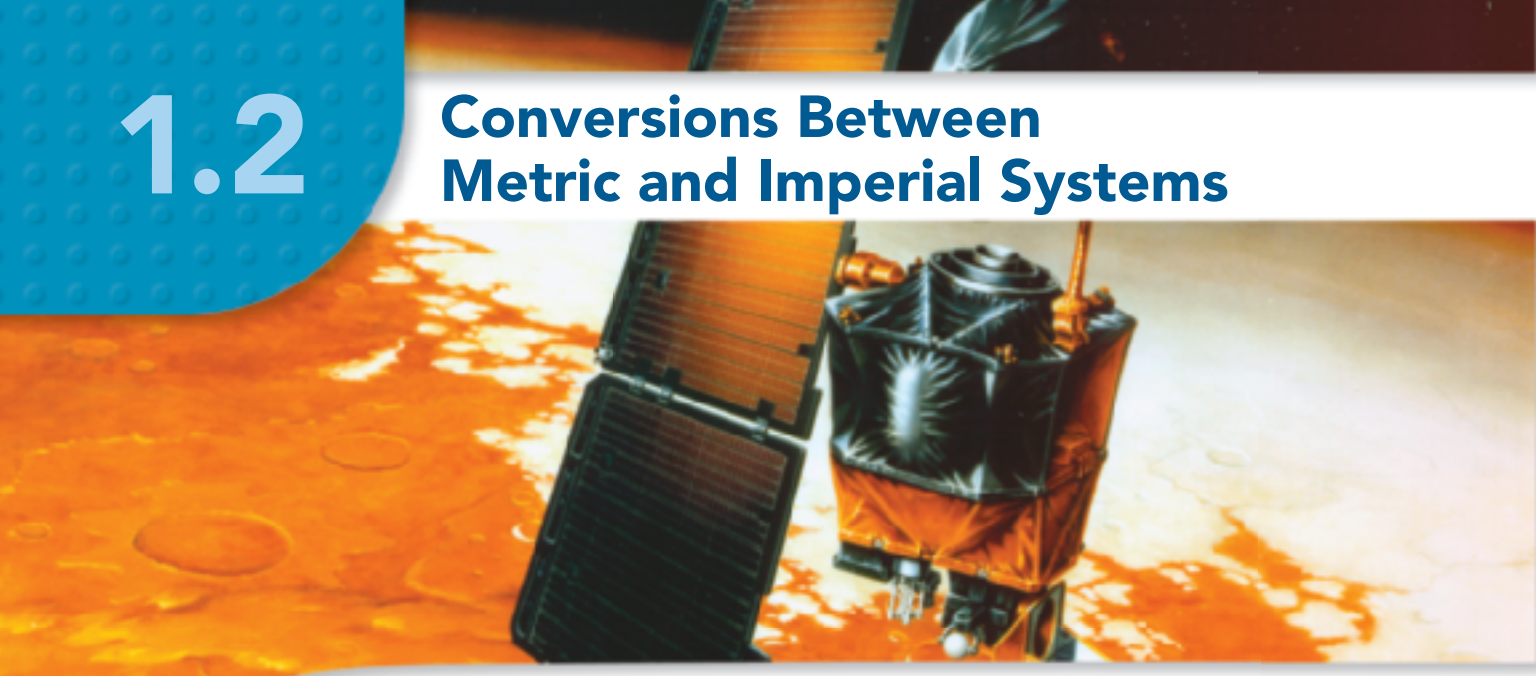
1.2 Conversions Between Metric and Imperial Systems



It is movie night with your family. You have a selection of classics and new films: *Fahrenheit 451, 20 000 Leagues Under the Sea, The Green Mile,* and *The Longest Yard.*

Is 451°F hot? How long is a league? A mile? A yard?

In movies and in real life, there are many references to distance, temperature, volume, and mass and weight. Making a quick mental conversion helps keep things in a context you understand. In some careers, it is often necessary to be able to make exact conversions between the imperial system and the metric system. In space exploration, for example, calculation errors can mean a failed mission, such as with the Mars Climate Orbiter.

Investigate

Tools

- graduated cylinders or measuring cups with both fluid ounces and millilitres
- metre stick
- scale with both pounds and kilograms
- thermometer with both Celsius and Fahrenheit
- yardstick

The Relationships Between Metric and Imperial Units

The table shows the most common units in each measurement system.

	Metric	Imperial
Length	millimetre (mm)	
	centimetre (cm)	inch (in.)
	kilometre (km)	mile (mi)
Mass (Metric)/ Weight (Imperial)	gram (g)	ounce (oz)
	kilogram (kg)	pound (lb)
	tonne (t)	ton (tn)
Liquid Volume	millilitre (mL)	fluid ounce (fl oz)
		pint (pt)
		quart (qt)
	litre (L)	gallon (gal)
Temperature	degree Celsius (°C)	degree Fahrenheit (°F)

Part A: Units of Length

Use a yardstick and a metre stick.

1. Approximately how many centimetres are in one inch?

2. **a)** Which is longer, a yard or a metre? By how much?
b) Approximately how many yards are in one metre?

Math Connect

Find out your weight in pounds and your mass in kilograms. Then calculate your weight on the moon by multiplying your weight by $\frac{1}{6}$. What would your mass on the moon be? Go to www.mcgrawhill.ca/links/foundations10 and follow the links to find out your weight on other planets.

Part B: Units of Mass and Weight

The imperial unit, the pound, is a measure of weight. The weight of an object is affected by gravity. The metric unit, the kilogram, is a measure of mass. Mass is a measure of the amount of matter an object contains. It is not affected by gravity. An object weighs less on the moon than it does on Earth, but it has the same mass. However, when measuring how heavy something is on Earth, weight and mass are essentially equivalent.

Use a scale.

3. **a)** Which is heavier, one kilogram or one pound?
b) Approximately how many pounds are in one kilogram?

4. Approximately how many grams are in one pound?

Part C: Units of Volume

Use graduated cylinders to explore how units of volume are related.

5. **a)** Which is larger, one cup or one litre?
b) Approximately how many cups are in one litre?

6. Approximately how many millilitres are in one cup?

Part D: Units of Temperature

7. Select five different temperatures in degrees Celsius.
a) Use a thermometer to find each equivalent temperature in degrees Fahrenheit.
b) Work with a partner. Compare the temperatures in degrees Celsius to the equivalent temperatures in degrees Fahrenheit. Describe a method you could use to estimate a temperature in degrees Fahrenheit given a temperature in degrees Celsius.

8. Choose two different temperatures in degrees Celsius.
a) Use the method you described in question 7b) to estimate the equivalent temperatures in degrees Fahrenheit.
b) Use a thermometer to find each equivalent temperature in degrees Fahrenheit. Compare your results to your estimates in part a). How close were your estimates?

Often, an estimate is all that is needed when converting between the metric and imperial measurement systems. Here are some benchmarks for the most common estimates:

There are about 1.6 kilometres in 1 mile.
There are about 2.5 centimetres in 1 inch.
One yard is approximately equal to 1 metre.
There are about 450 grams in 1 pound.
There are about 2.2 pounds in 1 kilogram.
There are about 4 litres in 1 gallon.
One tablespoon is approximately equal to 15 millilitres.
There are about 30 millilitres in 1 fluid ounce.

A quick way to estimate a temperature in degrees Fahrenheit given a temperature in degrees Celsius is to double the temperature and add 30. Remember that an estimate is NOT an accurate result.

Example 1 Estimating

A Chan finds that when he estimates a volume in gallons given a volume in litres, his estimate is always low, and when he estimates a volume in litres given a volume in gallons, his estimate is always high. Explain why this happens.

B When Beatta estimates a distance in miles, given a distance in kilometres, she multiplies by 6, moves the decimal one place to the left, then adds the original number. Explain why Beatta's method works.

Solution

A Four litres is a little less than one gallon. So, when Chan divides by 4 to estimate the volume in gallons given the volume in litres, the estimate will always be too low. Similarly, when he multiplies by 4 to estimate the volume in litres given the volume in gallons, his estimate will always be too high.

B When Beatta multiplies by 6 and moves the decimal one place to the left, she is actually finding 0.6 times the value. By adding the result to the original values, she is taking 1 (the original value) plus 0.6 of the original value, which is the same as multiplying by 1.6.

Example 2 Estimate or Calculate?

A Blueprints for a new amusement park ride were prepared using imperial units. The axles are to be manufactured in a metric facility. The blueprints indicate the diameter of the axles is to be $1\frac{3}{4}$". Is it sufficient to estimate the diameter of an axle in metric units? Why or why not? What is the diameter of the axles in millimetres?

B At Nitusha's most recent checkup, her mass was 55 kg. How many pounds does Nitusha weigh? Is an estimate good enough?

Solution

A An estimate is not sufficient in this situation. For safety, the conversion should be exact, so the axles will fit. There are 25.4 mm in one inch.Find the diameter of the axle in millimetres.

$= 1\frac{3}{4} \times 25.4$ *Convert $\frac{3}{4}$ to 0.75 and multiply 25.4 by 1.75.*

$= 44.45$

The diameter of the axles is 44.45 mm.

B Adults are usually weighed to the nearest pound. In this case, an estimate is sufficient.
There are 2.2 lb in 1 kg.
$55 \times 2.2 = 121$
Nitusha weighs approximately 121 lb.

Math Connect

Why are infants measured in smaller units than adults? Why are more precise measurements important in this case?

Example 3 Convert Temperatures

Suppose the forecast high temperature today is 23°C. Estimate the temperature in degrees Fahrenheit.

Solution

To estimate the temperature, double and add 30.
$2 \times 23 = 46$
$46 + 30 = 76$
Therefore, 23°C is approximately 76°F.

Key Concepts

- In many circumstances, an estimated conversion is all that is required.
- Approximate relationships, such as 1 in. is approximately equal to 2.5 cm, can be used to estimate conversions between the imperial and metric systems.

Discuss the Concepts

D1. Describe a situation in which

a) an estimated conversion is sufficient.

b) an exact conversion is required.

D2. When would you use the metric system to measure? When would you use the imperial system? Why?

Practise the Concepts A

For help with question 1, refer to Examples 1, 2, and 3.

1. Estimate each measure in the indicated units.

a)	10 mi	kilometres
b)	3 m	yards
c)	6 gal	litres
d)	156 lb	kilograms
e)	2 tbsp	millilitres
f)	60 cm	inches
g)	4 L	quarts
h)	600 g	pounds
i)	20°C	degrees Fahrenheit
j)	80°F	degrees Celsius

2. The weather forecast calls for 12 cm of snow. How many inches can you expect?

3. Yesterday, the high temperature in Orlando, Florida, was 87°F. The high temperature in Stouffville, Ontario, was 28°C. Which city had the greater high temperature? How do you know?

4. You have a 1.5 gal jug. How many litres will it hold?

5. Joe is travelling in the United States. A road sign indicates he is 228 mi from his destination. How many kilometres is Joe from his destination?

Apply the Concepts B

6. Work with a partner. For each situation, discuss which would be more appropriate: an exact measure or an approximation. Explain your choices.

a) the distance to a hole on a golf course
b) the dose of a medicine
c) the outside temperature when you are deciding what to wear
d) the length of a car trip
e) the dimensions of parts of a machine
f) your height

7. A metric tonne is 1000 kg. Which is heavier, a metric tonne or an imperial ton? Explain.

Chapter Problem

8. The city Roads and Parks Maintenance Department has called Darren in to consult. Trees are to be planted around a new park. Hydro poles run along one side of the park. The hydro wires are 5 m above the ground. The table shows the maximum heights of the varieties of trees city planners wish to plant around the park. Which varieties can be planted beneath the hydro wires? How do you know?

Variety	Maximum Height (feet)
Amur maple	15 to 20
Blackhaw viburnum	12 to 15
Blue ash	40
Paperbark maple	20 to 30
Serviceberry	15 to 25

9. Ilya was watching an American news broadcast. It spoke of gas prices being $3.20/gal. What was the price per litre?

Literacy Connect

10. You have a $\frac{5}{16}$ in. drill bit. Will it drill a hole large enough to fit a 5 mm bolt? Explain.

11. Eric found his great-grandmother's recipe for red currant jelly. All the measures are given in imperial units. Eric has metric measures. Work with a partner. Convert all of the measures to metric.

Red Currant Jelly

3 lb fresh red currants
3 c sugar
1 c + 1 tbsp water
1 tbsp cornstarch

12. Marcel can buy cheese at the farmers' market for $3.06/lb. At the grocery store, cheese sells for $6.59/kg. Which is the better buy? Why?

13. Masum's trainer recommended that she drink 2 qt of water a day. Masum bought a case of 500 mL bottles of water. How many bottles of water should she drink each day?

14. **a)** The temperature range in which most bacteria grow is from 5°C to 60°C. What is this range in degrees Fahrenheit?

b) *Salmonella* bacteria are destroyed at cooking temperatures above 150°F. What is this temperature in degrees Celsius?

Achievement Check

15. You are having a party and want to make a fruit punch for the group. The recipe calls for
1 large bottle of pineapple juice (1.89 L)
2 cans of frozen concentrated orange juice (355 mL each)
2 large bottles of ginger ale (2 L each)
1 package of frozen strawberries (600 g)

a) This recipe makes enough punch for 25 people. How many litres of punch is needed for a group of 85 guests?

b) What size of container is needed to hold one recipe worth of punch?

c) If the punch is mixed beforehand and stored in emptied and cleaned 4 L milk jugs, how many jugs of punch will be needed for 85 guests?

Extend the Concepts C

16. The manufacturer of a new car claims it will use 9 L of gas per 100 km. How many miles per gallon is that?

17. Gunilla's baby is ill. The dosage indicated on the medication's label is 2.5 mL/kg every 4 hours. The baby weighs 9 lb 6 oz, and Gunilla has measuring spoons in these sizes: $\frac{1}{8}$, $\frac{1}{4}$, $\frac{1}{2}$, and 1 tsp. How much medication should she administer every 4 hours? Would it be wise for Gunilla to estimate? Explain.

18. Raj drove 550 km and used 30 L of gas. How many miles per gallon does his car get?