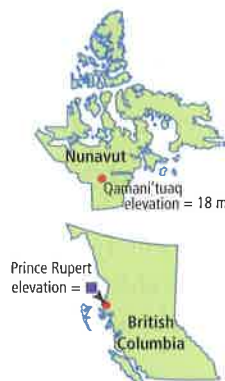## 10.3 Modelling & Solving
Equations: $\frac{x}{a} + b = c$

Pg 392 Q# 4-6 a , 10, 11, 13, 14, 17

Example 1: Model Equations With Algebra Tiles

The elevation of Qamani'tuaq, Nunavut, is 1 m less than $\frac{1}{2}$ the elevation of Prince Rupert, British Columbia. If the elevation of Qamani'tuaq is 18 m, what is the elevation of Prince Rupert?
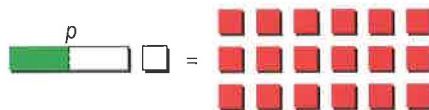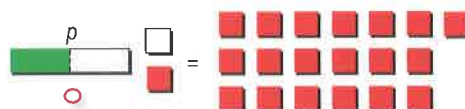
Solution

Let p represent the elevation of Prince Rupert.

The equation that models this situation is $\frac{p}{2} - 1 = 18$.

The fraction $\frac{1}{2}$ means you need to divide by 2. The words 1 m less mean you need to subtract 1.

To isolate the variable, first add one positive 1-tile to both sides.

You need two equal parts to fill the variable tile.

The $\frac{1}{2}$ variable tile must have the same value as the 19 positive 1-tiles.

Multiply by 2 to fill the variable tile.
To balance the equation, multiply the 19 positive 1-tiles by 2. The variable tile must then have a value of $2 \times 19 = 38$.
The elevation of Prince Rupert is 38 m.

Check:

$$\text{Left Side} = \frac{p}{2} - 1 \qquad \text{Right Side} = 18$$
$$= \frac{38}{2} - 1$$
$$= 19 - 1$$
$$= 18$$
$$\text{Left Side} = \text{Right Side}$$

The solution is correct.

Show You Know

Solve by modelling each equation.

a) $\frac{x}{4} - 5 = -7$ b) $\frac{-p}{3} + 1 = -4$

Example 2: Apply the Reverse Order of Operations

During the 2006–2007 NHL season, Kristian Huselius of the Calgary Flames had a total of 41 more than $\frac{1}{2}$ the number of shots on goal as Jarome Iginla. If Huselius had 173 shots on goal, how many did Iginla have?

> Use the reverse order of operations. Add and subtract first, then multiply and divide.

> Why would you not use algebra tiles to solve this problem?

Solution

Let j represent the number of shots on goal Jarome Iginla had.

This situation can be modelled with the equation $\frac{j}{2} + 41 = 173$.

$\frac{j}{2} + 41 - 41 = 173 - 41$ Subtract 41 from both sides of the equation.

$$\frac{j}{2} = 132$$

$\frac{j}{2} \times 2 = 132 \times 2$ Multiply both sides of the equation by 2.

$$j = 264$$

Jarome Iginla had 264 shots on goal during the 2006–2007 season.

Check:

Left Side $= \frac{j}{2} + 41$ Right Side $= 173$

$= \frac{264}{2} + 41$

$= 132 + 41$

$= 173$

Left Side $=$ Right Side

The solution is correct.

Show You Know

Solve by applying the reverse order of operations.

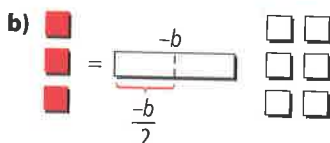a) $\frac{-x}{12} - 6 = 4$ b) $-4 = 3 + \frac{k}{7}$

Check Your Understanding
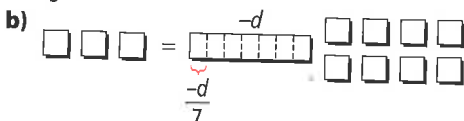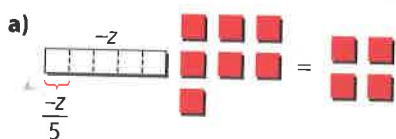
Practise

4. Solve the equation modelled by each diagram. Check your solution.

a)

b)

5. Solve the equation represented by each diagram. Verify your solution.

a)

b)

6. Draw a model for each equation. Then, solve. Verify your answer.

a) $-5 + \dfrac{g}{-2} = 3$ **b)** $-3 = 7 + \dfrac{n}{5}$

7. For each equation, draw a model. Then, solve. Check your answer.

a) $\dfrac{f}{-5} + 3 = -2$ **b)** $-1 = \dfrac{n}{8} - 4$

8. What is the first operation you should perform to solve each equation?

a) $\dfrac{t}{-5} + 12 = 9$ **b)** $\dfrac{p}{13} - 2 = -3$

c) $\dfrac{-k}{12} + 6 = 15$ **d)** $14 = 11 - \dfrac{x}{3}$

9. What is the second operation you should perform to solve each equation in #8?

10. Solve each equation. Verify your answer.

a) $2 + \dfrac{m}{3} = 18$ **b)** $\dfrac{c}{-8} - 8 = -12$

c) $16 = 9 + \dfrac{b}{-8}$ **d)** $-3 = \dfrac{n}{-7} + 19$

11. Solve. Check your answer.

a) $4 + \dfrac{j}{-8} = 8$ **b)** $\dfrac{r}{2} - 12 = -12$

c) $15 = -5 + \dfrac{x}{-6}$ **d)** $-2 = \dfrac{n}{13} - 17$

Apply

12. Show whether $n = -72$ is the solution to each equation.

a) $6 + \dfrac{n}{9} = 14$ **b)** $2 = 14 + \dfrac{n}{6}$

c) $\dfrac{n}{-3} + 6 = -18$ **d)** $-17 = \dfrac{n}{36} - 15$

13. The amount of sleep needed each night by people 18 years old or younger can be modelled by the equation $s = 12 - \dfrac{a}{4}$, where the amount of sleep in hours is s, and the age in years is a.

a) If 10 h is the amount of sleep Brian needs, how old is he likely to be?

b) Natasha is 13. She gets 8 h of sleep each night. Is this enough? Explain your reasoning.

14. The cost of a concert ticket for a student is $2 less than one half of the cost for an adult. The cost of the student ticket is $5. Let a represent the cost of an adult ticket. Write and solve an equation to determine the cost of an adult ticket.

15. In the following formula, T is the air temperature in degrees Celsius at an altitude of h metres, and t is the ground temperature in degrees Celsius:

$$T = t - \frac{h}{150}.$$

a) If the ground temperature is 25 °C, what is the temperature outside an aircraft at an altitude of 7500 m?

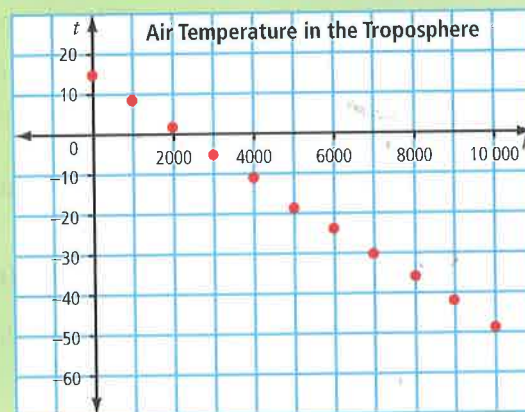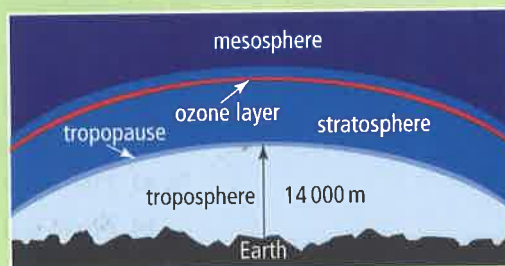**b)** What is the altitude of the same plane if the outside air temperature is −35 °C?

16. In Canada, the percent of secondary school students who say their favourite subject is science is 1% less than $\frac{1}{2}$ of the number of students who choose math. The percent of students who prefer science is 6%. Write and solve an equation to determine what percent of students prefer math.

17. The recommended energy requirement per day for 14-year-old boys depends on how active they are. The requirement can be modelled by the following equations, where a is the age and C is the number of Calories.

Active	Moderately Active
$a = \dfrac{C}{100} - 17$	$a = \dfrac{C}{100} - 13$

a) Tom is an active 14-year-old. What is the recommended number of Calories he should consume?

b) Juan is a moderately active 14-year-old boy. If he consumes 2831 Calories per day, is this greater or fewer Calories than the recommended amount?

c) The recommended requirement for a moderately active 14-year-old girl is 2100 Calories. Model this energy requirement by determining the value for x in the equation $a = \dfrac{C}{100} - x$.

MATH LINK

Meteorologists rely on models of our atmosphere to help them understand temperature and pressure differences, humidity, and a wide range of other variables. An important part of our atmosphere is the troposphere. It is the lowest layer of the atmosphere, where humans live and where weather occurs.

The equation that models air temperature change in the troposphere is $t = 15 - \dfrac{h}{154}$, where t is the temperature, in degrees Celsius, and h is the altitude, in metres.

a) What patterns do you see in the graph?

b) What connections do you see between the graph and the equation?

c) At what height in the troposphere is the temperature 0 °C?