

## 4.1 Solve Simple Equations

*Principles of Mathematics 9, pages 186–195*

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**A**

1. Solve by inspection.

a)  $x + 4 = 7$

b)  $y - 3 = 5$

c)  $4m = 12$

d)  $\frac{c}{3} = 2$

2. Solve using the balance method.

a)  $x + 2 = 6$

b)  $y - 2 = 4$

c)  $3a = 15$

d)  $\frac{b}{4} = 5$

3. Solve using opposite operations.

a)  $x + 5 = 8$

b)  $g - 5 = -3$

c)  $2 + h = 9$

d)  $-3 + c = -5$

4. Solve using opposite operations.

a)  $d + 5 = -2$

b)  $k - 4 = -1$

c)  $5u = -20$

d)  $\frac{w}{5} = -2$

**B**

5. Find the root of each equation using paper and pencil. Apply opposite operations. Check each root.

a)  $5x + 3 = 13$

b)  $7w - 3 = 11$

c)  $-2p + 3 = -5$

d)  $-4h - 5 = -1$

6. Use a Computer Algebra System (CAS) to solve. Apply opposite operations. Check each solution.

a)  $q + 3 = 5$

b)  $a - 6 = 7$

c)  $3m + 5 = 11$

d)  $-4b + 3 = -1$

7. Solve using the method of your choice. Check your answers.

a)  $a + 8 = -2$

b)  $c - 4 = 3$

c)  $-6d = -30$

d)  $\frac{h}{5} = -3$

8. Solve using the method of your choice. Check your answers.

a)  $5r + 7 = 42$

b)  $-3v + 5 = 8$

c)  $8 + 7g = 15$

d)  $-2j - 8 = 0$

9. At a computer store, packages of DVDs sell for \$15 each. One customer buys \$120 worth of DVDs.

a) Write an equation to model the number of packages of DVDs the customer bought.

b) Solve the equation.

10. Solve each equation. Express fraction answers in lowest terms. Check each solution.

a)  $3h + 4 = 6$

b)  $5k - 3 = -2$

c)  $-7w + 2 = -3$

11. Solve each equation. Express fraction answers in lowest terms. Check each solution.

a)  $-4d - 3 = -1$

b)  $3r + \frac{2}{5} = -4$

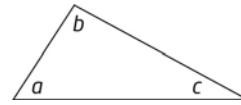
c)  $5t - 4 = \frac{2}{3}$

12. Copy the following solution. Write a short explanation beside each step. The first step has been done for you.

Step	Explanation
$5x - 4 = 6$	
$5x - 4 + 4 = 6 + 4$	Add 4 to both sides.
$5x = 10$	
$\frac{5x}{5} = \frac{10}{5}$	
$x = 2$	

C

13. The equation  $a + b + c = 180^\circ$  describes the sum of the angles in a triangle.



a) Use this formula to find the values of  $a$ ,  $b$ , and  $c$  when  $b = 2a$  and  $c = 3a$ .

b) Use this formula to find the values of  $a$ ,  $b$ , and  $c$  when  $b = 3a$  and  $c = 5a$ .

14. The publicity committee of the organizing committee of a mathematics conference has \$2000 to buy T-shirts for the student volunteers. Reflexx Services, a T-shirt supplier, charges \$15 per T-shirt plus a \$250 logo design fee.

a) Write an equation that models the number of T-shirts the publicity committee can afford.

b) Solve the equation. Write a conclusion to the problem.

15. Margaret is buying a new boat. The fuel tank of the boat has a mass of 2000 g. Each litre of gasoline has a mass of 840 g. The total mass of the gasoline plus the tank cannot exceed 10 400 g.

a) Write an equation that models the number of litres of gasoline that the tank may hold.

b) Solve the equation to determine the number of litres of gasoline in a full tank.

## 4.2 Solve Multi-Step Equations

*Principles of Mathematics 9, pages 196–203*

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### A

1. Solve using pencil and paper.

a)  $5 + 3x + 4x = 19$

b)  $15y - 6 - 10y = 9$

c)  $32 = 5 - 4a - 5a$

d)  $5m + 3 - 9m + 13 = 0$

2. Solve using pencil and paper.

a)  $6w + 8 = 4w + 18$

b)  $-8k - 5 = 2k + 15$

c)  $3b - 6 = -b - 2$

d)  $5 + 4d = -13 - 2d$

3. Solve using a Computer Algebra System (CAS). Use at least two steps.

a)  $7t + 8 = 3t - 12$

b)  $5c - 3 - 4c = 2c + 2$

c)  $0 = 4x + 3 - x - 9$

d)  $14 - n - 7 = 5n + 1$

4. Find the root of each equation using pencil and paper. Check each solution.

a)  $5(x + 4) = 3x + 14$

b)  $5q - 6 = 2(q + 3)$

c)  $4t + 3(2 - t) = 13$

d)  $u = 3(5 - u) + 1$

5. Find the root of each equation using pencil and paper. Check each solution.

a)  $3(r + 4) + 2(r + 5) = 32$

b)  $5(y - 3) - 3(y - 4) = 12$

c)  $4(v + 3) = 2(v + 6) - 8$

d)  $2(y - 4) = -3(y + 2) + 8$

### B

6. Two or more angles are supplementary if their sum is  $180^\circ$ . An angle is four times the value of its supplement. Set up and solve an equation to find the measures of the two angles.

7. Two or more angles are complementary if their sum is  $90^\circ$ . Three angles are complementary. One angle is three times the value of the smallest angle. The largest angle is five times the value of the smallest angle. Find the measures of the three angles.

8. Solve each equation using the method of your choice. Express fraction answers in lowest terms. Check your answers.

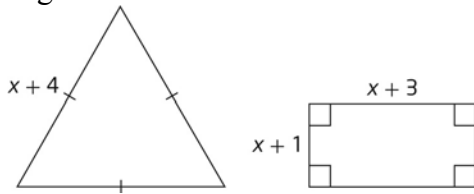
a)  $5x - 2 = 2x + 3$

b)  $4 + 5h = h - 2$

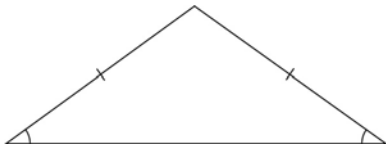
c)  $4(m + 3) + 2(m - 3) = 3(m - 2)$

d)  $7 - (4p + 3) = -3(p + 2) - (2p + 3)$

9. An equilateral triangle and a rectangle have the same perimeter. Find the side lengths of the equilateral triangle and the rectangle.



10. A family of isosceles triangles has the property that the two equal angles are each one third the value of the third angle. Find the measures of the angles.



11. The following shows that  $x = -3$  is the correct solution to the equation  $3(x + 4) + 6 = 9 - (x + 3)$ . Copy this check and explain each step. The first step has been done for you.

Step	Explanation
L.S. = $3(x + 4) + 6$	
$= 3[(-3) + 4] + 6$	Substitute the root into the left side.
$= 3(1) + 6$	
$= 3 + 6$	
$= 9$	

$$\begin{aligned} \text{R.S.} &= 9 - (x + 3) \\ &= 9 - [(-3) + 3] \\ &= 9 - (0) \\ &= 9 \end{aligned}$$

$$\text{L.S.} = \text{R.S.}$$

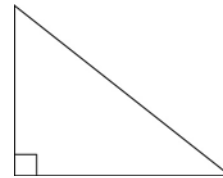
Therefore,  $x = -3$  is correct.

C

12. A family of isosceles triangles has side lengths in the ratio 2:2:3. A triangle belonging to this family has a perimeter of 70 cm.

- Find the length of each side.
- Explain how you solved this.

13. A family of right triangles has side lengths in the approximate ratio 3:4:5. One right triangle belonging to the family has a perimeter of 180 cm. Find its area.



14. Solve each equation. Express fraction answers in lowest terms.

a)  $\frac{1}{3}(x + 3) = \frac{1}{5}(x - 3)$

b)  $\frac{1}{5}k + \frac{1}{3} = \frac{1}{4}k + \frac{1}{2}$

c)  $m(m + 3) + 5m = 3 + m(m - 4)$

d)  $8 - d(d + 4) = 3d - d(d + 2) + 5$

## 4.3 Solve Equations Involving Fractions

*Principles of Mathematics 9, pages 204–210*

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**A**

1. Solve using pencil and paper.

a)  $\frac{1}{4}(x-3) = -2$

b)  $6 = -\frac{3}{5}(a-7)$

c)  $\frac{m+7}{5} = 3$

2. Solve using pencil and paper.

a)  $9 = \frac{3(k+4)}{2}$

b)  $\frac{3k+5}{2} = 10$

c)  $1 = \frac{2p-3}{5}$

3. Solve using a Computer Algebra System (CAS). Use at least two steps.

a)  $\frac{y-5}{3} = -4$

b)  $\frac{1}{3}(p+2) = -5$

c)  $3 = \frac{4}{5}(h+2)$

4. Solve using a CAS. Use at least two steps.

a)  $5 = \frac{4(n+3)}{2}$

b)  $6 = \frac{7-c}{2}$

c)  $\frac{3+w}{-2} = 4$

**B**

5. Find the root of each equation. Check your answers.

a)  $\frac{h-4}{5} = \frac{h-3}{6}$

b)  $\frac{d-2}{4} = \frac{d+1}{3}$

c)  $\frac{1}{3}(x+4) = \frac{1}{5}(x+2)$

6. Find the root of each equation. Check your answers.

a)  $\frac{1}{4}(p-7) = \frac{1}{6}(p-3)$

b)  $\frac{2(k-5)}{3} = \frac{4(k+2)}{5}$

c)  $\frac{3(s-4)}{4} = \frac{2(s-3)}{3}$

7. Find the root of each equation. Use a CAS to check your answers.

a)  $\frac{2}{5}(3m+2) = \frac{3}{4}(m+5)$

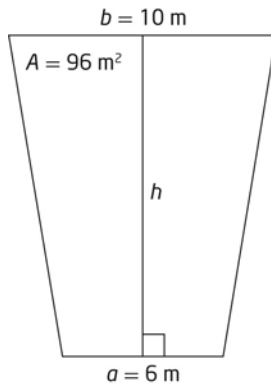
b)  $\frac{2}{3}(k+2) = \frac{3}{4}(2k-1)$

c)  $\frac{4c+5}{3} = \frac{2c+4}{5}$

d)  $\frac{5-3n}{4} = \frac{2-n}{3}$

e)  $\frac{2(3w+4)}{5} = \frac{2(2w-1)}{3}$

8. A trapezoidal deck has an area of  $96 \text{ m}^2$ . The front and back widths are 6 m and 10 m, as shown. What is the length of the deck from front to back?



9. Each solution contains an error. Identify the error and describe how to correct it.

a) 
$$\frac{x+5}{4} = \frac{x-2}{3}$$

$$4(x+5) = 3(x-2)$$

$$4x+20 = 3x-6$$

$$4x+20-3x-20 = 3x-6-3x-20$$

$$x = -26$$

b) 
$$\frac{1}{5}(2y+4) = \frac{1}{2}(y-3)$$

$$10 \times \frac{1}{5}(2y+4) = 10 \times \frac{1}{2}(y-3)$$

$$2y+4 = y-3$$

$$2y+4-y-4 = y-3-y-4$$

$$y = -7$$

10. Find the base of a triangle with height 8 cm and area  $72 \text{ cm}^2$ .

C

11. The equation  $F = \frac{9}{5}C + 32$  allows you to convert between Fahrenheit and Celsius temperatures.  $C$  is the temperature in degrees Celsius ( $^{\circ}\text{C}$ ) and  $F$  is the temperature in degrees Fahrenheit ( $^{\circ}\text{F}$ ).

- a) The temperature at a resort is  $30^{\circ}\text{C}$ . What is this equivalent to in degrees Fahrenheit?
- b) The temperature in the living room of a house is  $77^{\circ}\text{F}$ . What is this equivalent to in degrees Celsius?

12. Solve.

a) 
$$\frac{2a}{3} + \frac{a-4}{5} = \frac{1}{2}$$

b) 
$$\frac{u+1}{2} + \frac{2u+3}{3} = \frac{u}{4}$$

c) 
$$\frac{w+3}{4} = \frac{w}{3} + \frac{2w-1}{5}$$

13. The balcony of an apartment is in the shape of a right triangle in which the height is twice the base. The hypotenuse of the triangular area is 4.5 m.

- a) Determine the height and base of the triangular area. Round your answers to one decimal place.
- b) Approximately how much indoor-outdoor carpet is needed to cover the floor of the balcony?

## 4.4 Modelling With Formulas

*Principles of Mathematics 9, pages 211–219*

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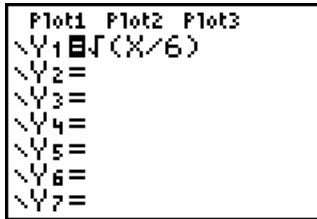
### A

- Rearrange each formula to isolate the variable indicated using pencil and paper.
  - $C = \pi d$  for  $d$  (circumference of a circle)
  - $d = vt$  for  $t$  (distance)
  - $A = P + I$  for  $I$  (investments)
- Rearrange each formula to isolate the variable indicated using pencil and paper.
  - $y = mx + b$  for  $m$  (linear relations)
  - $Ax + By + C = 0$  for  $y$  (linear relations)
  - $F = ma$  for  $a$  (motion)
  - $V = IR$  for  $R$  (voltage)
- Rearrange each formula to isolate the variable indicated.
  - $V = s^3$  for  $s$  (volume of a cube)
  - $P = I^2R$  for  $R$  (electrical power)
  - $V = \pi r^2 h$  for  $h$  (volume of a cylinder)
- Rearrange each formula to isolate the variable indicated.
  - $P = 2l + 2w$  for  $l$  (perimeter of a rectangle)
  - $A = s^2$  for  $s$  (area of a square)
  - $A = \frac{1}{2}bh$  for  $h$  (area of a triangle)
  - $c^2 = a^2 + b^2$  for  $a$  (Pythagorean theorem)

### B

- You can use the formula  $w = 2.2m$  to obtain an approximate value for converting a mass,  $m$ , in kilograms, to a weight,  $w$ , in pounds.
  - Use the formula to find the number of pounds in
    - 3 kg
    - 500 g (1 kg = 1000 g)
  - Rearrange the formula to express  $m$  in terms of  $w$ .
  - How many kilograms are in 8 pounds? Round your answer to the nearest tenth of a kilogram.
- Plot a graph of  $w = 2.2m$  either by hand or by using technology such as a graphing calculator or graphing software.
  - Is the graph linear or non-linear? Explain.
  - Use the graph to find
    - the number of kilograms in 3 pounds
    - the number of pounds in 5 kgRound your answers to the nearest tenth, if necessary.
- The surface area,  $A$ , of a cube is related to the length of a side of the cube,  $s$ , by the formula  $A = 6s^2$ .
  - Rearrange this formula to express  $s$  in terms of  $A$ .
  - Find the length of the side of a cube with surface area  $800 \text{ cm}^2$ . Round your answer to the nearest tenth of a centimetre.

8. Refer to question 7.
- a) Solve this problem using a graphing calculator or graphing software, by entering the equation shown.



- b) Is this a linear or a non-linear relation? Explain how you know.
9. Sometimes the same formula can have many different forms. The formula  $I = Prt$  is a useful formula in business.

Variable	Meaning
$I$	interest
$P$	principal
$r$	rate, expressed as a decimal
$t$	time, in years

Rearrange this formula to isolate each variable. The first one is done for you as an example.

$$I = Prt$$

$$\frac{I}{rt} = \frac{Prt}{rt}$$

$$\frac{I}{rt} = P$$

C

10. The volume,  $V$ , of a cube is related to its side length,  $s$ , by the formula  $V = s^3$ .
- a) Express  $s$  in terms of  $V$ .
- b) Graph both formulas using a graphing calculator or graphing software.
- c) How are the graphs similar?
- d) How are the graphs different?

11. The law of universal gravitation states that the force of gravitational attraction is directly proportional to the product of the masses and inversely proportional to the square of the separation distance between their centres:

$$F = \frac{Gm_1m_2}{d^2}$$

In this formula,

- $m_1$  and  $m_2$  are the masses, in kilograms, of the attracting objects
- $d$  is the separation distance, in metres, as measured from object centre to object centre
- $G$  is the proportionality constant ( $6.67 \times 10^{-11} \text{ N} \cdot \text{m}^2/\text{kg}^2$ )

The following steps show how the formula can be rearranged to express  $d$  in terms of  $F$ ,  $G$ ,  $m_1$ , and  $m_2$ . Copy these steps into your notebook and write a short explanation beside each one. Some hints are provided for you.

**Step**

**Explanation**

$$F = \frac{Gm_1m_2}{d^2}$$

Start with the original formula.

$$Fd^2 = Gm_1m_2$$

\_\_\_\_\_ both sides of the equation by \_\_\_\_\_.

$$\frac{Fd^2}{F} = \frac{Gm_1m_2}{F}$$

$$d^2 = \frac{Gm_1m_2}{F}$$

$$\sqrt{d^2} = \sqrt{\frac{Gm_1m_2}{F}}$$

Take the \_\_\_\_\_ of both sides.

$$d = \sqrt{\frac{Gm_1m_2}{F}}$$



## 4.5 Modelling With Algebra

*Principles of Mathematics 9, pages 220–229*

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**A**

- Write an algebraic expression to represent each description.
  - quadruple a number
  - three more than a number
  - one third a number
  - four less than triple a number
- Write an algebraic expression to represent each description.
  - five times a number
  - six more than twice a number
  - two less than a number
  - three fifths of a number
- Write an equation to represent each sentence. Explain your choice of variable and what it represents in each case.
  - five times a number is 85
  - an area increased by 8 is 177
  - three more than double a number is 33
  - the sum of three consecutive integers is 168
- Solve each equation in question 3 and explain what the answer means.
- Two friends are collecting pop-can tabs. Natasha has 250 more pop-can tabs than Krysten. Together they have collected 880 pop-can tabs. How many pop-can tabs has each friend collected?

**B**

- Justin and Kieran both participated in a walk-a-thon to raise money for a charity. Justin raised \$20 more than Kieran. Together they raised \$95. How much money did they each raise?
- Jacinth is 4 years older than her sister Naomi. The sum of their ages is 30. How old are the sisters?
- Jack is selling used computers. He is paid \$15/h plus a 5% commission on sales. What dollar amount of computer sales must Jack make to earn \$1000 in a 40-h work week?
- The sum of three consecutive integers is 120. Find the numbers.
- Alicia and Wayne are both collecting coins. Alicia has three times as many coins as Wayne. Together they have 712 coins. How many coins does Alicia have and how many coins does Wayne have?
- Sally, Letitia, and Jessica play together on a basketball team. At the end of the season, Sally had scored 8 more points than Letitia, while Letitia had scored twice as many points as Jessica. The three girls scored a total of 108 points. How many points did each girl score?

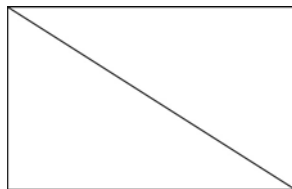
12. Ashley works part time, 2 h per day, selling memberships to a video club. She is paid \$8.50/h, plus a \$2 commission for each video club membership that she sells.

- Write an algebraic expression that describes Ashley's total earnings.
- Find the amount that Ashley makes in 10 h when she sells 30 memberships.
- How many memberships does Ashley have to sell to make \$475 in a 10-h workweek?
- How many hours does Ashley have to work to make \$250 if she sells 40 memberships?

13. Anoja, Amani, and Azra are three friends who each have part-time jobs. Last week, Anoja earned twice as much money as Azra, while Amani earned \$25 more than Anoja. The total earnings of the three friends last week was \$450. How much money did each of them earn last week?

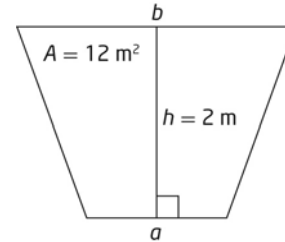
14. The length of the banquet hall where Naomi works is double its width. The area of the banquet hall is  $200 \text{ m}^2$ .

- Find the length and width of the banquet hall.
- If Naomi walks around the perimeter of the banquet hall, how far does she walk?
- If Naomi walks diagonally across the banquet hall, how far does she walk? Round your answer to the nearest tenth of a metre.

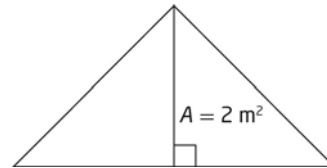


C

15. A reflecting pool is in the shape of a trapezoid. The front width is triple the back width. The pool has an area of  $12 \text{ m}^2$ . The distance from the front to the back of the pool is 2 m. Find the front width and the back width of the pool.



16. An isosceles triangle has been constructed so that its height is one half of its base. Without changing the base length, how should the height of the triangle change to triple the area?



17. Raza works at a flea market selling sunglasses. He is paid \$7.50/h plus a 75¢ commission for every pair of sunglasses he sells.

- Write an equation to model Raza's earnings.
- Find Raza's earnings if he sells 25 pairs of sunglasses during a 6-h shift.
- How many pairs of sunglasses must he sell to earn \$90 in 8 h?

## Chapter 4 Review

*Principles of Mathematics 9, pages 230–231*

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- Solve using pencil and paper.
  - $x + 5 = 9$
  - $f - 7 = 3$
  - $3h = 15$
  - $\frac{k}{4} = 3$
- Solve using a Computer Algebra System (CAS).
  - $2x + 5 = 11$
  - $3y - 5 = -8$
  - $10 + 4f = -34$
  - $-5m - 3 = 12$
- Find the root of each equation using any method. Express fraction answers in lowest terms. Check each answer.
  - $5x + 2 = 12$
  - $3p + 8 = 5$
  - $4 + 6w = 2$
  - $-6 + 4u = -3$
- John has \$23.65 to spend on a book and magazines. The book costs \$5.95. The magazines cost \$2.95 each.
  - Write an equation that models the number of magazines that John can afford.
  - Solve the equation.
- Solve using pencil and paper.
  - $5x + 4 = 2x + 13$
  - $4c - 3 = 2c + 5$
  - $-3r + 7 = -5r - 3$
  - $-6g - 4 = -3g + 2$
- Solve using a CAS.
  - $2a + 5 = 6a + 9$
  - $3b - 7 = b + 5$
  - $5n + 8 = 8n - 10$
  - $-7d + 3 = -3d + 11$
- A triangle has angle measures that are related as follows:
  - The largest angle is 12 times the smallest angle
  - The middle angle is 5 times the smallest angle.Find the measures of the angles.
- Find the root of each equation using pencil and paper. Check each root.
  - $\frac{1}{2}(x + 3) = 5$
  - $\frac{b - 5}{7} = 3$
  - $6 = \frac{2}{3}m - 1$
  - $-5 = \frac{3d + 4}{3}$

9. Find the root of each equation using a CAS. Check each root.

a)  $4 = \frac{5r + 7}{3}$

b)  $\frac{1}{3}(p + 5) = 2p - 3$

c)  $3q + 15 = \frac{1}{2}(q - 5)$

d)  $\frac{2b + 5}{4} = 3$

10. Find the solution to each equation.

a)  $\frac{x - 5}{3} = \frac{x + 4}{4}$

b)  $\frac{3}{4}(y - 2) = \frac{2}{3}(y + 1)$

c)  $\frac{b + 5}{3} = \frac{b - 3}{5}$

d)  $\frac{3}{5}(v + 2) = \frac{1}{2}(v - 3)$

11. Rearrange each formula to isolate the variable indicated.

a)  $F = ma$  for  $m$  (motion)

b)  $V = IR$  for  $I$  (voltage)

c)  $A = \pi r^2$  for  $r$  (area of a circle)

d)  $P = 2l + 2w$  for  $w$  (perimeter of a rectangle)

e)  $y = mx + b$  for  $x$  (linear relations)

12. The power,  $P$ , in an electric circuit is related to the voltage,  $V$ , and resistance,  $R$ , by the formula  $P = \frac{V^2}{R}$ .

a) Find the power, in watts (W), when the voltage is 100 V (volts) and the resistance is 50  $\Omega$  (ohms).

b) What is the resistance of a circuit that uses 100 W of power with a voltage of 20 V?

c) The resistance of a circuit is 15  $\Omega$ . The same circuit uses 60 W of power. Find the voltage in the circuit.

13. The total of three cousins' ages is 48. Suresh is half as old as Hakima and 4 years older than Saad. How old are the cousins?

14. Adila sells T-shirts at a rock concert. She earns \$8.00/h, plus \$0.50 for each T-shirt she sells.

a) How much will Adila earn in a 4-h shift if she sells 35 T-shirts?

b) How many T-shirts must Adila sell to earn \$80 in a 6-h shift?

15. Ramesh sells hot dogs at a ball game. He earns \$8.50/h, plus \$0.35 for each hotdog he sells.

a) How much will Ramesh earn in a 4-h shift if he sells 52 hot dogs?

b) How many hot dogs must Ramesh sell to earn \$103 in an 8-h shift?

c) How many hot dogs must Ramesh sell to earn \$79 in a 6-h shift?