Connect the Ideas

Hamadi is a pediatric nurse.
He uses a table like the one below to give
the correct dose of a pain reliever.

$\times 2$

Approximate body mass (kg)	5	10	15
Dose (mg)	60	120	180

$\times 3$

When the body mass doubles, the dose doubles.

When the body mass triples, the dose triples.

We say that the drug dose is *proportional* to the body mass.
5 : 60, 10 : 120, and 15 : 180 are equivalent ratios.

We can determine the drug dose for a body mass of 35 kg.
Let d milligrams represent this dose.
We need a ratio equivalent to 5 : 60, with the first term 35.
That is, 5 : 60 = 35 : d

Here are two ways to determine the value of d.

> In proportional situations, the quantities involved are related by multiplication or division.

> The statement 5 : 60 = 35 : d is a **proportion**. A proportion is a statement that two ratios are equal.

> Use a table.

Look for a multiplication relationship *between* ratios

$\times$?

5 : 60 = 35 : d
Think: What do we multiply 5 by to get 35? Multiply 60 by the same number.

$\times 7$ $\begin{array}{c|c} 5 & 60 \\ \hline 35 & d \end{array}$ $\times 7$

So, $60 \times 7 = d$
That is, $d = 420$

Look for a multiplication relationship *within* ratios

$\times$?

5 : 60 = 35 : d
Think: What do we multiply 5 by to get 60? Multiply 35 by the same number.

$\times 12$

$\begin{array}{c|c} 5 & 60 \\ \hline 35 & d \end{array}$

$\times 12$

So, $35 \times 12 = d$
That is, $d = 420$

A dose of 420 mg is needed for a body mass of 35 kg.

Practice

1. Describe two ways the numbers in each proportion are related.

    a) $5:20 = 125:500$ **b)** $10:1 = 120:12$ **c)** $75:25 = 300:100$ **d)** $1:3 = 16:48$

2. Multiply between ratios to determine each value of n.

    a) $2:5 = 8:n$ **b)** $2:n = 6:9$ **c)** $n:5 = 12:20$ **d)** $8:n = 4:15$

Need Help?

Read Connect the Ideas.

3. Multiply within ratios to determine each value of z.

    a) $4:8 = 3:z$ **b)** $5:z = 6:18$ **c)** $z:14 = 10:20$ **d)** $3:21 = z:56$

4. A portable music player with 4 GB of memory stores about 1000 songs.
A music player with 60 GB of memory stores about 15 000 songs.
Is the number of songs proportional to the amount of memory?
Explain your reasoning.

5. To make green paint, 3 parts yellow paint are mixed with 2 parts blue paint.
Janis has 12 L of blue paint. How much yellow paint does she need? Explain.

6. Ali earned $80 working 10 h.
How long would it take him to earn $200? Explain how you found your answer.

7. A recipe that serves 4 people uses 3 potatoes.
How many potatoes are needed to serve 20 people?

Sometimes, it is helpful to simplify one of the ratios in a proportion.

Example

Determine the value of c.

$c:20 = 18:15$

Solution

$c:20 = 18:15$

We cannot immediately identify how the terms are related.

$$c:20 = 18:15$$

Use mental math to determine an equivalent ratio for $18:15$.
Divide each term by 3.

$18:15 = \dfrac{18}{3}:\dfrac{15}{3}$

$ = 6:5$

So, $c:20 = 6:5$

$$\div 4$$

Since $20 \div 4 = 5$, then $c \div 4 = 6$

So, $c = 24$

8. Determine the value of each variable.

   a) $4:10 = 18:c$ **b)** $125:25 = n:6$ **c)** $6:y = 9:12$ **d)** $60:z = 24:6$

9. **Assessment Focus**   In 1996, the Royal Canadian Mint
issued the new $2 coin.

   a) A poster advertising the new coin showed a large
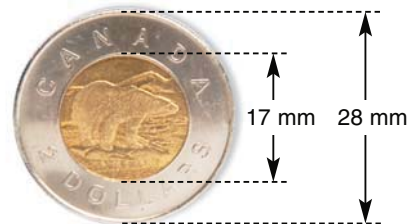photograph of the toonie.
The diameter of the inner core on the poster was 51 cm.
What was the outer diameter of the coin on the poster?
Show your work.

   b) Did you solve the problem using a proportion?
How could you solve it without using a proportion?

17 mm   28 mm

10. When a robin flies, it beats its wings about 23 times in 10 s.
How many times will it beat its wings in 2 min?
Explain your thinking.

11. A gear ratio is the ratio of the numbers of teeth
in two connected gears.
The gear ratio of two gears is $3:2$.
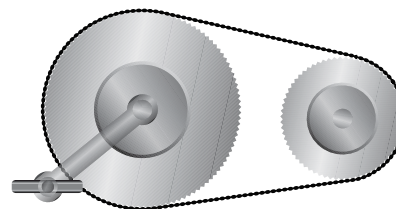
   a) The larger gear has 126 teeth.
How many teeth does the smaller gear have?
How did you solve the problem?

   b) Suppose the smaller gear has 126 teeth.
How many teeth would the larger gear have? Explain.
Show your work.

12. **Take It Further** There are 900 students enrolled
in Mount Forest Secondary School.
The ratio of girls to boys is $5:4$.

   a) How many boys and how many girls go to Mount Forest SS?
Explain how you found your answer.

   b) The average class size is 27 students.
Suppose this class is representative of all the students in the school.
How many students in this class are girls?
How many are boys?

In Your Own Words

Use one of the questions in this section.
Explain how you can use a proportion to answer the question.