and $-\frac{20}{1}$.
c) These slope values show the rate of increase in daily distance from one day to the next.
d) A negative slope means that he didn't increase his daily distance, but decreased it instead.

Chapters 1–6 Cumulative Review

1. D = $3\frac{5}{8}$ in.; CD = $2\frac{15}{16}$ in.; $3\frac{5}{8} - \frac{11}{16} = 2\frac{15}{16}$ in. or you could count the ticks on the ruler
2. 26 cm
3. **a)** $a^3 + 5a^2 - 10a - 8$ **b)** $10b^2 - 10b$
4. 0.82 cm; example: an ant
5. **a)** linear; each new person will add the same amount to the cost: \$10
b) p = people (independent variable) and C = cost (dependent variable)

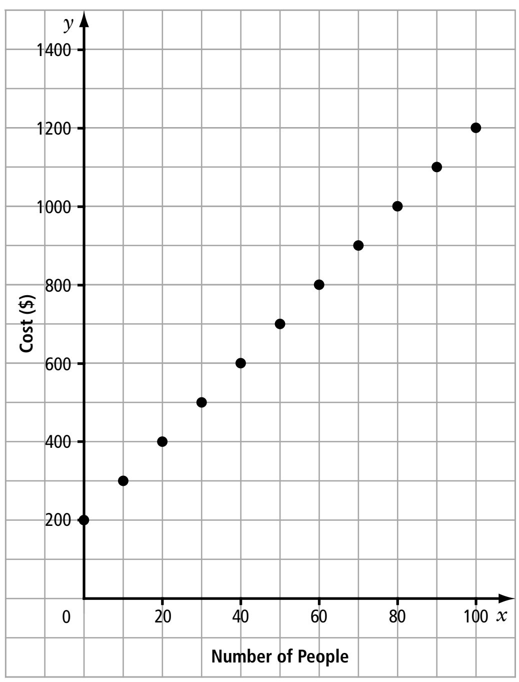
c)

p	C ($)
0	200
10	300
20	400
30	500
40	600
50	700
100	1200

d) The data is discrete because numbers of people can only be whole numbers.

e) Yes, this relation is a function because there is only one value of C for each value of p. Linear relationships are always functions.

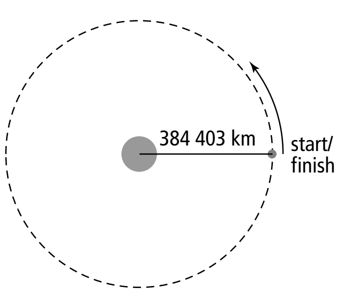
f)



6. CE = 10 cm

7. a) \$1795.02 **b)** \$295.02 **c)** \$2148.07

8. a)



b) 89 870.42 km

c) 3744.60 km/h

9. a) $V = 1321.01\text{ m}^3$; $SA = 738.68\text{ m}^2$

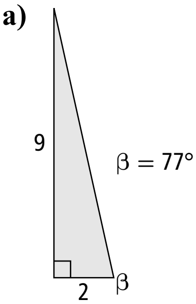
b) $V = 7938.80\text{ in.}^3$; $SA = 3103.89\text{ in.}^2$

c) $V = 17.65\text{ mm}^3$; $SA = 44.42\text{ mm}^2$

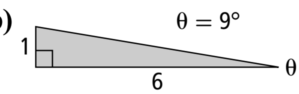
d) $V = 197.17\text{ ft}^3$; $SA = 226.4\text{ ft}^2$

e) $V = 36\,086.95\text{ cm}^3$; $SA = 5281.02\text{ cm}^2$

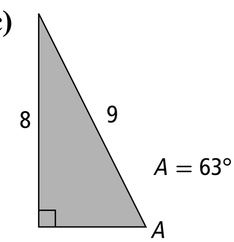
10. a)



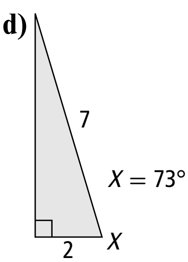
b)



c)



d)



11. a) $\frac{1}{x^3}$ **b)** $\frac{1}{32}$

c) $k^{\frac{31}{12}}$ **d)** $\frac{1}{2p^{\frac{7}{3}}}$

12. a) $(3x + 9)(x - 5)$

b) $(2z - 1)(2y + 5)$

c) $7ab(2ab - 3)$

d) $3xy(4x^2 - 3x + 1)$

13. a) $(x + 7)(x - 8)$

b) $-4(x^2 - 4x + 12)$

c) $(3m + 2n)(2m + 1n)$

d) $(5s + 2)(7s + 9)$

14. a) $(c - 11)(c + 11)$
b) $(1 + 9y^2)(1 + 3y)(1 - 3y)$
c) $3(3h - 7)(3h + 7)$
d) $(y + 2)^2$
e) $(5x - 11)^2$

15. $\frac{4}{6} = \frac{2}{3}$ and $\frac{1.5}{2.5} = \frac{3}{5}$; $\frac{2}{3} \neq \frac{3}{5}$, so, no, it cannot be enlarged without cropping.

16. 39°

17. a) $\sqrt[3]{c^4}$ **b)** $\sqrt[5]{324t^6}$
c) $\sqrt[4]{\frac{m^2}{12}}$

18. 4.36 km

19. a) Domain:
Words: all real numbers between but not including −6 and positive infinity
Interval Notation: $(-6, \infty)$
Set Notation: $\{x \mid -6 < x < \infty, x \in R\}$
Range:
Words: all real numbers between but not including −1 and negative infinity
Interval Notation: $(-1, -\infty)$
Set Notation: $\{y \mid -1 < y < -\infty, y \in R\}$
b) Domain:
Words: all real numbers between −7 and 0, inclusive
Interval Notation: $[-7, 0]$
Set Notation: $\{x \mid -7 \leq x \leq 0, x \in R\}$
Range:
Words: all real numbers between −5 and 2, inclusive
Interval Notation: $[-5, 2]$
Set Notation: $\{y \mid -5 \leq y \leq 2, y \in R\}$

20. a) AC = 19.49 km; BC = 15.36 km; ∠C = 38°,
b) DE = 14.25 m; ∠D = 37.67°; ∠F = 52.33°

21. a) $\frac{6}{7}$ **b)** −2

Extend It Further

1. C
2. C
3. A
4. D
5. D
6. domain = $\{x \mid 7 < x < 31, x \in N\}$
range = $\{f(x) \mid 39 \leq f(x) \leq 61, f(x) \in N\}$
7. The slope of the line joining (−3, 0) and (0, 6) is 2. The slope of the line joining (−3, 0) and (0, −1.5) is $\frac{-1}{2}$. The product of the two slopes is −1, which means that the lines are perpendicular to each other. An alternative solution is to use the Pythagorean relationship; the sides have lengths $\sqrt{45}$, $\sqrt{11.25}$, and $\sqrt{56.25}$. Since $(\sqrt{45})^2 + (\sqrt{11.25})^2 = (\sqrt{56.25})^2$, the triangle is a right triangle.
8. domain = $\{x \mid x \geq -200.9, x \in R\}$
9. $f(12) = f(3) + f(4) = x + y$
$f(144) = f(12) + f(12) = (x + y) + (x + y) = 2(x + y)$
10. (2, 0)
11. 6 units^2

12. a) 24°; $\frac{5}{11}$ **b)** −1

13. a) 23°; $\frac{5}{12}$
b) $\angle n = \angle m$ because they are corresponding angles.

14. b) $y = 4, -4$
c) 3, −3
d) a relation

Chapter 7 Linear Equations and Graphs

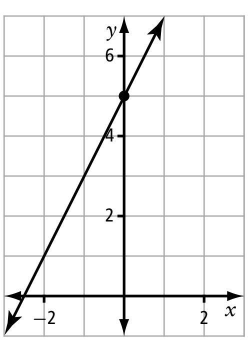
7.1 Slope-Intercept Form

1. **a)** $m = \frac{1}{2}$, y-intercept: −2
b) $m = -4$, y-intercept: 3
c) $m = 1$, y-intercept: 0
d) $m = 0.75$, y-intercept: 3.5

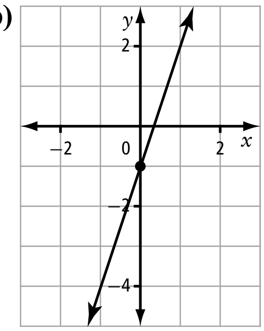
2. **a)** $x - x + y = 7 - x$
$y = -x + 7$
$m = -1$, y-intercept: 7
b) $y - 4x + 4x = 12 + 4x$
$y = 4x + 12$
$m = 4$, y-intercept: 12
c) $5x - 5x + 2y = -5x + 10$
$2y = -5x + 10$
$\frac{2y}{2} = \frac{-5x + 10}{2}$
$y = \frac{-5}{2}x + 5$
$m = \frac{-5}{2}$, y-intercept: 5
d) $x - 3y + 3y - 12 = 0 + 3y$
$x - 12 = 3y$
$\frac{x - 12}{3} = \frac{3y}{3}$
$\frac{1}{3}x - 4 = y$
$y = \frac{1}{3}x - 4$
$m = \frac{1}{3}$, y-intercept: −4

3. **a)** $y = 4x - 1$ **b)** $y = \frac{-1}{2}x + 7$
c) $y = \frac{2}{3}x - 2$ **d)** $y = 0.5x$
e) $y = -5x + 1$ **f)** $y = x + \frac{4}{5}$

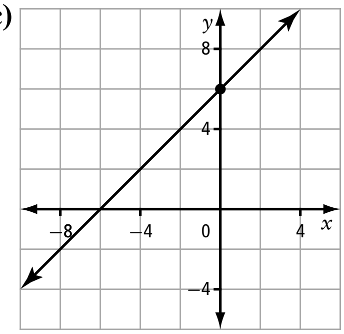
4. **a)**



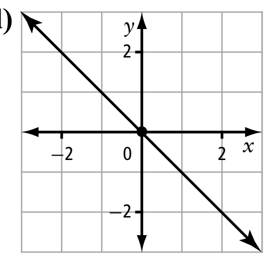
b)



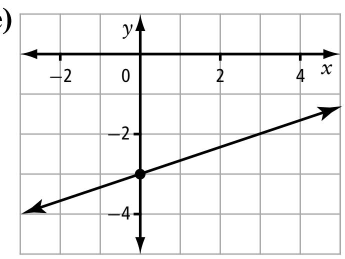
c)



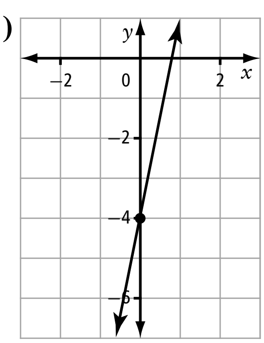
d)



e)



f)



5. a) $m = 1, b = 1, y = x + 1$
b) $m = -1, b = 4, y = -x + 4$
c) $m = \frac{2}{3}, b = 0, y = \frac{2}{3}x$
d) $m = -4, b = 2, y = -4x + 2$
e) $m = 0.6, b = -2, y = 0.6x - 2$
f) $m = \frac{-6}{5}, b = 6, y = \frac{-6}{5}x + 6$

6. a) Replace x with 12 and y with 8 in the equation $y = \frac{1}{2}x + b$.

$$y = \frac{1}{2}x + b$$
$$8 = \frac{1}{2}(12) + b$$

Solve for b.

$$8 = 6 + b$$
$$8 - 6 = 6 - 6 + b$$
$$2 = b$$

b) Replace x with -3 and y with $\frac{1}{2}$ in the equation $y = \frac{1}{2}x + b$.

$$y = \frac{1}{2}x + b$$
$$\frac{1}{2} = \frac{1}{2}(-3) + b$$

Solve for b.

$$\frac{1}{2} = \frac{-3}{2} + b$$
$$\frac{1}{2} + \frac{3}{2} = \frac{-3}{2} + \frac{3}{2} + b$$
$$\frac{4}{2} = b$$
$$2 = b$$

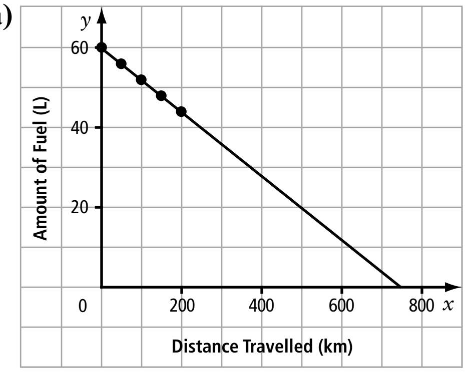
7. a) $m = 2$ b) $m = -4$

8. a) $y = 2x - 250$
b) $m = 2$; the price per raffle ticket
c) $b = -250$; the cost of the pair of hockey tickets
d) 275 tickets

9. a) $y = 75x - 600$
b) \$255 loss; \$525 profit; \$1275 profit
c) 8 competitors

10. a) \$25
b) $y = 15x + 25$
c) $b = 25$, which represents the fixed charge
d) discrete because rental is charged per whole hour

11. a)



b) Substitute two points on the line, for example, (0, 60) and (50, 56), into the slope formula:

$$m = \frac{y_2 - y_1}{x_2 - x_1}$$
$$m = \frac{56 - 60}{50 - 0}$$
$$m = \frac{-4}{50}$$
$$m = \frac{-2}{25}$$

The line intersects the y-axis at 60, so $b = 60$.

c) Replace m with $\frac{-2}{25}$ and b with 60 in the slope-intercept form: $y = \frac{-2}{25}x + 60$.

d) The amount of fuel in the car's tank before driving any distance.

e) The tank is empty when $y = 0$. Replace y with 0 and solve for x:

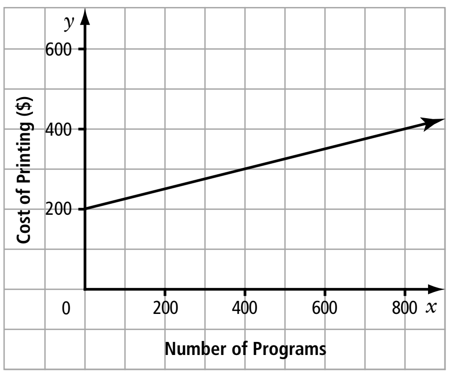
$$y = \frac{-2}{25}x + 60$$
$$0 = \frac{-2}{25}x + 60$$
$$0 - 60 = \frac{-2}{25}x + 60 - 60$$
$$-60 = \frac{-2}{25}x$$
$$\left(\frac{-25}{2}\right)(-60) = \left(\frac{-25}{2}\right)\left(\frac{-2}{25}x\right)$$
$$750 = x$$

The tank will be empty after 750 km.

12. a)

Number of Programs	Cost of Printing ($)
0	200.00
50	212.50
100	225.00
150	237.50
200	250.00
250	262.50

b)



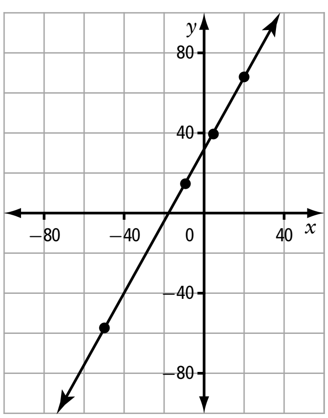
c) $m = \frac{1}{4}$; the cost of printing each program

d) $b = 200$; the fixed cost

e) $y = \frac{1}{4}x + 200$

f) 600 programs

13. a)



b) Use two points from the table to find the slope: (20, 68) and (−10, 14).

$m = \frac{y_2 - y_1}{x_2 - x_1}$

$m = \frac{14 - 68}{-10 - 20}$

$m = \frac{-54}{-30}$

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

c) $b = 32$, which represents the temperature in Fahrenheit when the temperature is 0 °C.

d) Replace m with $\frac{9}{5}$ and b with 32 in the slope-intercept form: $y = \frac{9}{5}x + 32$.

e) In the equation $y = \frac{9}{5}x + 32$, replace y with x and x with y. Then, solve for y.

$$x = \frac{9}{5}y + 32$$
$$x - 32 = \frac{9}{5}y + 32 - 32$$
$$x - 32 = \frac{9}{5}y$$
$$\frac{5}{9}(x - 32) = \left(\frac{5}{9}\right)\left(\frac{9}{5}y\right)$$
$$\frac{5}{9}x - \frac{160}{9} = y$$

f) Use the $y = \frac{9}{5}x + 32$ form of the equation, replacing x with −40.

$y = \frac{9}{5}x + 32$

$y = \frac{9}{5}(-40) + 32$

$y = -72 + 32$

$y = -40$

−40 °C = −40 °F

Use the $y = \frac{5}{9}x - \frac{160}{9}$ form of the equation, replacing x with 100.

$y = \frac{5}{9}(100) - \frac{160}{9}$

$y = 37.8$

100 °F = 37.8 °C

Use the $y = \frac{9}{5}x + 32$ form of the equation, replacing x with 0.

$y = \frac{9}{5}x + 32$

$y = \frac{9}{5}(0) + 32$

$y = 32$

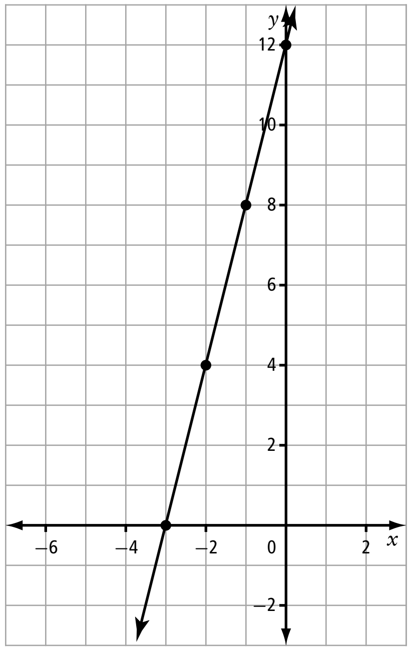
0 °C = 32 °F

14. 80 people

15. a) Example:

x	y
0	12
−3	0
−2	4
−1	8

b) The slope is 4 and the y-intercept is (0, 12).

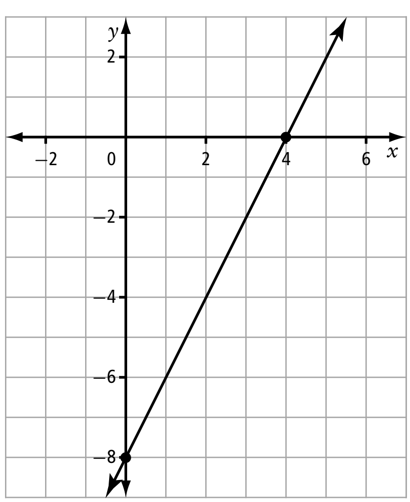


c) Example: I prefer using the slope and y-intercept. There is less computation involved when writing the equation in slope-intercept form. It is simple to graph the line using the slope and the y-intercept.

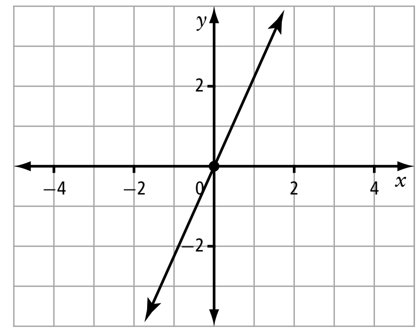
7.2 General Form

1. **a)** $x - 3y + 15 = 0$ **b)** $2x + 7y = 0$
c) $8y - 1 = 0$ **d)** $2x + 10y - 12 = 0$

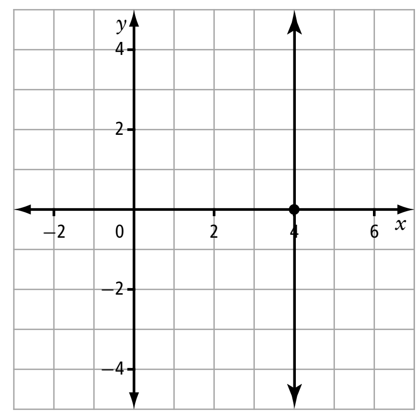
2. **a)** (4, 0), (0, −8)



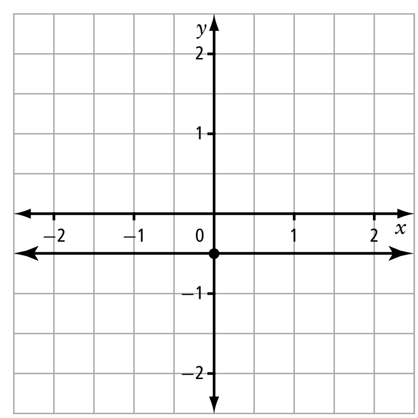
b) (0, 0)



c) (4, 0), no y-intercept



d) no x-intercept, $(0, \frac{-1}{2})$



3. a) domain: $x \in R$; range: $y \in R$
To find the slope, use the points (0, 4) and (3, 0).
$m = \frac{y_2 - y_1}{x_2 - x_1}$
$m = \frac{4 - 0}{0 - 3}$
$m = \frac{-4}{3}$
The x-intercept is (3, 0) and the y-intercept is (0, 4).

In the slope-intercept form, replace m with $\frac{-4}{3}$ and b with 4:
$y = \frac{-4}{3}x + 4.$
Multiply both sides of the equation by 3:
$3y = 3\left(\frac{-4}{3}x + 4\right)$
$3y = -4x + 12$

Bring all terms to one side of the equation:

$3y = -4x + 12$
$3y + 4x = -4x + 4x + 12$
$4x + 3y = 12$
$4x + 3y - 12 = 12 - 12$
$4x + 3y - 12 = 0$

b) domain: $x \in R$; range: $y = -3$
Since this is a horizontal line, the slope is 0.
The y-intercept is (0, −3).
The equation of the line in general form is $y + 3 = 0$.

4. Examples:
a) $y + 5 = 0$ **b)** $x + 0 = 0$
c) $x - 8 = 0$ **d)** $3x - 7y = 0$
e) $x + y - 3 = 0$

5. a) $B = -1$ **b)** $A = 4$
c) $C = 0$

6. a) Let $14x$ represent the number of calories burned swimming for x minutes. Let $12y$ represent the number of calories burned biking for y minutes. The equation to represent the total number of calories burned is $14x + 12y = 4200$.

b) To find the x-intercept, replace y with 0.

$14x + 12y = 4200$
$14x + 12(0) = 4200$
$14x = 4200$
$x = 300$

The x-intercept represents how many minutes he would need to spend swimming if he burned 4200 calories by only swimming.

To find the y-intercept, replace x with 0.
$14x + 12y = 4200$
$14(0) + 12y = 4200$
$12y = 4200$
$y = 350$

The y-intercept represents how many minutes he would need to spend biking if he did not spend any time swimming.

c) The domain is $0 \leq x \leq 300$. There can be no values less than 0 or greater than 300. The range is $0 \leq y \leq 350$. There can be no values less than 0 or greater than 350.

d) Replace y with 120 and solve for x.
$14x + 12y = 4200$
$14x + 12(120) = 4200$
$14x + 1440 = 4200$
$14x + 1440 - 1440 = 4200 - 1440$
$14x = 2760$
$x = 197$
He would need to swim 197 minutes, or 3 hours and 17 minutes.

7. a) $5x + 2y - 2250 = 0$
b) $m = \frac{-5}{2}$; (450, 0) and (0, 1125);
domain: $0 \leq x \leq 450$,
range: $0 \leq y \leq 1125$
c) 400 minutes, or 6 hours and 40 minutes

8. 108 square units

9. Examples:
a) (−4, 1) and (6, 4), $3x - 10y + 22 = 0$
b) (2, 8) and (7, 8), $y - 8 = 0$
c) (−2, −1) and (6, −4), $3x + 8y + 14 = 0$
d) (−3.5, 6) and (−3.5, −2), $2x + 7 = 0$

7.3 Slope-Point Form

1. a) $m = 4$, $(3, -7)$
   b) $m = \frac{1}{3}$, $(-5, 5)$
   c) $m = -2$, $(6, 0)$
   d) $m = 1$, $(3, -1)$
2. a) $y = \frac{2}{3}x + \frac{11}{3}$; $2x - 3y + 11 = 0$
   b) $y = -2x - 2$; $2x + y + 2 = 0$
   c) $y = \frac{3}{4}x - 3$; $3x - 4y - 12 = 0$
   d) $y = 3x + 19$; $3x - y + 19 = 0$
3. a) For slope-point form, replace m with $\frac{4}{3}$ and (x_1, y_1) with $(-1, -5)$:
   $$y - y_1 = m(x - x_1)$$
   $$(y + 5) = \frac{4}{3}(x + 1)$$
   For slope-intercept form, rewrite $(y + 5) = \frac{4}{3}(x + 1)$ in the form $y = mx + b$:
   $$\begin{aligned}(y + 5) &= \frac{4}{3}(x + 1)\\ y + 5 &= \frac{4}{3}x + \frac{4}{3}\\ y + 5 - 5 &= \frac{4}{3}x + \frac{4}{3} - 5\\ y &= \frac{4}{3}x - \frac{11}{3}\end{aligned}$$
   For general form, rewrite $y = \frac{4}{3}x - \frac{11}{3}$ in the form $Ax + By + C = 0$:
   $$\begin{aligned}3y &= 3\left(\frac{4}{3}x - \frac{11}{3}\right)\\ 3y &= 4x - 11\\ 3y - 3y &= 4x - 3y - 11\\ 0 &= 4x - 3y - 11\end{aligned}$$
   b) Slope-point form: $(y + 3) = 1\left(x + \frac{1}{2}\right)$
   Slope-intercept form: $y = x - \frac{5}{2}$
   General form: $0 = 2x - 2y - 5$
   c) Slope-point form: $(y - 4) = -1.5(x - 1)$
   Slope-intercept form: $y = -1.5x + 5.5$
   General form: $0 = 15x + 10y - 55$
   d) Slope-point form:
   First find the slope of the line through the points $(-5, -8)$ and $(-7, -9)$.
   $$m = \frac{y_2 - y_1}{x_2 - x_1}$$
   $$m = \frac{-9 - (-8)}{-7 - (-5)}$$
   $$m = \frac{1}{2}$$
   Then, replace m with $\frac{1}{2}$ and (x_1, y_1) with $(-5, -8)$ in the slope-point form.
   $$y - y_1 = m(x - x_1)$$
   $$(y + 8) = \frac{1}{2}(x + 5)$$
   Slope-intercept form:
   $$y = \frac{1}{2}x - \frac{11}{2}$$
   General form:
   $$\begin{aligned}y &= \frac{1}{2}x - \frac{11}{2}\\ 2y &= 2\left(\frac{1}{2}x - \frac{11}{2}\right)\\ 2y &= x - 11\\ 2y - 2y &= x - 2y - 11\\ 0 &= x - 2y - 11\end{aligned}$$
   e) Slope-point form: $(y + 2) = \frac{1}{2}(x + 1)$
   Slope-intercept form: $y = \frac{1}{2}x - \frac{3}{2}$
   General form: $0 = x - 2y - 3$
4. Examples:
   a) $y - 2 = \frac{1}{2}(x - 6)$
   b) $y - 2 = -1(x - 2)$
   c) $y + 5 = \frac{-4}{3}(x - 2)$
5. a) $y - 1 = 0(x + 3)$; $y - 1 = 0$
   b) $y - 8 = 2(x + 1)$; $2x - y + 10 = 0$
   c) The slope of the line $5x + 2y - 10$ is $-\frac{5}{2}$. So, the second line must have this same slope. Since it passes through the point $(-1, 4)$, the equation of the second line in slope-point form is $y - 4 = \frac{-5}{2}(x + 1)$. To convert this to general form, move all terms to the left side of the equation:
   $$\begin{aligned}y - 4 &= \frac{-5}{2}(x + 1)\\ y - 4 &= \frac{-5}{2}x - \frac{5}{2}\\ (2)(y - 4) &= (2)\left(\frac{-5}{2}x - \frac{5}{2}\right)\\ 2y - 8 &= -5x - 5\\ 2y - 8 + 5 &= -5x - 5 + 5\\ 2y - 3 &= -5x\\ 5x + 2y - 3 &= -5x + 5x\\ 5x + 2y - 3 &= 0\end{aligned}$$
   d) $y + 6 = \frac{-5}{2}(x - 2)$; $5x + 2y + 2 = 0$
   e) $y - 3 = \frac{3}{5}(x - 0)$; $3x - 5y + 15 = 0$
   f) $y - 0 = \frac{-3}{2}(x - 0)$; $3x + 2y = 0$

6. Write the equation of the line with x-intercept (10, 0) and y-intercept (0, −5).
Find the slope.

$m = \frac{y_2 - y_1}{x_2 - x_1}$

$m = \frac{-5 - 0}{0 - 10}$

$m = \frac{-5}{-10}$

$m = \frac{1}{2}$

Substitute $m = \frac{1}{2}$ and $b = -5$ into the slope-intercept form: $y = \frac{1}{2}x - 5$.

Replace x with −2 and y with −6.

$y = \frac{1}{2}x - 5$

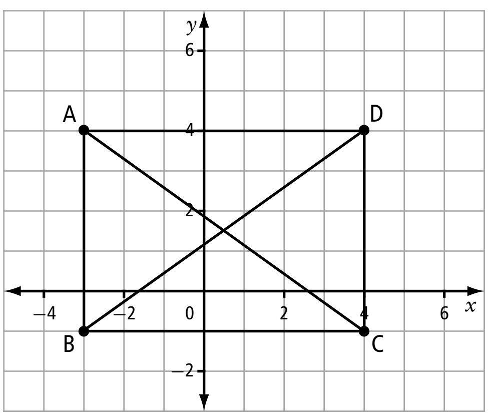
$-6 = \frac{1}{2}(-2) - 5$

$-6 = -1 - 5$

$-6 = -6$

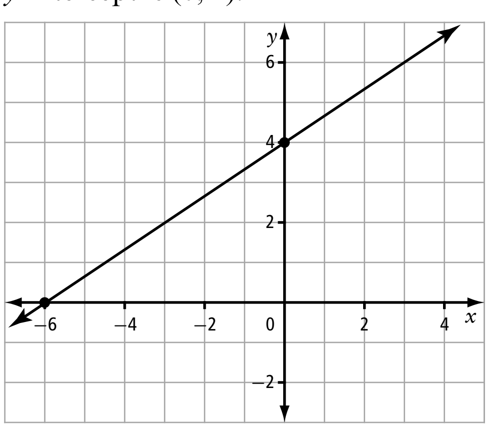
Since replacing x with −2 and y with −6 in the equation of the line results in a true statement, the point (−2, −6) is on the line.

7.



AC: $5x + 7y - 13 = 0$
BD: $5x - 7y + 8 = 0$

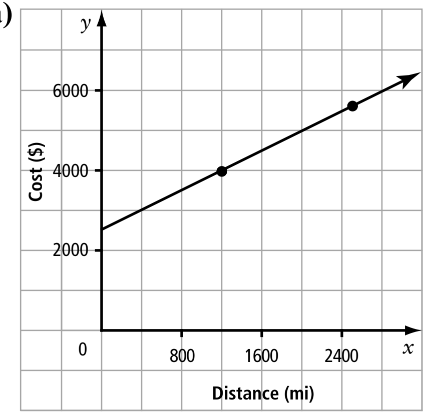
8. The x-intercept is (−6, 0) and the y-intercept is (0, 4).



9. $k = 1$

10. a) Lines 3 and 4 **b)** Line 5
c) Lines 1 and 2

11. a)



b) $m = \frac{5}{4}$, which represents the cost of operating a snowmobile per mile
c) $b = 2500$; the fixed cost of operating a snowmobile
d) $5x - 4y + 10\,000 = 0$
e) $3625

12. a) $5x - 2y - 52 = 0$
b) 2.5 cm/h; at 1400 hours it was 21 cm tall
c) rate of burn per hour
d) the height at 1400 hours

13. Rewrite each equation in slope-intercept form. Enter the equations into a graphing calculator or graphing program and read the intersection points, which are the vertices.

Line 1:

$$2x + 3y - 18 = 0$$
$$2x - 2x + 3y - 18 = 0 - 2x$$
$$3y - 18 = -2x$$
$$3y - 18 + 18 = -2x + 18$$
$$3y = -2x + 18$$
$$\frac{3y}{3} = \frac{-2x}{3} + \frac{18}{3}$$
$$y = \frac{-2x}{3} + 6$$

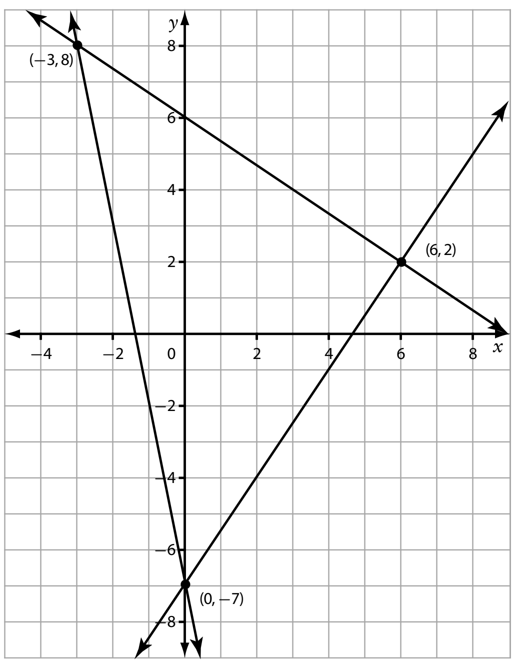
Line 2:

$$5x + y + 7 = 0$$
$$5x - 5x + y + 7 = 0 - 5x$$
$$y + 7 = -5x$$
$$y + 7 - 7 = -5x - 7$$
$$y = -5x - 7$$

Line 3:

$$3x - 2y - 14 = 0$$
$$3x - 3x - 2y - 14 = 0 - 3x$$
$$-2y - 14 = -3x$$
$$-2y - 14 + 14 = -3x + 14$$
$$-2y = -3x + 14$$
$$\frac{-2y}{-2} = \frac{-3x}{-2} + \frac{14}{-2}$$
$$y = \frac{3x}{2} - 7$$

Enter the equations into a graphing calculator or graphing program.



The vertices of the triangle are (−3, 8), (0, −7), and (6, 2).

14. a) $3x - 4y + 24 = 0$

b) The x-intercept is (−8, 0) and the y-intercept is (0, 6). The denominator of the x-term in the original equation is the x-intercept. The denominator of the y-term in the original equation is the y-intercept.

c) Example: Predict that the x-intercept is (3, 0) and the y-intercept is (0, −5). Verify by replacing y with 0 and solving for x to find the x-intercept.

$$\frac{x}{3} - \frac{y}{5} = 1$$
$$\frac{x}{3} - \frac{0}{5} = 1$$
$$\frac{x}{3} = 1$$
$$x = 3$$

Therefore, the x-intercept is (3, 0).

Verify by replacing x with 0 and solving for y to find the y-intercept.

$$\frac{x}{3} - \frac{y}{5} = 1$$
$$\frac{0}{3} - \frac{y}{5} = 1$$
$$0 - \frac{y}{5} = 1$$
$$\frac{-y}{5} = 1$$
$$y = -5$$

Therefore, the y-intercept is (0, −5).

The above shows that the prediction was correct.

15. a) Example: $y - 1.4 = -\frac{31}{90}(x - 2010)$
b) in the year 2014

7.4 Parallel and Perpendicular Lines

1. **a)** perpendicular **b)** parallel **c)** perpendicular **d)** perpendicular **e)** perpendicular **f)** parallel

2. **a)** parallel: −3; perpendicular: $\frac{1}{3}$
b) parallel: 1; perpendicular: −1
c) parallel: −4; perpendicular: $\frac{1}{4}$
d) parallel: 0; perpendicular: undefined
e) parallel: $\frac{5}{2}$; perpendicular: $\frac{-2}{5}$

3. **a)** $n = 4$ **b)** $n = -2$ **c)** $n = 2.5$ **d)** $n = \frac{3}{2}$

4. **a)** $r = -2$ **b)** $r = 15$ **c)** $r = -18$ **d)** $r = 8$

5. **a)** $5x + y - 7 = 0$ **b)** $x + 3y + 4 = 0$ **c)** $x + y - 4 = 0$

6. **a)** $2x + y - 5 = 0$ **b)** $4x + 7y = 0$ **c)** $2x - y - 12 = 0$

7. **a)** $\frac{1}{2}, \frac{1}{2}$
b) no, the equations represent the same line

8. **a)** $x - 5y - 31 = 0$ **b)** $3x - y + 10 = 0$

9. $y - 15 = 0$

10. a) The slope of side MN is $-\frac{4}{3}$, the slope of side NC is $\frac{-7}{5}$, and the slope of side MC is $\frac{-3}{2}$. Since no two slopes have a product of −1, these points do not represent the vertices of a right triangle.

b) The slope of DF is $\frac{1}{2}$, the slope of FG is $\frac{-4}{7}$, and the slope of DG is −2. Since the product of the slopes of sides DF and DG is −1, the points represent the vertices of a right triangle.

11. Examples:

a) Find the slope of $4x + y - 11 = 0$ by writing the equation in slope-intercept form, $y = mx + b$:

$$\begin{aligned} 4x + y - 11 &= 0 \\ 4x - 4x + y - 11 &= 0 - 4x \\ y - 11 &= -4x \\ y - 11 + 11 &= -4x + 11 \\ y &= -4x + 11 \end{aligned}$$

The slope is −4.

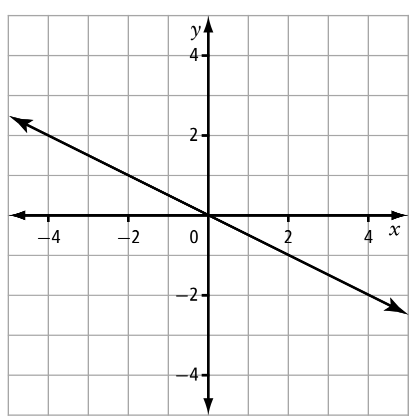
Any line with the same slope but a different y-intercept will be parallel to the given line. Example, $y = -4x + 16$. An infinite number of equations can be written in the form $y = mx + b$, where $m = -4$ and $b \neq 11$.

b) A line perpendicular to $4x + y - 11 = 0$ has a slope that is the negative reciprocal of −4, or $\frac{1}{4}$. Example, $y = \frac{1}{4}x - 6$.

Any line with a slope of $\frac{1}{4}$ will be perpendicular to the given line, regardless of the y-intercept. There is an infinite number of these lines.

12. $12x + y - 3 = 0$

13. The line must have a slope of $\frac{-1}{2}$ and a y-intercept of 0.



14. $k = -4$

15. $k = -4$

16. $k = \frac{7}{6}$

17. a) Write the equation in slope-intercept form:

$$\begin{aligned} kx - 2y - 1 &= 0 \\ kx - kx - 2y - 1 &= 0 - kx \\ -2y - 1 &= -kx \\ -2y - 1 + 1 &= -kx + 1 \\ -2y &= -kx + 1 \\ \frac{-2y}{-2} &= \frac{-kx}{-2} + \frac{1}{-2} \\ y &= \frac{kx}{2} - \frac{1}{2} \end{aligned}$$

Therefore, the slope of the first line is $\frac{k}{2}$.

$$\begin{aligned} 8x - ky + 3 &= 0 \\ 8x - 8x - ky + 3 &= 0 - 8x \\ -ky + 3 &= -8x \\ -ky + 3 - 3 &= -8x - 3 \\ -ky &= -8x - 3 \\ \frac{-ky}{-k} &= \frac{-8x}{-k} - \frac{3}{-k} \\ y &= \frac{8x}{k} + \frac{3}{k} \end{aligned}$$

The slope of the second line is $\frac{8}{k}$.

Since the lines are parallel, the slopes must be equal. Set the two slopes equal to each other and solve for k.

$\frac{k}{2} = \frac{8}{k}$

$k^2 = 16$

$k = \sqrt{16}$

$k = \pm 4$

The values of k are 4 and −4.

b) Since the lines are perpendicular, the slope must have a product of −1.

$\left(\frac{k}{2}\right)\left(\frac{8}{k}\right) = -1$

$\frac{8k}{2k} = -1$

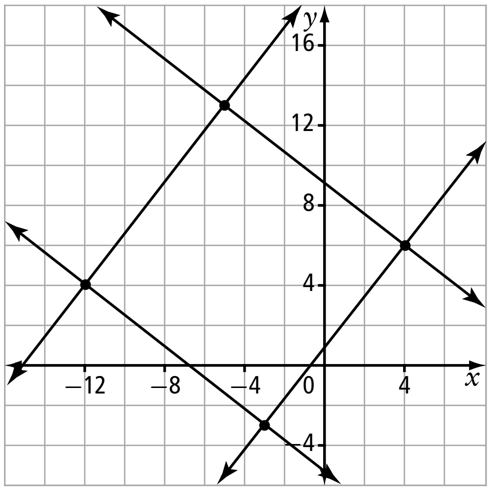
$4 \neq 1$

Therefore, there are no values of k that will work.

18. a) $y - 1 = 0$

b) $x + 2y - 4 = 0$

19. Example:
$7x + 9y - 82 = 0$, $7x + 9y + 48 = 0$,
$9x - 7y + 6 = 0$, $9x - 7y + 136 = 0$



Chapter 7 Review

7.1 Slope-Intercept Form

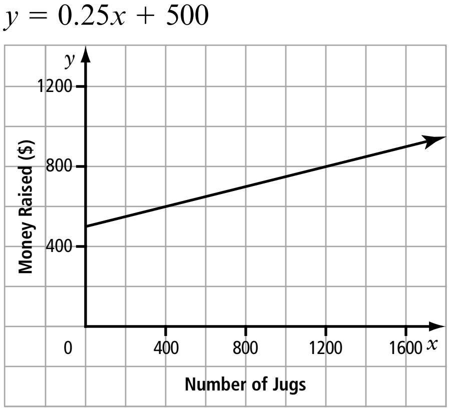
1. **a)** $m = \frac{3}{2}$; $b = -2$; $y = \frac{3}{2}x - 2$
b) $m = -1$; $b = 5$; $y = -x + 5$
c) $m = \frac{-1}{6}$; $b = 1$; $y = \frac{-1}{6}x + 1$
d) $m = 3$; $b = -4$; $y = 3x - 4$

2. $b = 8$

3. If the line $y = mx - 8$ passes through the point (−2, 6), replace x with −2 and y with 6. Solve for m.

$$y = mx - 8$$
$$6 = m(-2) - 8$$
$$6 = -2m - 8$$
$$6 + 8 = -2m - 8 + 8$$
$$14 = -2m$$
$$\frac{14}{-2} = \frac{-2m}{-2}$$
$$-7 = m$$

4. **a)** $y = 0.25x + 500$
b)

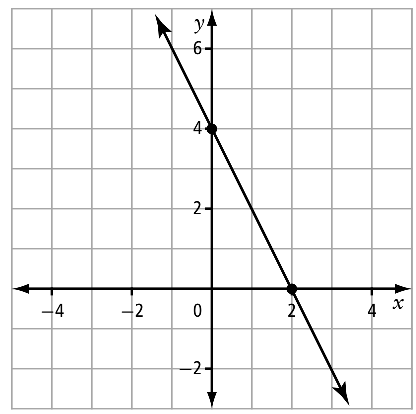


c) $m = 0.25$; $b = 500$; the slope represents the redemption value per jug; the y-intercept represents the amount of money already raised
d) 1400 jugs

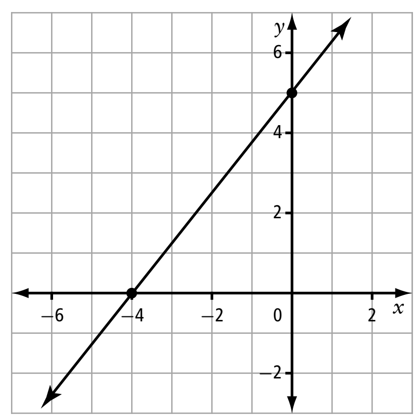
7.2 General Form

5. **a)** $x + 2y + 18 = 0$ **b)** $2x - 3y + 6 = 0$
c) $x + y + 3 = 0$

6. **a)** y-intercept is (0, 4); x-intercept is (2, 0)



b) y-intercept is (0, 5); x-intercept is (−4, 0)



7. **a)** $60x + 10y - 4200 = 0$
b) x-intercept is (70, 0), y-intercept is (0, 420); The x-intercept represents the number of days of growth under ideal conditions to reach a height of 42 m. The y-intercept represents the number of days of growth under less than ideal condition to reach a height of 42 m.
c) $0 \le x \le 70$, $0 \le y \le 420$
d) 90 days

7.3 Slope-Point Form

8. $y + 5 = 2(x + 6)$; $2x - y + 7 = 0$

9. $y - 4 = 8(x - 0)$; $8x - y + 4 = 0$

10. a) Example:
Use the points (8570, 3) and (5570, 12) to find the slope:

$$m = \frac{y_2 - y_1}{x_2 - x_1}$$
$$m = \frac{12 - 3}{5570 - 8570}$$
$$m = \frac{9}{-3000}$$
$$m = \frac{-3}{1000}$$

Choose the point (8570, 3). Write the equation in slope-point form:

$$y - 3 = \frac{-3}{1000}(x - 8570)$$

b) Replace x with 6500, and solve for y:

$$y - 3 = \frac{-3}{1000}(x - 8570)$$
$$y - 3 = \frac{-3}{1000}(6500 - 8570)$$
$$y - 3 = \frac{-3}{1000}(-2070)$$
$$y - 3 = 6.21$$
$$y - 3 + 3 = 6.21 + 3$$
$$y = 9.21$$

The temperature at the base of Eagle Chair is approximately 9 °F.

7.4 Parallel and Perpendicular Lines

11. a) perpendicular **b)** parallel
c) perpendicular

12. $x + 2y - 12 = 0$

13. Find the slope of the line through the points (−1, 3) and (2, 1).

$$m = \frac{y_2 - y_1}{x_2 - x_1}$$
$$m = \frac{1 - 3}{2 - (-1)}$$
$$m = \frac{-2}{3}$$

The negative reciprocal of $\frac{-2}{3}$ is $\frac{3}{2}$. The x-intercept is (−4, 0). Place these values in the slope-point form of the equation of a line:

$$y - 0 = \frac{3}{2}(x - (-4))$$
$$y = \frac{3}{2}x + 6$$

Multiply the equation by 2:

$$2y = 2\left(\frac{3}{2}x + 6\right)$$
$$2y = 3x + 12$$

Write in general form.

$$2y - 2y = 3x - 2y + 12$$
$$0 = 3x - 2y + 12$$

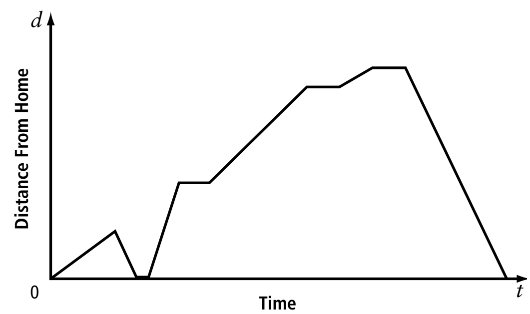
14. All of the lines have a slope of $\frac{-2}{3}$ and all of the lines have different intercepts, therefore, the equations represent parallel lines.

Chapters 1–7 Cumulative Review

1. a) $m = -7$; $b = 10$ **b)** $m = \frac{-9}{2}$; $b = \frac{15}{2}$

2. a) 1277.4 cm^2 **b)** 57.6 m^2

3.



4. a) 8 **b)** 9
c) 30

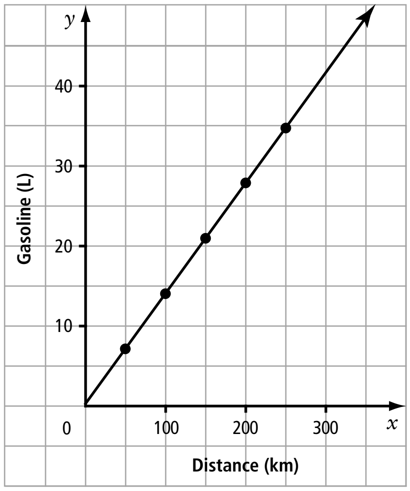
5. a) $(x + 12)(x + 1)$
b) $3(2m - n)(m - n)$
c) $(3x + y)(5x - y)$
d) $2t(s - 3)(s + 2)$
e) $(c - 9)(c + 9)$
f) $(x - 4)(x + 4)(x - 3)(x + 3)$
g) $(1 - 2y)(1 + 2y)(1 + 4y)^2$
h) $7(2h - 11f)(2h + 11f)$

6. a) $31n^2 - 13n - 50$
b) $-8s^4 + 16s^3 + 20s^2 - 13s - 3$

7. 17.5 cm

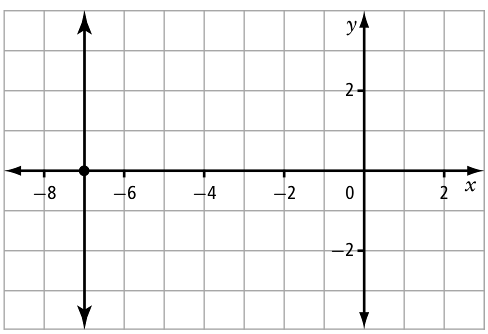
8. a) Example: amount of gasoline (L) = g, dependent variable; distance (km) = d, independent variable
b) Example: (0, 0), (50, 6.9), (100, 13.8), (150, 20.7), (200, 27.6), (250, 34.5)
c) The relation is continuous because vehicles can travel for a fraction of a kilometre.

d)

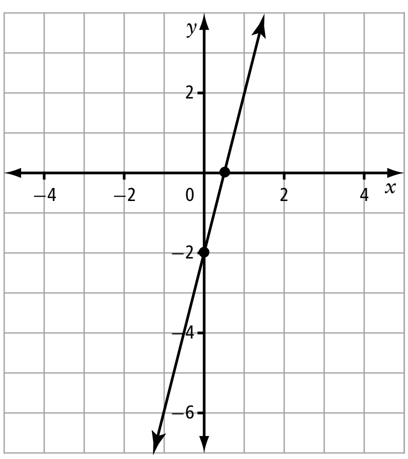


e) The relation is linear because the amount of gas used is constant with the number of kilometres driven.

9. a) x-intercept (−7, 0); y-intercept does not exist



b) x-intercept (0.5, 0); y-intercept (0, −2)



10. a) 878.9 mg **b)** 3686.4 kg

11. a) $2ac$ **b)** $1 - 4s$
c) $3z^2 - 2x$

12. a) ∠C = 63°; AB = 16.49 km; BC = 18.50 km
b) DE = 10.96 m; ∠D = 56.14°; ∠F = 33.84°

13. a) $y - 4 = -3(x + 5)$; $y = -3x - 11$; $y + 3x + 11 = 0$
b) $y - 2 = \frac{1}{2}(x + 3)$; $y = \frac{1}{2}x + \frac{1}{2}$; $x + 2y - 1 = 0$

14. AC = 37.5 cm

15. a) $\frac{1}{x^{\frac{2}{15}}}$ **b)** $\frac{1}{27h^6}$
c) $8^{\frac{23}{20}}$ **d)** $64x^9$

16. 2787 m; 1.6 km; 2865 m

17. a) 1006.72 cm^2 **b)** 7585 cm^2
c) 78.54 cm^2 **d)** 431.97 cm^2
e) 38.62 cm^2

18. 44.2 mi

19. a) $\sqrt[3]{3^2}$ **b)** $\sqrt{16}$
c) $\sqrt{\left(\frac{y^3}{x^5}\right)^3}$

20. a) Domain
Words: all real numbers between −4 and 4, not inclusive
Interval Notation: (−4, 4)
Set Notation: $\{x \mid -4 < x < 4, x \in \mathrm{R}\}$
Range
Words: all real numbers between 4 and 8, not inclusive
Interval Notation: (4, 8)
Set Notation: $\{y \mid 4 < y < 8, y \in \mathrm{R}\}$
b) Domain
Words: all real numbers
Interval Notation: $(-\infty, \infty)$
Set Notation: $\{x \mid -\infty < x < \infty\ x \in \mathrm{R}\}$
Range
Words: all real numbers
Interval Notation: $(-\infty, \infty)$
Set Notation: $\{y \mid -\infty < y < \infty, y \in \mathrm{R}\}$

21. 118.3 m

22. 0.5 m^3

23. a) $-\frac{2}{3}$
b) 3

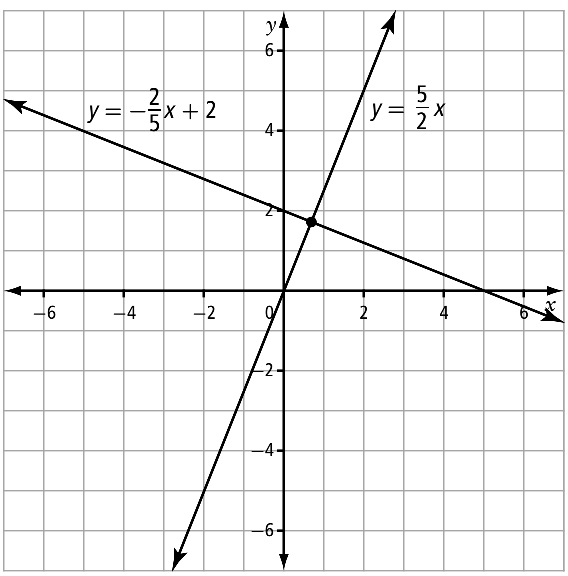
24. 25%

25. $y = 2x + 16$

Chapter 7 Extend It Further

1. D

The shortest distance between a point and a line is the length of the line segment that passes through the point and runs perpendicular to the original line. The given line in this question is $2x + 5y = 10$, or $y = \frac{-2}{5}x + 2$ in slope-intercept form. The line has a slope of $\frac{-2}{5}$. The perpendicular line has a slope of $\frac{5}{2}$ and, since it passes through the origin, its equation is $y = \frac{5}{2}x$. The point where the two lines intersect is the point on the original line that is closest to the origin.



To find the intersection point, first find a value of x that lies on both lines:

$$\frac{-2}{5}x + 2 = \frac{5}{2}x$$
$$(5)\left(\frac{-2}{5}x + 2\right) = (5)\frac{5}{2}x$$
$$-2x + 10 = \frac{25}{2}x$$
$$(2)(-2x + 10) = (2)\frac{25}{2}x$$
$$-4x + 20 = 25x$$
$$-4x + 4x + 20 = 25x + 4x$$
$$20 = 29x$$
$$\frac{20}{29} = x$$

Substitute this value into the equation for either of the lines to find the y-coordinate:

$$y = \frac{5}{2}\left(\frac{20}{29}\right)$$
$$y = \frac{100}{58}$$
$$y = \frac{50}{29}$$

So, the point on the line that is closest to the origin is $\left(\frac{20}{29}, \frac{50}{29}\right)$.

2. B

3. D

4. Let $A(a, 0)$, $B(0, b)$, and $C(0, 0)$ be the three vertices. It follows that the midpoint M has coordinates $\left(\frac{a}{2}, \frac{b}{2}\right)$. Using the Pythagorean relation or the midpoint formula,

$$MA = \sqrt{\left(\frac{a}{2} - a\right)^2 + \left(\frac{b}{2} - 0\right)^2} = \sqrt{\frac{a^2}{4} + \frac{b^2}{4}}$$
$$MB = \sqrt{\left(\frac{a}{2} - 0\right)^2 + \left(\frac{b}{2} - b\right)^2} = \sqrt{\frac{a^2}{4} + \frac{b^2}{4}}$$
$$MC = \sqrt{\left(\frac{a}{2} - 0\right)^2 + \left(\frac{b}{2} - 0\right)^2} = \sqrt{\frac{a^2}{4} + \frac{b^2}{4}}$$

5. **a)** $A = 3$ and $B = 4$
b) $s = -1505$

6. **a)** the slope of the line becomes more steep
b) the slope of the line becomes less steep
c) the line shifts upward, parallel to the first line
d) the line shifts downward, parallel to the first line

7. **a)** $F - 32 = \frac{9}{5}C$
b) −40 °F

8. **a)** $y = \frac{3}{4}x + \frac{9}{4}$
b) The y-intercept represents the base fare when you enter the taxi.

9. **a)** $<, >$ **b)** $>, >$

10. **a)** $<, <$ **b)** $<, >$

Unit 3 Review

1. A
2. C
3. D
4. C
5. B
6. B
7. B
8. D
9. C
10. B
11. A
12. A
13. $20.00 per ticket
14. 3
15. 2
16. 20
17. 21
18. 8
19. $8x + 5y - 1 = 0$

20. a) $y = 2.5x - 150$
   b) slope is 2.5; price of a single bar
   c) y-intercept is −150; initial expenses
   d) 60 bars

21. a) $y = -\frac{3}{2}x - 2$
   b) $3x + 2y + 4 = 0$
   c) use the x-intercept and y- intercept to graph; use a table of values

22. a)

Number of Songs	Cost ($)
1	0.49
2	0.98
3	1.47
4	1.96
5	2.45

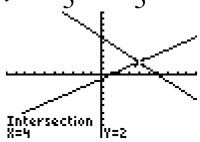
   b) function; each number of songs downloaded results in a unique cost
   c) $C = 0.49s$
   d) discrete; the domain must be natural numbers

Chapter 8 Solving Systems of Linear Equations Graphically

8.1 Systems of Linear Equations and Graphs

1. a) $y = -x + 6$

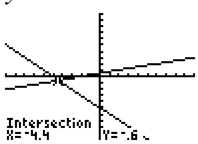
$y = \frac{2}{3}x - \frac{2}{3}$



The point of intersection is (4, 2).

b) $y = \frac{1}{4}x + \frac{1}{2}$

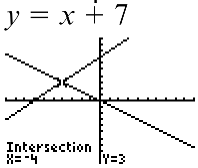
$y = -x - 5$



The point of intersection is $\left(-\frac{22}{5}, -\frac{3}{5}\right)$.

c) $y = -\frac{3}{4}x$

$y = x + 7$

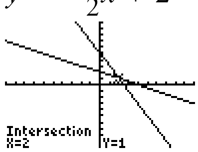


The point of intersection is (−4, 3).

2. a) yes **b)** no

3. a) $y = -2x + 5$

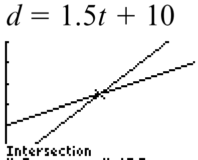
$y = -\frac{1}{2}x + 2$



The point of intersection is (2, 1).

b) $d = 3.5t$

$d = 1.5t + 10$



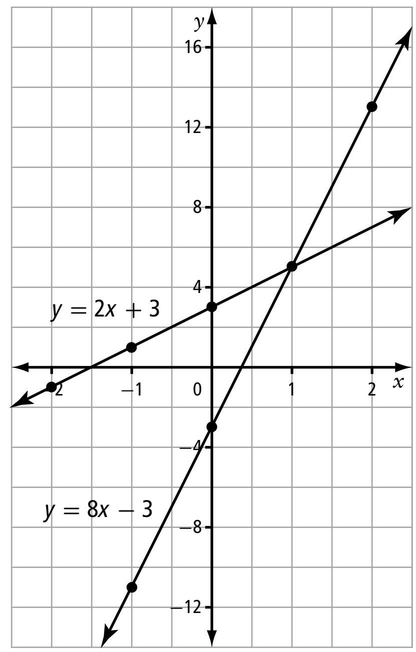
The point of intersection is (5, 17.5).

4. a) table of values for $y = 8x - 3$

x	−1	0	1	2
y	−11	−3	5	13

table of values for $y = 2x + 3$

x	−2	−1	0	1
y	−1	1	3	5



solution is (1, 5)

The solution (1, 5) can be verified by substitution.

$y = 8x - 3$

Left Side	Right Side
y	$8x - 3$
$= 5$	$= 8(1) - 3$
	$= 5$

Left Side = Right Side

$y = 2x + 3$

Left Side	Right Side
y	$2x + 3$
$= 5$	$= 2(1) + 3$
	$= 5$

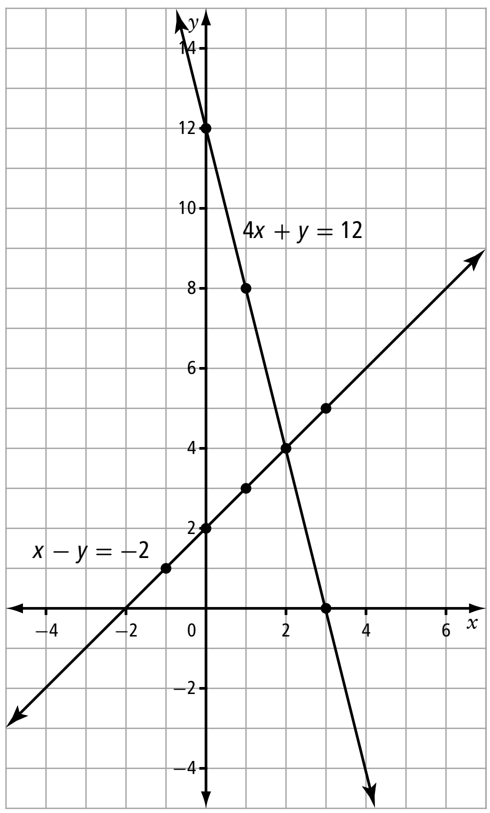
Left Side = Right Side

b) table of values for $x - y = -2$

x	-1	0	1	3
y	1	2	3	5

table of values for $4x + y = 12$

x	0	1	2	3
y	12	8	4	0



solution is (2, 4)
The solution (2, 4) can be verified by substitution.

$x - y = -2$

Left Side	Right Side
$x - y$	-2
$= 2 - 4$	$= -2$
$= -2$	

Left Side = Right Side

$4x + y = 12$

Left Side	Right Side
$4x + y$	12
$= 4(2) + 4$	$= 12$
$= 8 + 4$	
$= 12$	

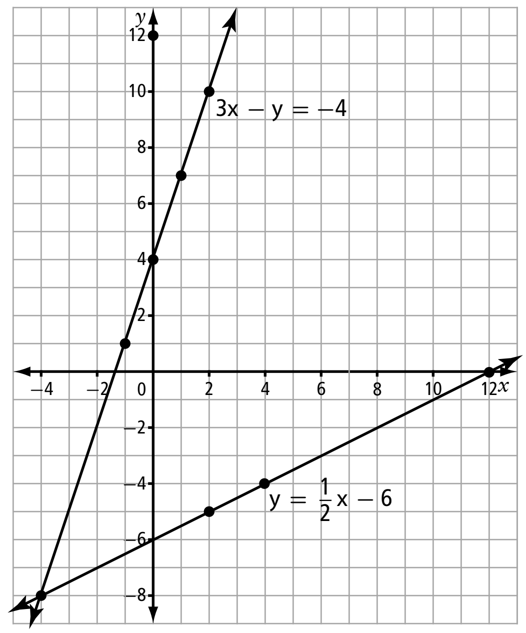
Left Side = Right Side

c) table of values for $y = \frac{1}{2}x - 6$

x	-4	2	4	12
y	-8	-5	-4	0

table of values for $3x - y = -4$

x	-2	-1	0	2
y	-2	1	4	10



solution is $(-4, -8)$
The solution $(-4, -8)$ can be verified by substitution.

$y = \frac{1}{2}x - 6$

Left Side	Right Side
y	$\frac{1}{2}x - 6$
$= -8$	$= \frac{1}{2}(-4) - 6$
	$= -2 - 6$
	$= -8$

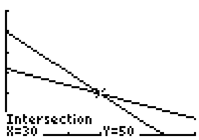
Left Side = Right Side

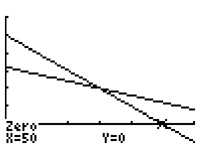
$3x - y = -4$

Left Side	Right Side
$3x - y$	-4
$= 3(-4) - (-8) = -4$	
$= -12 + 8$	
$= -4$	

Left Side = Right Side

5. **a)** $M = 10 + 0.5d$
$M = 5 + d$
b) Amounts of money are equal on day 10, when both have $15.

6. **a)** The initial volume of oil in the first tank is 125 m^3. If the tank is being drained at the rate of 2.5 m^3 per minute, the amount of oil remaining at any time is the initial amount less 2.5 times the number of minutes for which the tank has been emptied. Therefore, the amount of oil remaining in the first tank may be modelled by the equation $A = 125 - 2.5t$. Applying the same analysis in the case of the second tank yields the equation $A = 80 - t$ to model the amount of oil remaining in that tank. Thus, the system of linear equations to model this situation is $A = 125 - 2.5t$ and $A = 80 - t$.
b)


The point of intersection is (30, 50).
c) The point of intersection represents the time when the amounts of oil in the two tanks are equal and describes that amount. At the point (30, 50), both tanks have 50 m^3 of oil in them. This occurs after 30 min of draining.
d) The tank containing 125 m^3 of oil will drain first. From the graph you can see that the line of its equation intersects the x-axis first. At this point, $A = 0$, which means that the tank is empty.


7. **a)** $a + c = 69$
$15a + 10c = 900$
b) $c = -a + 69$
$c = -1.5a + 90$
c) The point of intersection is (42, 27).
d) The point of intersection describes the numbers of both types of tickets sold: 42 adults' tickets and 27 children's tickets.

8. **a)** $V = 200 - 8t$
$V = 0 + 8t$
b) The point of intersection is (12.5, 100).
c) The volumes in both tanks are equal at 100 L in each.
d) 25 min
e) no

9. **a)** x-intercept = 8; x-intercept = −1
b) y-intercept = 4; y-intercept = 1
c) slope is 1; slope is $-\frac{1}{2}$
d) (2, 3)
e) $y = x + 1$; $y = -\frac{1}{2}x + 4$

10. **a)** $x + y = 62$
$\frac{1}{2}x = 1 + y$
b) Mr. Darwal is 42 years old. His daughter is 20 years old.

11. **a)** $d = 210t$
$d = 150t$
b) (0, 0)
c) 240 km farther

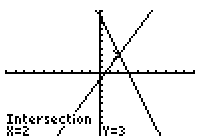
12. Since two points are given for each line, you can use the slope formula to calculate the slopes of the lines. Slope of the first line passing through points (1, 1) and (4, 7):
$m = \frac{y_2 - y_1}{x_2 - x_1}$
$m = \frac{7 - 1}{4 - 1}$
$m = \frac{6}{3}$
$m = 2$
Slope of the second line passing through the points (1, 6) and (3, 0):
$m = \frac{y_2 - y_1}{x_2 - x_1}$
$m = \frac{0 - 6}{3 - 1}$
$m = -\frac{6}{2}$
$m = -3$
Using slope-point form, write the equation of each line.
First line: Use the point (1, 1) and slope 2.
$y - y_1 = m(x - x_1)$
$y - 1 = 2(x - 1)$
$y - 1 = 2x - 2$
Isolate y to express the equation in slope-intercept form.

$$y - 1 = 2x - 2$$
$$y - 1 + 1 = 2x - 2 + 1$$
$$y = 2x - 1$$

The equation of the first line is $y = 2x - 1$.
Second line: Use the point (3, 0) and slope -3.

$$y - y_1 = m(x - x_1)$$
$$y - 0 = -3(x - 3)$$
$$y = -3x + 9$$

The equation of the second line is $y = -3x + 9$.
Graphing these lines produces a point of intersection at (2, 3).



13. $-40°C = -40°F$

14. a) $d = 10t$
$d = 40(1 - t)$
or
$d = 40t$
$d = 10(1 - t)$

b) The x-coordinate represents the time required to travel between Ferdinand's home and the school in one of the directions. The y-coordinate represents distance travelled.

c) 0.2 h or 12 min; 0.8 h or 48 min

d) 8 km

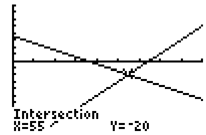
15. Yes, if lines are parallel they will have no point of intersection.

16. 8

17. In a parallelogram, opposite angles are equal and alternate interior angles are equal. Therefore, from the diagram you can see that $x + y = 35$ and $2x - y = 130$. Express the equations in slope-intercept form:

$$x + y = 35 \qquad 2x - y = 130$$
$$x + y - x = 35 - x \qquad 2x - y - 2x = 130 - 2x$$
$$y = 35 - x \qquad -y = 130 - 2x$$
$$y = -x + 35 \qquad y = 2x - 130$$

Graphing these produces two lines that intersect at (55, -20).



Therefore, the value of x is 55 and the value of y is -20.

8.2 Modelling and Solving Linear Systems

1. a) $s = 3c$ and $s + 4 = 2(c + 4)$

b) $V = 5 + 0.9t$ and $V = 3 + 1.2t$

2. a)

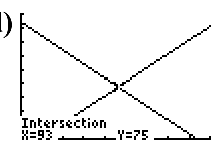
x	y	$x - y$
30	138	-108
50	118	-68
70	98	-28
80	88	-8
90	78	12
100	68	32

It can be inferred that $90 < x < 100$ and $68 < y < 78$.

b) $x + y = 168$
$x - y = 18$

c)
$$x + y = 168 \qquad x - y = 18$$
$$x + y - x = 168 - x \qquad x - y - x = 18 - x$$
$$y = -x + 168 \qquad -y = 18 - x$$
$$y = x - 18$$

d)



The point of intersection is (93, 75).

e) Yes, this confirms the inferences drawn from the values in the table in part a) because 93 is between 90 and 100, and 75 is between 68 and 78.

3. a) $x + y = 15\,000$
$0.065x + 0.05y = 885$

b) $y = -x + 15\,000$
$y = -1.3x + 17\,700$

c) The point of intersection is (9000, 6000). Josee invested $9000 at 6.5% interest per year and invested $6000 at 5% interest per year.

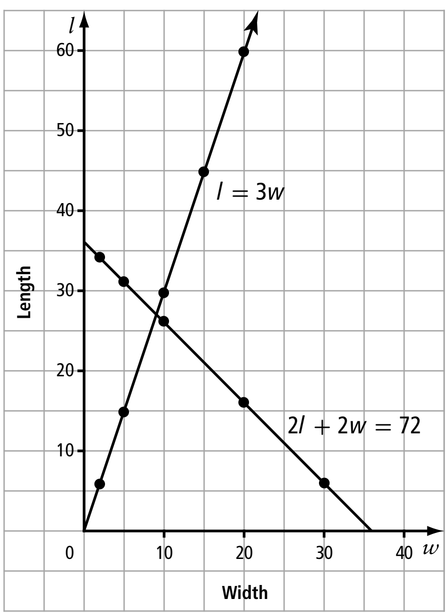
4. a) $x + y = 5$
   b) $0.4x + 0.25y = 0.32(5)$
   c) $y = -x + 5$ and $y = -1.6x + 6.4$
   d) The point of intersection is $\left(\frac{7}{3}, \frac{8}{3}\right)$ or approximately (2.3, 2.7). The chemist needs about 2.3 L of 40% bromine solution and about 2.7 L of 25% bromine solution.

5. a) Answers may vary. Example:
   $l = 3w$

w	2	5	10	15	20
l	6	15	30	45	60

   $2l + 2w = 72$

w	2	5	10	20	30
l	34	31	26	16	6

   b)


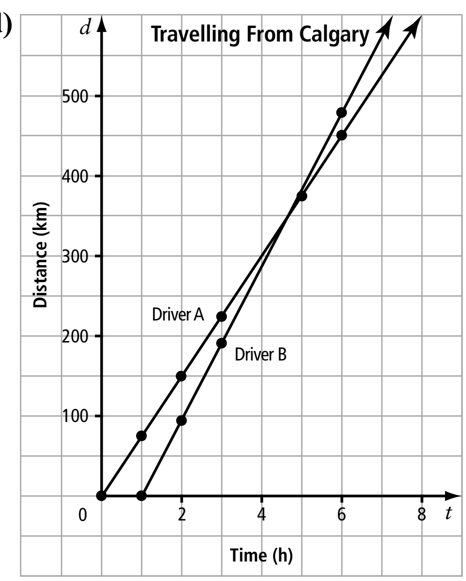
   From reading the graph, the point of intersection can be estimated to be about (8, 27).
   c) The actual point of intersection is (9, 27).
   d) The width of the rectangle is 9 m and its length is 27 m.

6. a) $c + p = 0.5$
   $12c + 3p = 0.5(5)$
   b) $p = -c + 0.5$
   $p = -4c + 0.8\overline{3}$
   c) The point of intersection is approximately (0.11, 0.39). The company should use 0.11 kg of cashews and 0.39 kg of peanuts per bag.

7. a) $A = 1200 - 20s$
   $A = 200 + 30s$
   b) 20 s after the time interval begins; 800 m

8. a) The first equation means that the difference in elevation between Mount Columbia and Cypress Hills is 2279 m. The second equation means that the sum of the elevations is 5215 m.
   b) $s = a - 2279$ and $s = -a + 5215$
   c) The point of intersection is (3747, 1468). Mount Columbia has an elevation of 3747 m and Cypress Hills has an elevation of 1468 m.

9. a) The first restaurant charges $175 for room rental and $20 per person. The second restaurant charges $100 for room rental and $22.50 per person.
   b) The point of intersection is (30, 775).
   c) The first restaurant is cheaper if there are more than 30 guests to a maximum of 100 guests: $30 < n \leq 100$. The second restaurant is cheaper if there are fewer than 30 guests: $0 < n < 30$.

10. a) Driver B left one hour later than Driver A.
   b) Driver B
   c) Driver B has caught up to and passed Driver A.
   d)


   From the graph, you can estimate that it takes approximately 5 h for the drivers to travel the same distance.

11. a) $2.5(s + c) = 50$; $4(s - c) = 50$
b) $s = -c + 20$; $s = c + 12.5$; the point of intersection is (3.75, 16.25).
c) The boat's speed is 16.25 km/h and the current's speed is 3.75 km/h.

12. a) One tank has 120 L. The other tank has 10 L.
b) The 120-L tank is draining and the 10-L tank is filling.
c) At 10 min, both tanks contain 90 L of water.
d) The slopes of the lines represent the rates at which the tanks are draining or filling. Use two points on each line and the slope formula to calculate slope.
First line: Use points (0, 120) and (10, 90).
$m = \frac{y_2 - y_1}{x_2 - x_1}$
$m = \frac{90 - 120}{10 - 0}$
$m = \frac{30}{10}$
$m = -3$
The first tank is draining at a rate of 3 L/min.
Second line: Use points (0, 10) and (10, 90).
$m = \frac{y_2 - y_1}{x_2 - x_1}$
$m = \frac{90 - 10}{10 - 0}$
$m = \frac{80}{10}$
$m = 8$
The second tank is filling at a rate of 8 L/min.
e) $V = 120 - 3t$ and $V = 10 + 8t$

13. a) The point of intersection is (1, 70).
b) Company A will charge less.
c) A: $C = 45 + 25t$
B: $C = 30 + 40t$

14. Answers may vary. Example:
a) Charges for Company A are \$100 for a sign-up fee and \$18.50 per month. Charges for Company B are \$75 to sign up, plus \$20 per month. Which company should you choose?
b) A \$900 deposit is put into two different investments. One part earns interest at a rate of 5% per year; the other earns interest at 4.5% per year. If total interest earned in one year is \$74, how much money was invested at each rate?
c) One person is 8 years older than another. Five times the first person's age added to 9 times the other person's age totals 100 years. Find the age of each person.

15. Answers may vary. Examples are: $x + y = 27$ and $x - y = -21$ or $y - 6x = 6$ and $3x + y = 33$

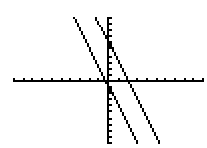
8.3 Number of Solutions for Systems of Linear Equations

1. a) no solution; lines have same slope and different y-intercepts
b) one solution; lines have different slopes
c) infinite number of solutions; lines are multiples of each other (same slope and same y-intercept)
d) no solution; lines have same slope and different y-intercepts
e) one solution; lines have different slopes

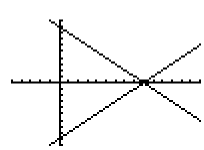
2. a) $2x - 3y = C$, $C \neq 8$
b) $x - 3y = 8$ or any other change to the coefficient of x or y
c) $4x - 6y = 16$ or any other multiple of the first equation

3. a) no solution
b) no solution
c) one solution
d) one solution
e) one solution

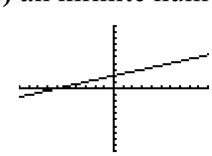
4. a) no solution



b) one solution



c) an infinite number of solutions



5. For a system of linear equations in the form $Ax + By = C$ and $Dx + Ey = F$:
   a) If the coefficients D, E, and F are the same multiple of coefficients A, B, and C, respectively, then there will be an infinite number of solutions.
   b) If coefficients D and E are the same multiple of coefficients A and B, respectively, but F is not this same multiple of C, then there will be no solution.
   c) In all other cases, there will be one solution.

6. a) $7x - 3y = C$, $C \neq 12$
   b) $14x - 6y = 24$ or any other multiple of the given equation
   c) Example: $7x - 3y = 12$. Only coefficient A in the equation of the second line has to be different as that is the number that dictates the slope.

7. Jocelyn: $E = 1200 + 0.03s$;
   Mario: $E = 1000 + 0.045s$;
   Kendra: $E = 2000 + 0.03s$;
   Pavel: $E = 2000 + 0.03s$
   a) Jocelyn and Kendra or Jocelyn and Pavel
   b) Kendra and Pavel
   c) Jocelyn and Mario, or Mario and Kendra, or Mario and Pavel

8. a) $C = 20 + 0.35t$
   $C = 15 + 0.4t$
   b) $C = 20 + 0.35t$
   $C = 15 + 0.35t$
   c) $C = 20 + 0.35t$
   $C = 20 + 0.35t$

9. a) Ling is correct. The slopes are similar, but the lines are not parallel and will intersect at (37.5, 25). Since the slopes of the lines are different, the system must have one solution.
   b) The system can be solved by comparing coefficients. Because the left sides of the equations are identical, any value of y that is substituted will result in the same value on the left side of each equation. However, only one value of x (37.5) will yield equivalent values on the right side of the equations. Therefore, the system has only one solution.

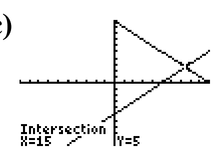
10. a) Gold Coast: $E = 1.25k - 40$; The Salmon House: $E = 1.00k - 25$
    b) one solution
    c) The point of intersection is (60, 35). A fisher should bring a catch to The Salmon House when $k < 60$ kg because of the lower processing fee and to Gold Coast Fishery when $k > 60$ kg because of the higher rate of pay per kilogram.
    d) There would be no point of intersection and The Salmon House would be the better choice regardless of the size of the catch.

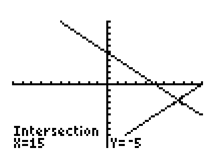
11. a) $C \neq 60$
    b) $C = 60$

12. a) $A = 1$
    b) $A \neq 1$

13. a) $h = 5w$ and $h = 6w - 24$
    b) one solution
    c) (24, 120); The solution represents the time when both towers are the same height. Each tower will be 120 ft in height 24 weeks after construction starts on the first tower.

14. a) The equations would be $x + y = 20$ and $x - y = 10$. This would lead to one solution since natural numbers that satisfy both equations can be found easily.
    b) The equations would be $x + y = 10$ and $x - y = 20$. This would lead to no solution since a negative number is needed to satisfy this system of linear equations, but a negative number is not a natural number.
    c)





    d) The difference is due to the domain being N, which does not include negative numbers.

15. Let d represent distance, in metres Let t represent time, in seconds.
   a) $d = 220 + 3.1t$ and $d = 198 + 3.6t$; There is one solution. Boat C catches up to Boat A in 44 s at 356.4 m into the race.
   b) $d = 220 + 3.1t$ and $d = 230 + 3.2t$; There is one solution; however, at the point of intersection the value of t is less than zero, which is outside the range for time ($t \geq 0$). Boat D has already overtaken Boat A, which will not catch up.
   c) $d = 206 + 3.4t$ and $d = 230 + 3.2t$; There is one solution; however, at the point of intersection the value of d is greater than 500, which is outside the domain for distance ($d \leq 500$). Boat B is gaining on Boat D, but will not catch up before Boat D crosses the finish line.

16. Eva is correct. Vince is correct in saying that the lines will intersect, but the intersection is at a negative time and a negative volume, which is not allowed in the context of the problem. In this problem, the domain of time is $t \geq 0$ and the range of volume is $V \geq 150$.

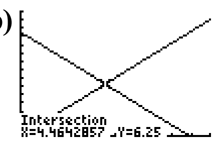
17. a) $\frac{a}{d} = \frac{b}{e} \neq \frac{c}{f}$ b) $\frac{a}{d} = \frac{b}{e} = \frac{c}{f}$

Chapter 8 Review

8.1 Systems of Linear Equations and Graphs

1. a) yes
   b) no
2. a) approximately (3.48, −0.39)
   b) approximately (−15.45, 7.05)
3. a) (2, 4)
   b) $y = -2x + 8$ and $y = \frac{1}{2}x + 3$
4. a) The solution is (2, 55).
   b) After 2 h, the second cyclist has caught up to the first cyclist at a distance of 55 km.

8.2 Modelling and Solving Linear Systems

5. a) $C = 0.50t$
   $C = 25 + 0.25t$
   b) $x + y = 23$
   $0.10x + 0.25y = 3.35$
   c) $d = 85t$
   $d = 100(t - 1)$
6. a) Basic cost is the y-intercept of the graph. For DirectCar, this is \$60. For Wheels To Go, the basic cost is \$40. The slope of the graph represents the charge per kilometre of distance travelled. For DirectCar, the charge is \$0.50/km. For Wheels To Go, the charge is \$0.75/km.
   b) Wheels To Go
   c) Choose DirectCar when $d > 80$ km.
   d) Charges are equal (a total of \$100) at 80 km. Choose Wheels To Go when $d < 80$ km and choose DirectCar when $d > 80$ km.
7. a) $V = 12.5 - 1.4t$
   $V = 1.4t$
   b) 

   c) The point of intersection is approximately (4.46, 6.25). After about 4.46 min, the truck and the bin both have 6.25 m^3 of grain in them.
8. a) $A = 885 - 35t$
   $A = 1450 - 60t$
   b) The solution is (22.6, 94).
   c) After 22.6 s, both files have 94 MB left to download.

8.3 Number of Solutions for Systems of Linear Equations

9. a) $x + y = 45$
   $x = 3y - 15$
   b) Bill is 30. Nancy is 15.
10. a) no solution; lines have same slope but different y-intercepts so they are parallel
    b) an infinite number of solutions; second equation is a multiple of the first
    c) one solution; lines have different slopes and therefore must intersect at one point
11. no solution

12. **a)** P and R, P and S, P and Q, Q and R, and Q and S
b) R and S

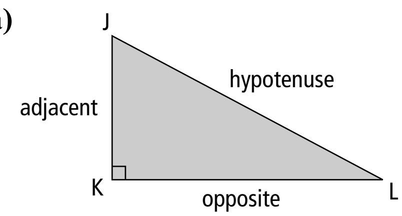
13. **a)** $p + d = 24$ and $2p + 4d = 82$
b) solution is (7, 17), i.e., 7 parrots and 17 dogs
c) With 83 legs, the solution would not be a whole number of normal parrots or dogs.
d) Even though the slopes of the lines are different and the lines intersect, the domain and range are *N*, not *R*.

Chapters 1–8 Cumulative Review

1. 2.5 cm or about 10 in.

2. 1077.2 yd^2

3. **a)**

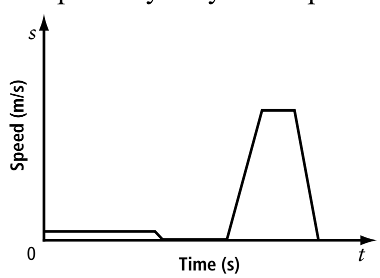


b) $\tan J = \frac{KL}{JK}$, $\sin J = \frac{KL}{JL}$, $\cos J = \frac{JK}{JL}$

4. **a)** perfect square **b)** perfect cube
c) perfect cube **d)** both
e) both **f)** perfect square

5. **a)** $-29n^2 + 34n + 9$
b) $-6s^4 + 17s^3 + 41s^2 - 12$

6. Graphs may vary. Example:



7. **a)** $y = -\frac{2}{5}x - 3$
b) $y = 12$

8. To verify if the given point is a solution, substitute the coordinates of the point for *x* and *y* in each equation. If the values work in both equations, then the point is a solution.
a) yes **b)** no

9. **a)** 1 652 959 **b)** 460 166

10. **a)** 36.0°
b) 57.8°
c) 15.6°

11. **a)** Answers may vary. Example: The independent variable is time, *t*. The dependent variable is population, *p*.
b) The graph is linear because the number of students grows at a constant rate (89 students) each year.
c) $P = 89t + 3420$
d) 4399
e) 1979

12. **a)** (1, 1) **b)** (6, −3)

13. **a)** $s = 3.28$ cm
b) $s = 43.09$ cm
c) $r = 4.42$ cm

14. **a)** $6ab$
b) $18xy^2$
c) p^2q^2

15. **a)** (0, 3), (−1, 0), $3x - y + 3 = 0$
b) (−2, 0), $x + 2 = 0$

16. 1.5 cm; length of a thumbtack

17. 89 in^2

18. The castle is 5.87 m taller than the boy's height.

19. **a)** $\frac{1}{x^{\frac{5}{4}}}$ **b)** $\frac{1}{512h^{\frac{27}{2}}}$
c) $12^{\frac{31}{35}}$ **d)** $\frac{4096}{x^{\frac{20}{3}}}$

20. **a)** $(c - 12)(c + 12)$
b) $(1 + 16y^2)(1 - 4y)(1 + 4y)$
c) $54(h - 3f)(h + 3f)$
d) $(x - 3)(x + 3)(x - 2)(x + 2)$

21. [−32.6, 162.7]

22. **a)** $y = -2x - 7$, $2x + y + 7 = 0$
b) $y = \frac{1}{3}x + \frac{22}{3}$, $\frac{1}{3}x - y + \frac{22}{3} = 0$

23. a) $(x + 9)(x - 6)$
b) $(3x - 1)(x + 3)$
c) $2(5m - n)(2m - n)$
d) $(2x + 3y)(6x - y)$
e) $3t(s + 4)(s - 3)$

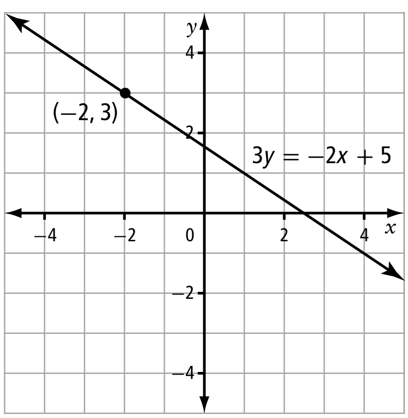
24. a) The variable w represents the number of minutes that each tank has been draining.
b) $T(4) = 80$ and $H(4) = 96$. 80 L of water remain in the first tank after 4 min. 96 L of water remain in the second tank after 4 min.
c) $w = 15$; After 15 min, 25 L will remain in the first tank.
d) Tank 1: $0 \le w \le 20$, $0 \le T(w) \le 100$; Tank 2: $0 \le w \le 20$, $0 \le H(w) \le 120$

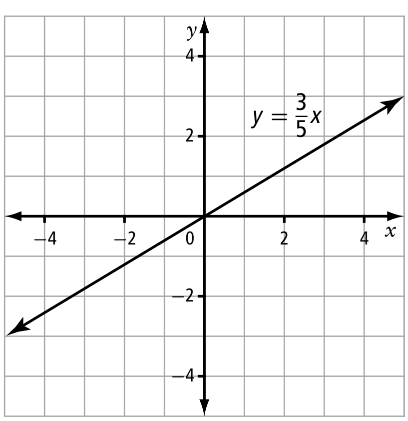
25. a) 98 174.77 ft^3 **b)** 1321.04 cm^3
c) 4928 ft^3 **d)** 11 742.10 cm^3

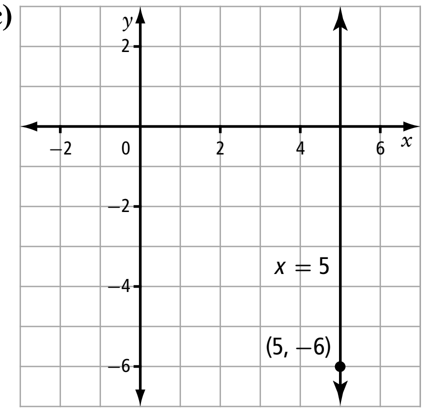
26. 11°

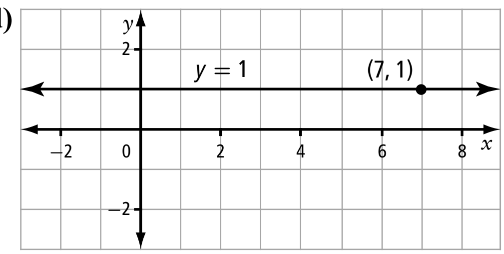
27. 49 mph

28. $y = \left(-\frac{1}{3}\right)x + 3$

29. a)


b)


c)


d)


30. $y = \frac{7}{6}x - \frac{1}{2}$

31. a) no solution; both lines have the same slope but different y-intercepts
b) one solution; the lines have different slopes
c) infinite number of solutions; both lines have the same slope and the same y-intercept

32. a) $x + y = 14$ and $0.25x + 0.10y = 2.90$, where x represents the number of quarters and y represents the number of dimes
b) 10 quarters and 4 dimes

33. a) 478 km **b)** 407 ft

34. 2714.68 cm^3

35. 35.75 m

36. a) $(18x)^{\frac{5}{2}}$ **b)** $7^{\frac{2}{3}}$
c) $z^{\frac{2}{5}}$ **d)** $\frac{a}{b}$

37. a) $(4s - 3)^2$
b) $27s(2s + 1)^2$
c) $(15 - 4y)^2$

Chapter 8 Extend It Further

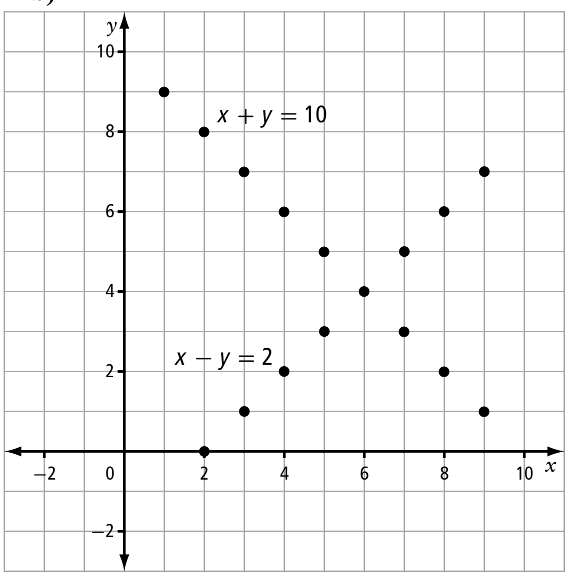
1. Achilles will catch up to the tortoise at a distance of 11.1 units from the starting point regardless of their speeds. Algebraically:

$$d_{\text{tortoise}} = d_{\text{Achilles}}$$
$$100 + rt = 10rt$$
$$100 = 9rt$$
$$11.1 = rt$$

2. **a)** $m = 5.5, n \neq 2$
b) $m = 5.5, n = 2$

3. **a)** Let x represent the first digit and let y represent the second digit: $x + y = 10$ and $x - y = 2$

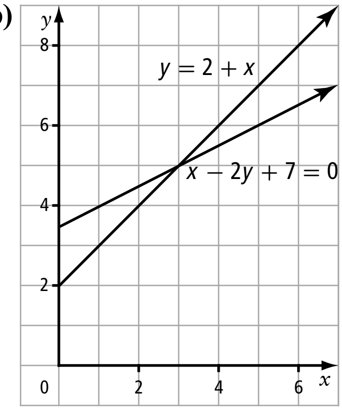
b)



c) 64

4. **a)** $y = x + 2, x - 2y + 7 = 0$

b)



c) 77 units^2

5. **a)** (4, 1.5)
b) $x = 4$ and $y - 6 = -\frac{9}{8}x$

6. **a)** $A + 3B = -1, 2A + B = 8$
b) $A = 5, B = -2$

7. 6 units

8. 27

9. 256

10. 16

11. −1

Chapter 9 Solving Systems of Linear Equations Algebraically

9.1 Solving Systems of Linear Equations by Substitution

1. **a)** $x = 13.5$ and $y = 11.5$
b) $x = -11$ and $y = -44$
c) $x = -1$ and $y = 20$
d) $x = 2$ and $y = -3$
e) $x = 5$ and $y = -1$
f) $x = 2$ and $y = 3$

2. Method 1: Isolate the variable x in the equation $2x - y = -5$.

$$\begin{aligned} 2x - y &= -5 \\ 2x - y + y &= -5 + y \\ 2x &= -5 + y \\ \frac{2x}{2} &= \frac{-5 + y}{2} \\ x &= \frac{-5 + y}{2} \end{aligned}$$

Substitute for x in the equation $5x + y = -2$. Then, solve for y.

$$\begin{aligned} 5x + y &= -2 \\ 5\left(\frac{-5 + y}{2}\right) + y &= -2 \\ \frac{-25 + 5y}{2} + y &= -2 \\ 2\left(\frac{-25 + 5y}{2} + y\right) &= 2(-2) \\ -25 + 5y + 2y &= -4 \\ -25 + 7y &= -4 \\ -25 + 25 + 7y &= -4 + 25 \\ 7y &= 21 \\ \frac{7y}{7} &= \frac{21}{7} \\ y &= 3 \end{aligned}$$

Substitute $y = 3$ in the equation $2x - y = -5$ and solve for x.

$$\begin{aligned} 2x - y &= -5 \\ 2x - 3 &= -5 \\ 2x - 3 + 3 &= -5 + 3 \\ 2x &= -2 \\ \frac{2x}{2} &= \frac{-2}{2} \\ x &= -1 \end{aligned}$$

The solution is $x = -1$ and $y = 3$.

Method 2: Isolate the variable y in the equation $5x + y = -2$.

$$\begin{aligned} 5x + y &= -2 \\ 5x - 5x + y &= -2 - 5x \\ y &= -2 - 5x \end{aligned}$$

Substitute for y in the equation $2x - y = -5$. Then, solve for x.

$$\begin{aligned} 2x - y &= -5 \\ 2x - (-2 - 5x) &= -5 \\ 2x + 2 + 5x &= -5 \\ 7x + 2 &= -5 \\ 7x + 2 - 2 &= -5 - 2 \\ 7x &= -7 \\ \frac{7x}{7} &= \frac{-7}{7} \\ x &= -1 \end{aligned}$$

Substitute $x = -1$ in the equation $5x + y = -2$ and solve for y.

$$\begin{aligned} 5x + y &= -2 \\ 5(-1) + y &= -2 \\ -5 + y &= -2 \\ -5 + 5 + y &= -2 + 5 \\ y &= 3 \end{aligned}$$

The solution is $x = -1$ and $y = 3$.
Example: I prefer the second method where I solved for y. The coefficient on y was 1, so there were no fractions involved. In the first method, where I solved for x, there were fractions. Fractions involve more complicated computations than integers do.

3. The point (2, 4) is not the solution to the system $3x - y = 2$ and $x + y = 5$. The point (2, 4) lies on the line of the first equation because substituting 2 for x and 4 for y results in a true statement.

$$\begin{aligned} 3x - y &= 2 \\ 3(2) - 4 &= 2 \\ 6 - 4 &= 2 \\ 2 &= 2 \end{aligned}$$

However, the point (2, 4) does not lie on the line $x + y = 5$ because replacing x with 2 and y with 4 does not result in a true statement.

$x + y = 5$
$2 + 4 \neq 5$

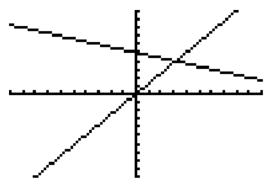
4. 6000
5. 400 shares of the \$4.50 stock and 880 shares of the \$2.50 stock
6. Let C represent the number of cans. Let B represent the number of bottles.
Write an equation to represent the total number of cans and bottles collected.
$C + B = 900$
Write an equation to represent the total amount of money, in dollars, received.
$0.1C + 0.25B = 145.20$
Solve the system of linear equations by substitution. Solve for C in the first equation.
$$C + B = 900$$
$$C + B - B = 900 - B$$
$$C = 900 - B$$
Substitute for C in the second equation and solve for B.
$$0.1C + 0.25B = 145.20$$
$$0.1(900 - B) + 0.25B = 145.20$$
$$90 - 0.1B + 0.25B = 145.20$$
$$90 + 0.15B = 145.20$$
$$90 - 90 + 0.15B = 145.20 - 90$$
$$0.15B = 55.20$$
$$\frac{(0.15B)}{0.15} = \frac{(55.20)}{0.15}$$
$$B = 368$$
Substitute $B = 368$ in the first equation and solve for C.
$$C + B = 900$$
$$C + 368 = 900$$
$$C + 368 - 368 = 900 - 368$$
$$C = 532$$
The team brought in 532 cans for recycling.
7. 14
8. 15 new wave songs and 3 hip-hop songs; It is assumed that the station plays the same number of each song in each hour.
9. Jane is 26. Tim is 14.
10. 42
11. music video: \$12.50; CD: \$4.75
12. Team A: 16 wins, 4 losses;
Team B: 4 wins, 16 losses
13. No. The correct system of linear equations is $T + Q + 45 = 125$ and $2T + 0.25Q + 45 = 184$. $T = 68$ and $Q = 12$. The coins in the machine consisted of 12 quarters, 45 \$1 coins, and 68 \$2 coins.
14. Step 2; The correct line is $2x - 15x + 10 = 23$. The solution is $x = -1$ and $y = 5$.
15. Let x represent the distance over which Mandy drove at a speed of 80 km/h.
Let y represent the distance over which Mandy drove at a speed of 100 km/h.
Write an equation to represent the total distance driven.
$x + y = 400$
Write a second equation to express the time of the trip in terms of speed and distance travelled. (Recall that time equals distance divided by speed.)
$\frac{x}{80} + \frac{y}{100} = 4.5$
Isolate the variable y in the equation $x + y = 400$.
$$x + y = 400$$
$$x - x + y = 400 - x$$
$$y = 400 - x$$
Substitute for y in the equation $\frac{x}{80} + \frac{y}{100} = 4.5$.
$$\frac{x}{80} + \frac{y}{100} = 4.5$$
$$\frac{x}{80} + \frac{400 - x}{100} = 4.5$$
Multiply each term of the equation by the lowest common multiple of the denominators to clear out the fractions. The lowest common multiple of 80 and 100 is 400.
$$400\left(\frac{x}{80} + \frac{400 - x}{100}\right) = 400(4.5)$$
$$\frac{400x}{80} + \frac{400(400 - x)}{100} = 1800$$
$$5x + 4(400 - x) = 1800$$
solve for x.
$$5x + 4(400 - x) = 1800$$
$$5x + 1600 - 4x = 1800$$
$$x + 1600 = 1800$$
$$x + 1600 - 1600 = 1800 - 1600$$
$$x = 200$$
Substitute $x = 200$ in the equation $x + y = 400$ and solve for y.
$$x + y = 400$$
$$200 + y = 400$$
$$200 - 200 + y = 400 - 200$$
$$y = 200$$
Mandy drove a distance of 200 km at a speed of 100 km/h.

16. $y = 4$

17. a) There is one solution. The slopes of the lines are different, which means that the lines intersect.

b) The point of intersection is located in the first quadrant. Rewrite each equation to isolate the variable y and enter the new form of the equations into a graphing calculator.

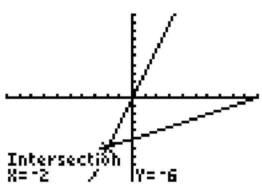
$$5x - 4y = 0 \qquad x + 3y = 15$$
$$5x - 5x - 4y = 0 - 5x \qquad x - x + 3y = 15 - x$$
$$-4y = -5x \qquad 3y = 15 - x$$
$$-\frac{4y}{4} = \frac{-5x}{4} \qquad \frac{3y}{3} = \frac{15}{3} - \frac{x}{3}$$
$$y = \frac{5}{4}x \qquad y = 5 - \frac{x}{3}$$



The point of intersection is in the first quadrant.

18. $x = 14$, $y = 19$, and $z = -8$

19. a)



b) $x = -2$ and $y = -6$

c) Example: The methods are similar in that they produce the same solution. The difference is that the graphing method allows you to see how the two variables relate.

d) Example: I prefer the substitution method because there is a coefficient of 1 in one of the equations. This makes it simple to solve for the variable so that it can be substituted into the second equation.

9.2 Solving Systems of Linear Equations by Elimination

1. a) $x = -1$ and $y = 3$ **b)** $x = 1$ and $y = 1$ **c)** $x = 1$ and $y = 2$ **d)** $x = 8$ and $y = -2$ **e)** $x = -3$ and $y = 12$

2. a) $x + 3y = -1$, $2x + 4y = 12$ **b)** $2x + 3y = 1$, $4x - 2y = 10$

c) $3x - 2y = 5$, $-5x + 4y = 1$ **d)** $x - 3y = -4$, $4x + 2y = 12$

e) $3x + 2y = -9$, $2x + 3y = 9$

3. a) $x = 20$ and $y = -7$ **b)** $x = 2$ and $y = -1$ **c)** $x = 11$ and $y = 14$ **d)** $x = 2$ and $y = 2$ **e)** $x = -9$ and $y = 9$

4. a) $x = 2$ and $y = 3$

b) Multiply each term of the equation $\frac{1}{2}x - \frac{1}{3}y = 1$ by the lowest common multiple of the denominators to clear out the fractions. The lowest common multiple of 2 and 3 is 6.

$$6\left(\frac{1}{2}x - \frac{1}{3}y\right) = 6(1)$$
$$\frac{6}{2}x - \frac{6}{3}y = 6$$
$$3x - 2y = 6$$

Multiply each term of the equation $x + \frac{1}{4}y = 2$ by the lowest common multiple of the denominators to clear out the fractions. The lowest common multiple of 1 and 4 is 4.

$$4\left(x + \frac{1}{4}y\right) = 4(2)$$
$$4x + \frac{4}{4}y = 8$$
$$4x + y = 8$$

Eliminate variable y. The lowest common multiple of 1 and 2 is 2. Multiply the equation $3x - 2y = 6$ by 1 and multiply the equation $4x + y = 8$ by 2.

$$3x - 2y = 6 \qquad 4x + y = 8$$
$$1(3x - 2y) = 1(6) \qquad 2(4x + y) = 2(8)$$
$$3x - 2y = 6 \qquad 8x + 2y = 16$$

Add the two equations to eliminate y.

$$\begin{array}{r} 3x - 2y = 6 \\ +(8x + 2y = 16) \\ \hline 11x \qquad = 22 \end{array}$$

Solve for x.

$$\frac{11x}{11} = \frac{22}{11}$$
$$x = 2$$

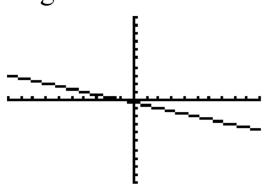
Substitute $x = 2$ into the second equation and solve for y.

$$x + \frac{1}{4}y = 2$$
$$2 + \frac{1}{4}y = 2$$
$$2 - 2 + \frac{1}{4}y = 2 - 2$$
$$\frac{1}{4}y = 0$$
$$y = 0$$

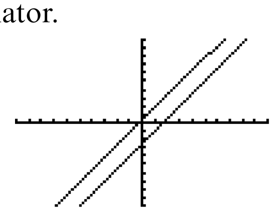
The solution to the system is $x = 2$ and $y = 0$.

c) $x = -6$ and $y = 10$

5. a) The two equations are the same. Therefore, the solution is an infinite number of points. Another method of finding the solution is to write each equation in "$y =$" form and enter it into a graphing calculator.



b) The two equations represent lines with the same slope. The lines are parallel and do not intersect. Therefore, there is no solution. Another method of finding the solution is to write each equation in "$y =$" form and enter it into a graphing calculator.



6. 24 \$2 coins and 112 \$1 coins

7. The initiation fee is \$45 and the monthly fee is \$25.

8. The daily rental charge was \$28 and the charge per kilometre was \$0.25.

9. \$300 at 12% and \$360 at 10%

10. 175 motorcycles and 325 cars

11. adult: \$19; child: \$11

12. 0.9 miles

13. 2050 vehicles

14. Let C represent the number of oranges purchased.
Let G represent the number of granola bars purchased.
Write an equation to represent the total number of snacks purchased.
$C + G = 50$
Express the cost of the snacks in terms of the price of each item. Since oranges cost \$2.40 per dozen, the price of one orange is $\frac{\$2.40}{12} = \$0.20$. Since the price of a 5-bar box of granola is \$3.25, the price of one bar is $\frac{\$3.25}{5} = \$0.65$.
Write an equation to represent the total amount of money that Shanice spent.

$0.2C + 0.65G = 19$

Eliminate the variable C. Multiply the second equation by 5 to make the coefficient of C equal to 1.

$$5(0.2C + 0.65G) = 5(19)$$
$$C + 3.25G = 95$$

Subtract this new form of the second equation from the first equation.

$$\begin{array}{r} C + \quad G = \ \ 50 \\ -(C + 3.25G = \ \ 95) \\ \hline -2.25G = -45 \end{array}$$

Solve for G.

$$-2.25G = -45$$
$$\frac{-2.25G}{-2.25} = \frac{-45}{-2.25}$$
$$G = 20$$

Therefore, Shanice bought 20 granola bars, or 4 boxes of bars.

15. Cashews cost \$2.60 per pound. Peanuts cost \$1.50 per pound.

16. a) Let T represent the 10s digit. Let D represent the 1s digit.
The original number may be expressed as $10T + D$.
The number with the digits of the first number reversed is represented as $10D + T$.
Write an equation to represent the sum of the digits.
$T + D = 14$

Write an equation to represent the number formed by reversing the digits that is 36 more than the original number.

$10D + T = 36 + 10T + D$

Rewrite the equation to be in the same form as the first equation.

$$10D + T = 36 + 10T + D$$
$$10D + T - 10T - D = 36 + 10T - 10T + D - D$$
$$-9T + 9D = 36$$

Solve the system using elimination. Eliminate the variable T.

The lowest common multiple of 1 and 9 is 9. Multiply the first equation by 9 and multiply the second equation by 1.

$$T + D = 14 \qquad -9T + 9D = 36$$
$$9(T + D) = 9(14) \quad 1(-9T + 9D) = 1(36)$$
$$9T + 9D = 126 \qquad -9T + 9D = 36$$

Add the two equations.

$$9T + 9D = 126$$
$$+(-9T + 9D = 36)$$
$$18D = 162$$

Solve for D.

$$18D = 162$$
$$\frac{18D}{18} = \frac{162}{18}$$
$$D = 9$$

Substitute $D = 9$ in the first equation and solve for T.

$$T + D = 14$$
$$T + 9 = 14$$
$$T + 9 - 9 = 14 - 9$$
$$T = 5$$

The solution is $T = 5$ and $D = 9$. Therefore, the original number is 59.

b) 56

17. $m = 7$ and $n = 2$

18. Example: **a)** $4x + 2y = 6$ **b)** $2x + y = 5$ **c)** $y = -10$

19. $A = 3$

20. **a)** $x = -1$ and $y = 1$ **b)** $x = -1$ and $y = 1$

c) Example: I prefer the elimination method because using substitution involved using fractions.

d) Example: When using the substitution method, I look for a coefficient of 1 in one of the equations. If there is no coefficient of 1, then I use the elimination method.

9.3 Solving Problems Using Systems of Linear Equations

1. **a)** $x = -2$ and $y = -6$ **b)** $x = 0$ and $y = 3$ **c)** $x = 2$ and $y = -2$ **d)** $x = 0$ and $y = -5$ **e)** $x = -20$ and $y = 7$

2. **a)** Solve by elimination.

Eliminate the variable x. The lowest common multiple of 2 and 8 is 8. Multiply the first equation by 4 and multiply the second equation by 1.

$$2x - 5y = -18 \qquad 8x - 13y = -58$$
$$4(2x - 5y) = 4(-18) \quad 1(8x - 13y) = 1(-58)$$
$$8x - 20y = -72 \qquad 8x - 13y = -58$$

Subtract the second equation from the new form of the first equation.

$$8x - 20y = -72$$
$$-(8x - 13y = -58)$$
$$-7y = -14$$

Solve for y.

$$-7y = -14$$
$$\frac{-7y}{-7} = \frac{-14}{-7}$$
$$y = 2$$

Substitute $y = 2$ in the first equation and solve for x.

$$2x - 5y = -18$$
$$2x - 5(2) = -18$$
$$2x - 10 = -18$$
$$2x - 10 + 10 = -18 + 10$$
$$2x = -8$$
$$\frac{2x}{2} = \frac{-8}{2}$$
$$x = -4$$

The solution is $x = -4$ and $y = 2$.

b) $x = \frac{3}{14}$ and $y = \frac{15}{14}$

c) $x = 3$ and $y = -3$

3. The width is 1080 m and the length is 2120 m.

4. He should invest \$6000 at 9% and \$6000 at 11%.

5. 15 mph

6. \$1.50

7. Let H represent the amount of hay. Let G represent the amount of grain.
Write an equation to represent the daily amounts of hay and grain that are fed to the horse.
$H + G = 20$
The total cost to feed the horse for 60 days is \$702. Therefore, the daily cost is $\frac{\$702}{60} = \$11.70$.
Write an equation to represent the cost of feeding the horse each day.
$0.08H + 2.10G = 11.70$
Solve by substitution. Solve for H in the first equation.
$H + G = 20$
$H + G - G = 20 - G$
$H = 20 - G$
Substitute $H = 20 - G$ into the second equation and solve for G.

$$\begin{aligned} 0.08H + 2.10G &= 11.70 \\ 0.08(20 - G) + 2.10G &= 11.70 \\ 1.6 - 0.08G + 2.10G &= 11.70 \\ 2.02G &= 10.10 \\ \frac{2.02G}{2.02} &= \frac{10.10}{2.02} \\ G &= 5 \end{aligned}$$

Substitute $G = 5$ into the first equation and solve for H.

$$\begin{aligned} H + G &= 20 \\ H + 5 &= 20 \\ H + 5 - 5 &= 20 - 5 \\ H &= 15 \end{aligned}$$

The solution is $H = 15$ and $G =$ 5.Therefore, the horse is fed 15 lbs of hay and 5 lbs of grain per day.

8. The team made 32 field goals and 6 three-point shots.

9. 250

10. Tom spent 25 h swimming and 45 h biking.

11. The hourly wage for outdoor work is \$18 and the hourly wage for indoor work is \$15.

12. **a)** $y = 0.15x + 25$, $y = 0.10x + 30$
b) 100 km

13. **a)** $2W + T = 26$, $3T = W + 1$
b) 11

14. **a)** 458 km **b)** 38.93 L

15. The slower snowmobile rider rides at 40 km/h. The faster snowmobile rider rides at 55 km/h. The assumption is that both riders are riding at a constant rate of speed.

16. 771.4 mL

17. Let C represent the number of correct answers. Let I represent the number of incorrect answers.
Write an equation to represent the total number of answers on the test. The assumption is that all questions were answered.
$C + I = 76$
Write an equation to represent the total score achieved.
$C + (-0.2)I = 58$
Solve for C in the first equation.

$$\begin{aligned} C + I &= 76 \\ C + I - I &= 76 - I \\ C &= 76 - I \end{aligned}$$

Substitute $C = 76 - I$ into the second equation and solve for I.

$$\begin{aligned} C + (-0.2)I &= 58 \\ 76 - I + (-0.2)I &= 58 \\ 76 - 1.2I &= 58 \\ 76 - 76 - 1.2I &= 58 - 76 \\ -1.2I &= -18 \\ \frac{-1.2I}{1.2} &= \frac{-18}{1.2} \\ I &= 15 \end{aligned}$$

Substitute $I = 15$ into the first equation and solve for C.

$$\begin{aligned} C + I &= 76 \\ C + 15 &= 76 \\ C + 15 - 15 &= 76 - 15 \\ C &= 61 \end{aligned}$$

Therefore, the student answered 61 questions correctly.

18. 62.5 square units

19. **a)–c)** Answers may vary.

Chapter 9 Review

9.1 Solving Systems of Linear Equations by Substitution

1. **a)** $x = -2$ and $y = 5$ **b)** $m = 2$ and $n = 1$
c) $a = 1$ and $b = 4$ **d)** $w = -2$ and $z = 7$

2. **a)** no solution
b) an infinite number of solutions

c) one solution, $x = -\frac{14}{3}$ and $y = \frac{16}{3}$
d) one solution, $x = -3$ and $y = 3$

3. The length of the bridge in Kobe, Japan, is 1992 m and the length of the Capilano Bridge is 137 m.
4. 60 goals
5. Let x represent the length of the shorter piece of board. Let y represent the length of the longer piece.
Write an equation to represent the total length of the board.
$x + y = 180$
Write an equation to represent the relationship between the lengths of the two pieces of board.
$3y = 85 + 4x$
Isolate x in the first equation.
$x + y = 180$
$x + y - y = 180 - y$
$x = 180 - y$
Substitute $180 - y$ for x in the second equation.
$3y = 85 + 4x$
$3y = 85 + 4(180 - y)$
$3y = 85 + 720 - 4y$
$3y = 805 - 4y$
Solve for y.
$3y = 805 - 4y$
$3y + 4y = 805 - 4y + 4y$
$7y = 805$
$\frac{7y}{7} = \frac{805}{7}$
$y = 115$
Substitute $y = 115$ into the first equation and solve for x.
$x + y = 180$
$x + 115 = 180$
$x - 115 - 115 = 180 - 115$
$x = 65$
Therefore, the lengths of the two pieces of board are 115 cm and 65 cm.
6. 864 burgers

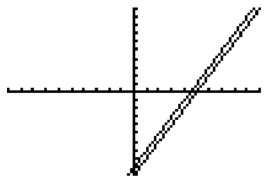
9.2 Solving Systems of Linear Equations by Elimination

7. a) $x = 2$ and $y = -3$
b) $x = -1$ and $y = 5$
c) $x = -\frac{6}{5}$ and $y = \frac{17}{15}$
d) $x = -2$ and $y = 3$
e) $x = 4$ and $y = 2$
8. Let M represent the monthly charge. Let T represent the text message charge.
Write an equation to represent Wade's January bill.
$M + 300T = 63$
Write an equation to represent the total of Wade's bills in February and March.
$2M + 675T + 12 = 142.50$
Rewrite the equation in the form $ax + by = c$.
$2M + 675T + 12 = 142.50$
$2M + 675T + 12 - 12 = 142.50 - 12$
$2M + 675T = 130.50$
Eliminate the variable M. The lowest common multiple of 1 and 2 is 2.
Multiply the first equation by 2.
$M + 300T = 63$
$2(M + 300T) = 2(63)$
$2M + 600T = 126$
Subtract the second equation from the first equation.
$2M + 600T = 126$
$-(2M + 675T = 130.50)$
$-75T = -4.50$
Solve for T.
$-75T = -4.50$
$\frac{-75T}{-75} = \frac{-4.50}{-75}$
Substitute $T = 0.06$ into the first equation and solve for M.
$M + 300(0.06) = 63$
$M + 18 = 63$
$M + 18 - 18 = 63 - 18$
$M = 45$
Therefore, the monthly charge is \$45.00 and the text charge is \$0.06 per message.
9. $m = -1$ and $n = 2$
10. a) yes b) yes
c) no d) no
11. \$650 at 10% and \$1450 at 7%
12. 10.75 m by 23.75 m
13. Marmot Basin has 86 runs and Sunshine Village has 107 runs.

9.3 Solving Problems Using Systems of Linear Equations

14. a) There is no solution.

b) The two lines are parallel and do not intersect. Therefore, there is no solution.



15. Michele ran 15 km.

16. Let F represent the fixed weekly wage. Let C represent the commission rate.

Write an equation to represent wages paid for the first week.

$F + 15\,500C = 1015$

Write an equation to represent wages paid for the second week.

$F + 9800C = 844$

Isolate F in the first equation.

$F + 15\,500C = 1015$

$F + 15\,500C - 15\,500C = 1015 - 15\,500C$

$F = 1015 - 15\,500C$

Substitute $F = 1015 - 15\,500C$ into the second equation.

$$F + 9800C = 844$$
$$1015 - 15\,500C + 9800C = 844$$
$$1015 - 5700C = 844$$
$$1015 - 1015 - 5700C = 844 - 1015$$
$$-5700C = -171$$

Solve for C.

$-5700C = -171$

$\frac{-5700C}{-5700} = \frac{-171}{-5700}$

$C = 0.03$

Substitute $C = 0.03$ into the second equation and solve for F.

$$F + 9800C = 844$$
$$F + (9800)(0.03) = 844$$
$$F + 294 = 844$$
$$F + 294 - 294 = 844 - 294$$
$$F = 550$$

Avatar's fixed wage is \$550 and his rate of commission is 3%.

17. 2.5 km

18. 2.25 mph

19. \$63.75

20. 900 kW

21. 13.5 t

Chapters 1–9 Cumulative Review

1. To verify if the given point is a solution, use the values of x and y in both equations. If the values work in both equations, then the point is a solution.

a) Yes **b)** No

2. \$238.36

3. a) $\frac{4}{5}$ **b)** $\frac{3}{5}$

c) $\frac{3}{5}$ **d)** $\frac{4}{5}$

e) $\frac{4}{3}$ **f)** $\frac{3}{4}$

4. a) 64 **b)** −625

c) 49 **d)** $-\frac{27}{5}$

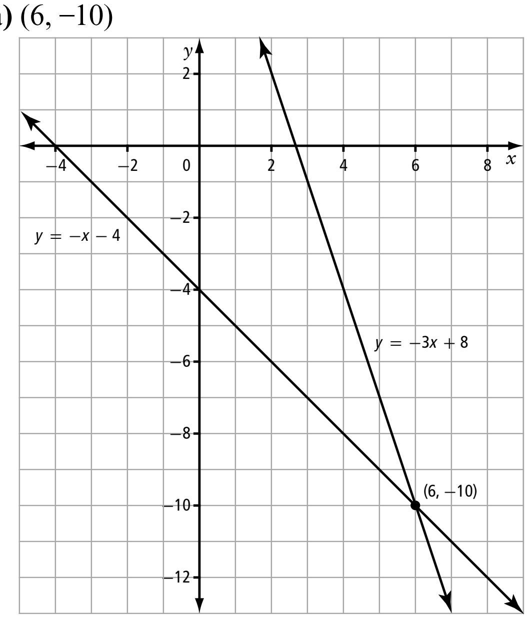
e) $\frac{3}{64}$ **f)** $-\frac{1}{125}$

5. a) $-56n^2 + 102n - 27$

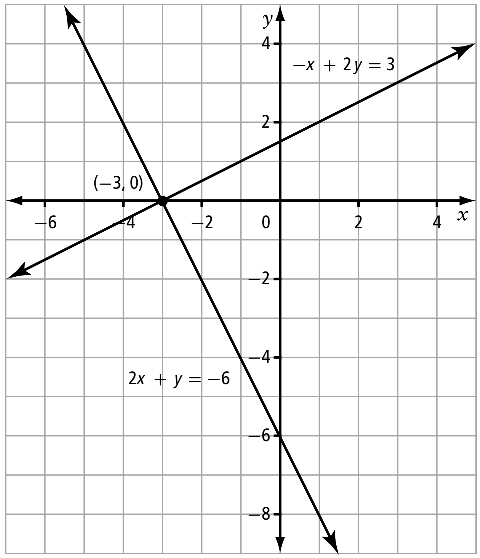
b) $-4s^4 - 6s^3 + 21s^2 + 13s - 15$

6. Example: It takes Jon 5 s to reach the bottom of the first hill on his bike. For a few seconds, Jon pedals to maintain his speed on a flat section of road. He then begins to go down a second hill and continues to accelerate. At the bottom of the hill, the road rises up. Jon coasts up the third hill as his speed slows. At the top, Jon maintains his speed by pedalling until he reaches a slight decline, at which point he begins to accelerate again. He then maintains this speed by pedalling.

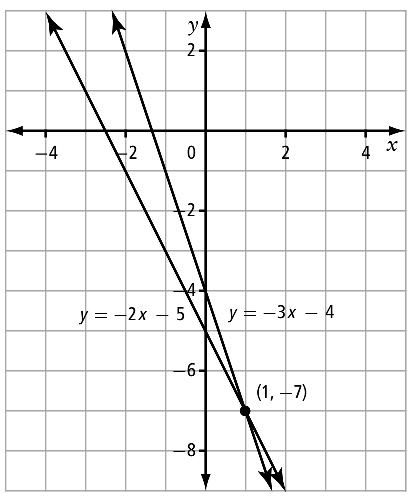
7. a) (6, −10)



b) (−3, 0)



c) (1, −7)



8. **a)** 26.2° **b)** 67.4°
c) 14.3°

9. **a)** slope is −5, y-intercept is (0, 8)
b) slope is $\frac{3}{7}$, y-intercept is $\left(0, -\frac{10}{7}\right)$

10. **a)** 2674.75 cm^2 **b)** 133.88 $in.^2$
c) 10 908 cm^2 **d)** 3019.07 cm^2

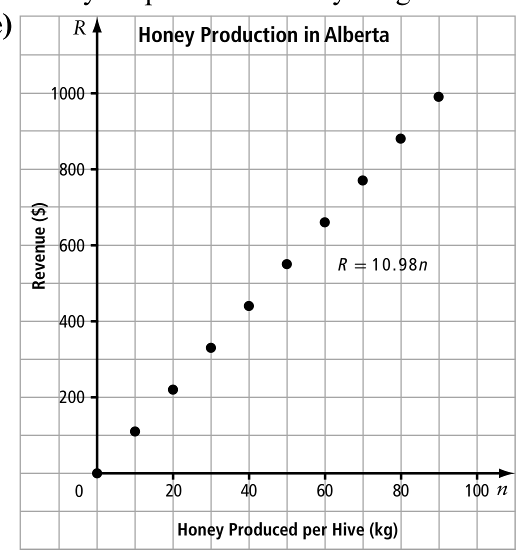
11. **a)** domain: $\{x \mid x \in \mathbb{R}\}$; range: $\{y \mid y \in \mathbb{R}\}$; intercepts are $(-1, 0), (0, -2.5)$; slope is $-\frac{5}{2}$; equation of the line in general form is $5x + 2y + 5 = 0$
b) domain: $\{x \mid x \in \mathbb{R}\}$; range: $\{-4\}$; y-intercept is (0, −4); slope is 0; equation of the line in general form is $y + 4 = 0$

12. **a)** $2ab^2$ **b)** $9xy^2$
c) pq

13. **a)** linear
b) Example: Let n represent the quantity, in kilograms, of honey sold. Let R represent the sales revenue, in dollars. In this situation, n is the independent variable and R is the dependent variable. In order to calculate the money earned from sales, first you need to know how much honey was sold. Therefore, revenue is dependent on the amount of honey that is sold.
c)

n	*R* ($)	*n*	*R* ($)
0	0	50	549.00
10	109.80	60	658.80
20	219.60	70	768.60
30	329.40	80	878.40
40	439.20	90	988.20

d) The data would be discrete if the beekeeper sells honey only in quantities that are in whole units. The data would be continuous if the beekeeper sells honey in quantities of any weight.
e)



14. **a)** one solution
b) no solution
c) infinite number of solutions

15. 3.65cm; Example: length of a nail

16 **a)** (2, 4) **b)** (0, −5)

17. **a)** 14.6 **b)** 8.1
c) 106.7

18. a) $x^{\frac{23}{5}}$ **b)** $\frac{1}{64}$
c) z^4 **d)** $\frac{1}{5p^{\frac{5}{2}}}$
e) $x^{200}y^{125}$ **f)** $\frac{x^{\frac{9}{4}}(0.16)^{\frac{3}{4}}}{y^{\frac{9}{2}}}$

19. a) $(4x - 1)(x + 2)$
b) $(x - 3)(x - 6)$
c) $-3(2m - 3n)(4m - n)$
d) $(7x + 2y)(5x - 3y)$
e) $12t(s + 6)(s - 4)$

20. a) $(4, -2)$ **b)** $(-1, 8)$

21. 176 miles; 50 km; 66 ft; 213 m

22. a) 0.67 ft **b)** 5.85 cm
c) 4.33 m **d)** 9.40 cm

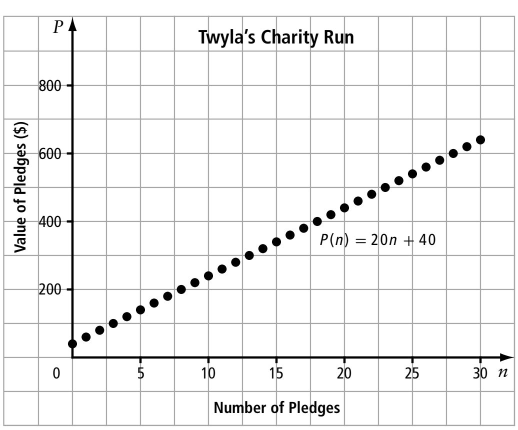
23. a) $\frac{4}{9}$, 0.777..., $\sqrt[3]{634}$, $\sqrt{82}$; The last two numbers are irrational.
b) $\sqrt[5]{67}$, $\sqrt[4]{1296}$, $14\frac{1}{3}$, $\sqrt{289}$; $\sqrt[5]{67}$ is irrational.

24. $[-18.4, 69.8]$

25. a) slope-intercept form: $y = 3x + 5$; general form: $3x - y + 5 = 0$
b) slope-intercept form: $y = \frac{3}{4}x - \frac{45}{4}$; general form: $3x - 4y - 45 = 0$

26. a) $(c - 13)(c + 13)$
b) $(9 + 4y^2)(3 - 2y)(3 + 2y)$
c) $7(5h - 12f)(5h + 5f)$
d) $(x - 4)(x + 4)(x - 5)(x + 5)$

27. a) Example: domain: $\{x \mid 0 \le x \le 30\ x \in \mathbb{N}\}$; range: $\{y \mid y \ge 40,\ y \in \mathbb{N}\}$



b) If there were 9 pledges, there would be a total of \$220 in funds.
c) 24 pledges
d) This situation depicts a function because for every value in the domain there is a unique value in the range.

28. $y = \frac{5}{4}x + \frac{5}{2}$

29. a) $(3s - 9)^2$ **b)** $s(4s + 12)^2$
c) $(16 - 5y)^2$

30. a) 15.2 cm; 152 mm **b)** 5.98 in.
c) No, it is not necessary to measure the figure three times. It only needs to be measured once. That measurement can then be converted to the other required units.

31. 6.3 ft

32. a) $2\sqrt{10}$ **b)** $3\sqrt{2}$
c) $3\sqrt[3]{4}$ **d)** $3\sqrt[4]{2}$

33. A: undefined; B: $-\frac{3}{5}$; C: $\frac{1}{5}$; D: 5; E: 0

Chapter 9 Extend It Further

1. C

2. D

3. B

4. A

5. Adding the two equations yields $444x + 444y = 888$, or $x + y = 2$. Subtracting the two equations yields $198x - 198y = 198$, or $x - y = 1$. The solution to the system of linear equations $x + y = 2$ and $x - y = 1$ is $\left(\frac{3}{2}, \frac{1}{2}\right)$.

6. (40.5, 39.5)

7. Let x be the volume of the tank, in litres. Let m be the fill rate of hose M, in litres per hour. Let n be the fill rate of hose N, in litres per hour.

$$\frac{x}{m + n} = 4.8$$
$$\frac{x - 2m}{m + n} = 3.6$$

The solution is $m = 12$, $n = 8$, and $x = 96$ L. Hose N will fill the tank in $\frac{96}{8} = 12$ h.

8. $x = \frac{21}{16}$, $y = \frac{28}{67}$

9. a) $a = 4$, $b = 2.7$ **b)** \$15.34

10. 9.6 m/s

11. 121 407 or 220 407

12. -1

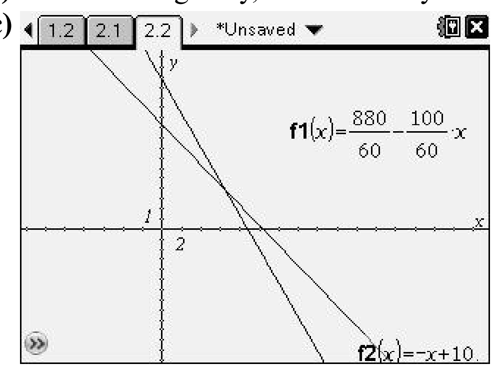
Unit 4 Review

1. A
2. B
3. A
4. A
5. B
6. A
7. C
8. C
9. C
10. B
11. D
12. C
13. C
14. A
15. D
16. D
17. 16
18. 17
19. 7
20. 9
21. 5

22. a) $2x + y = 10$
$3x + 2y = 17$
b) mass of each cylinder = 3 kg, mass of each rectangular block = 4 kg

23. a) $x = -\frac{6}{25}, y = -\frac{14}{25}$
b) $x = -\frac{24}{5}, y = -\frac{19}{2}$

24. a) Answers may vary.
b) 7 h on the highway, 3 h in the city
c)



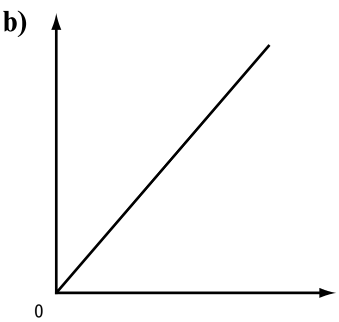
25. a) $x + y = 180$
$x - 3y = -12$
b) Answers may vary.
c) 132° and 48°

26. $A = 3, B = 1$

Practice Final Exam

1. B
2. A
3. C
4. A
5. A
6. B
7. A
8. 44 in.
9. D
10. B
11. 4
12. B
13. D
14. 0.1 m^3
15. C
16. D
17. A
18. C
19. 216
20. D
21. C
22. 1
23. A
24. A
25. D
26. C
27. B
28. B
29. B
30. D
31. B
32. D
33. C
34. A
35. 4.5
36. 3
37. C
38. D
39. 72 km
40. C
41. A
42. C
43. C
44. D
45. 32°
46. **a)** Rate of change $= \frac{600 \text{ m}}{8 \text{ min}} = \frac{75 \text{ m}}{\text{min}}$. The rate of change is 75 m per minute.

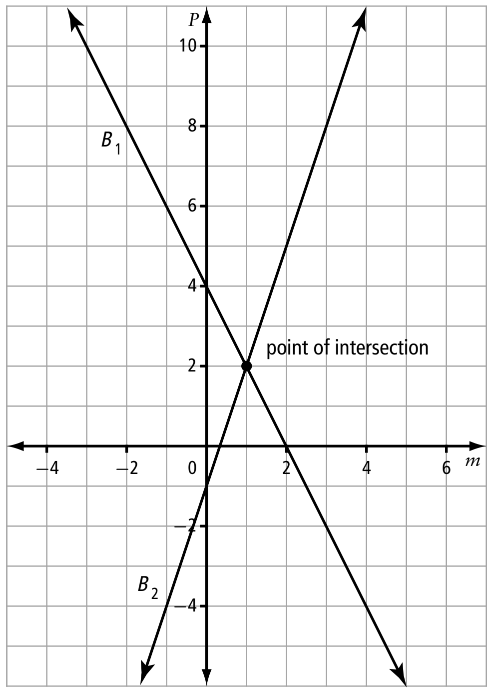
b)



c) 24(tan 14°) + 24(tan 38°) =
5.983 872... + 18.750 854 = 24.734 726...
The chairs are approximately 25 ft apart.

47. Example:
- Stage A: The car starts from rest and accelerates at a constant rate to reach a speed of 90 km/h, which it maintains for almost 2 h.
- Stage B: The car decelerates quickly over a short period of time to 50 km/h (perhaps while entering the outskirts of a town.
- Stage C: The car accelerates back up to 90 km/h.
- Stage D: The cruise control is set and the car travels at a constant speed of 90 km/h for more than 2 h.
- Stage E: The car decelerates and stops. The approximate trip time is 5 h.

48. a) The solution is (1, 2).



b) $3(1) + \frac{3}{2}(2) = 6$

c) After 2 months (since at 2 months the profit is \$0)

d) Answers may vary. Example: In order to launch the new product, the company has start-up production costs, which in this case amount to \$1000.

e) Trial 1:

B_1: $P = \frac{1}{2}m + \frac{3}{2}$

B_2: $P = \frac{1}{2}m + \frac{3}{2}$

Both equations are identical. Therefore, there is an infinite number of solutions. The company would be unable to use these equations to compare sales of the two products.

Trial 2:

B_1: $\frac{6}{5}P = 3m - 2$

$P = \frac{5}{2}m - \frac{5}{3}$

B_2: $\frac{1}{5}P = \frac{1}{2}m - \frac{2}{3}$

$P = \frac{5}{2}m - \frac{10}{3}$

The lines representing these equations are parallel. Therefore, they have no points in common. The company would be unable to find a common time period for sales of the two products.