Chapter 1 Measurement Systems

1.1 SI Measurement

KEY IDEAS

- SI (Système International d'Unités) is Canada's official measurement system.
- All SI units are based on multiples of 10.
- The *metre* is the basic unit of length.
- Lengths can be measured with SI rulers, metre sticks, or calipers.
- A *referent* is an item that an individual uses as a measurement unit for estimating.
- When measuring, use an appropriate SI unit. Kilometres are appropriate for measuring large distances, such as the distance between cities. Millimetres are appropriate for measuring small units of length, such as a plant's growth in one week.
- To convert from one SI unit to another unit, use *unit analysis* or *proportional reasoning*.
- Some SI units for measuring length are shown in the table. Also shown are each unit's abbreviation, its multiplying factor, and a possible referent.

Unit	Abbreviation	Multiplying Factor	Possible Referent
kilometre	km	1000	length of 12 city blocks
hectometre	hm	100	length of a football field
decametre	dam	10	length of a classroom
metre	m	1	height of a doorknob above the floor
decimetre	dm	0.1	width of a fisted hand
centimetre	cm	0.01	width of a fingernail
millimetre	mm	0.001	thickness of a dime

- Use *unit analysis* to convert one SI unit into another SI unit.

  Convert 109 000 mm to metres.
  1 m = 1000 mm
  So, $109\,000 \text{ mm} \left(\frac{1 \text{ m}}{1000 \text{ mm}}\right) = 109 \text{ m}$

- Use *proportional reasoning* to convert one SI unit into another SI unit.

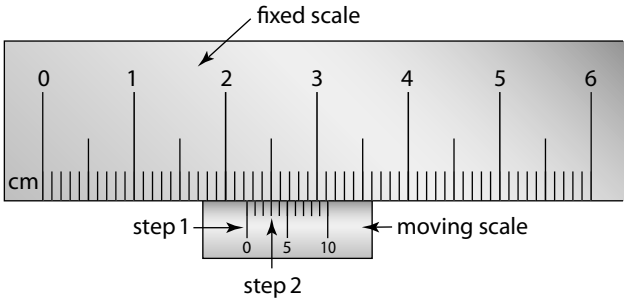
  Convert 0.0098 km to metres.
  Let x represent the number of metres.

$$1000 \text{ m} = 1 \text{ km}$$
$$\frac{1000 \text{ m}}{1 \text{ km}} = \frac{x \text{ m}}{0.0098 \text{ km}}$$
$$1000(0.0098) = x$$
$$9.8 = x$$

  Therefore, 0.0098 km is equivalent to 9.8 m.

- Follow these steps to read a caliper.
  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.
  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.

  The reading for the caliper shown is 2.23 cm. (2.2 + 0.03 = 2.23)



Example

Two students in a Biology class measure the length of an insect specimen. Kelly determines the length to be 8 mm. Caleb states that the length is 0.008 m.

a) What referent could be used to estimate the length of the specimen?

b) What unit of measurement of all possible units is the most appropriate for measuring the length? Explain.

c) How do Kelly's and Caleb's measurements compare? Show your reasoning.

Solution

a) The width of a fingernail, which is a referent for a centimetre, could be convenient to use to estimate the length.

b) Since the insect specimen is very small, the most appropriate unit for measuring it is the millimetre (or centimetre).

c) To compare the two measurements, either convert 8 mm to metres or convert 0.008 m to millimetres.

Use unit analysis to convert 8 mm to metres.

$$1 \text{ m} = 1000 \text{ mm}$$
$$(8 \text{ mm})\left(\frac{1 \text{ m}}{1000 \text{ mm}}\right) = 0.008 \text{ m}$$

Therefore, 8 mm is equivalent to 0.008 m.

The measurements are equivalent.

or

Use proportional reasoning to convert 0.008 m to millimetres.
Let x represent the number of millimetres.

$$1 \text{ m} = 1000 \text{ mm}$$
$$\frac{1 \text{ m}}{1000 \text{ mm}} = \frac{0.008 \text{ m}}{x \text{ mm}}$$
$$1000(0.008) = x$$
$$8 = x$$

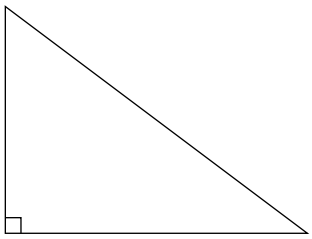
Therefore, 0.008 m is equivalent to 8 mm.

A Practise

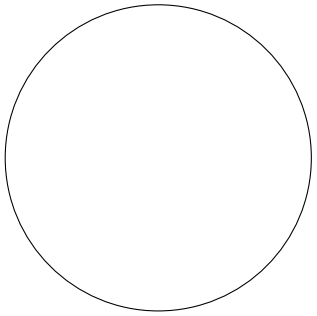
1. Estimate and measure.

a) Estimate the perimeter or circumference of each figure.

i)



ii)

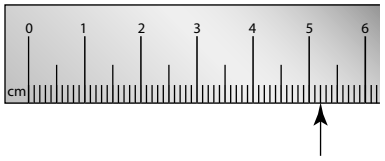


b) Measure and calculate the perimeter or circumference of each figure. Give each answer in both millimetres and centimetres.

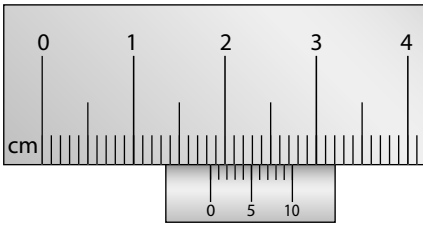
c) What referent could you use to estimate the perimeter of figure i)?

2. What reading is shown on each measuring instrument? Give each reading in both millimetres and centimetres.

a) SI ruler



b) SI caliper



3. Consider each measurement. State whether it is reported in the most appropriate unit. If it is not, explain why and convert to a more appropriate unit.

a) The length of the Iditarod Trail sled dog race is 1 850 750 m.

b) The wingspan of a sycamore moth is approximately 0.042 m.

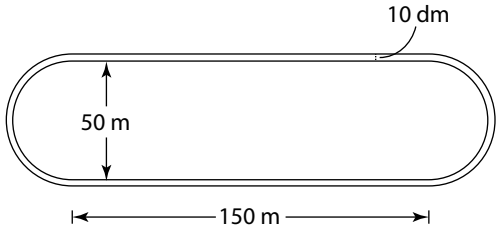
c) The circumference of the tire of a mountain bike is 207 cm.

B Apply

4. **a)** The front wheel of a motorcycle has a radius of 20.32 cm. On a trip, the wheel rotated 25 000 times. What was the distance of the trip in kilometres?

b) What referent could you use to estimate a kilometre distance?

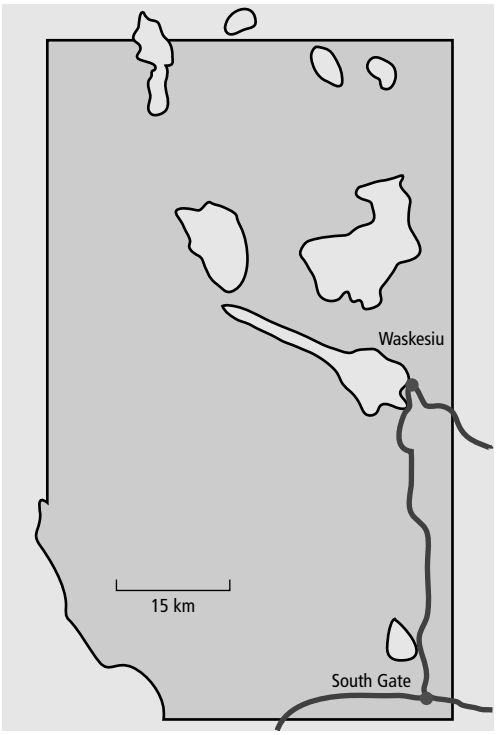
☆5. A running oval with each end in the shape of a semi-circle has the dimensions shown. Stefan runs on the inner track and Vashaal runs on the outer track. The distance between the tracks is 10 dm. Express the difference, in metres, in the distances that the boys run for one lap. Show your reasoning.



6. **a)** A grass flea can leap a distance 350 times its length in a single jump. What is the length of a grass flea that covered a distance of 70 m in 500 jumps? Express your answer in an appropriate unit.

b) Justify your choice of unit in part a).

☆**7.** A map of Prince Albert National Park is shown.



a) Express the scale of the map as a ratio in lowest terms.

b) Estimate the length and width of the park.

c) Determine the length and width of the park using the scale.

d) Determine the distance from Waskesiu to the South Gate. Express your answer in metres and kilometres.

C Extend

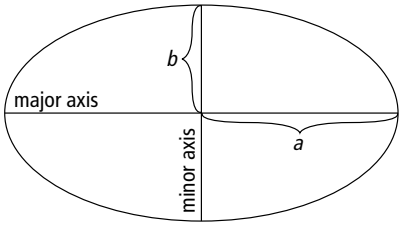
☆**8.** The ratio of length to width of an *Edmonton Journal* newspaper page is 15 to 7. A diagonal drawn on the page has a length of 0.0662 dam. What are the dimensions of the page in centimetres?

9. A rancher has 1600 m of fencing to construct two adjoining fields with the greatest area possible. The minimum area a field can have is 10 000 m^2, or 1 hectare (ha).

a) What are the dimensions of the fields? Explain your thinking.

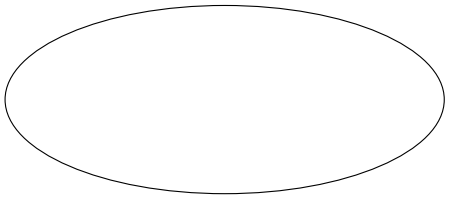
b) What is the total area of both fields?

10. The oblate spheroid is the approximate shape of many planets. An everyday example of an oblate spheroid is an M&M'S® candy. The oblateness of a spheroid (three-dimensional) or an ellipse (two-dimensional) is the ratio of the polar radius, b, to the equatorial radius, a, subtracted from 1.



$$\text{oblateness} = 1 - \frac{b}{a}$$

a) Determine the oblateness of the ellipse shown.



b) What is the oblateness of Earth, if Earth's equatorial diameter is 12 756.274 km and its polar diameter is 12 713.504 km?

c) Determine the oblateness of a sphere. How does it compare to the oblateness of Earth?

D Create Connections

11. Tukani wants to determine the height of his school without actually climbing the school wall with a measuring tape. Instead, he places a metre stick vertically against the wall and takes a photograph showing the ground to the top of the wall and including the metre stick.

a) Explain how Tukani can use the photograph to determine the height of the school.

b) With a partner, try to determine the height of your school.

c) What personal referent could Tukani use instead of the metre stick?

1.2 Imperial Measurement

KEY IDEAS

- The imperial system is based on old English units of measurement derived from nature and everyday activities.
- Canada began a transition from the imperial system to SI in 1970.
- Imperial measurements are used in the United States.
- The imperial system is still used in some instances in Canada.
- From shortest to longest, the basic imperial units for measuring distances are the inch, foot, yard, and mile.

Unit	Abbreviation/ Symbol	Conversion	Possible Referent
mile	mi	1 mi = 1760 yd or 5280 ft or 63 360 in.	length of 15 to 17 city blocks
yard	yd	1 yd = 3 ft or 36 in.	length of a large walking stride
foot	ft or ′	1 ft = 12 in.	length from elbow to wrist
inch	in. or ″		length from end of thumb to first knuckle

- An imperial ruler or measuring tape can measure distances to the nearest $\frac{1}{16}$ in. A caliper can measure distances to the nearest $\frac{1}{1000}$ in.
- Use *unit analysis* to convert one imperial unit into another one.
  Convert $5\frac{3}{4}$ yd into inches.

$$1 \text{ yd} = 36 \text{ in.}$$

$$\left(\frac{36 \text{ in}}{1 \text{ yd}}\right)(5\tfrac{3}{4} \text{ yd}) = 207 \text{ in.}$$

  Therefore, $5\frac{3}{4}$ yd is equivalent to 207 in.

- Use *proportional reasoning* to convert one imperial unit into another one.
  Convert 20 240 yd into miles.

$$1 \text{ mi} = 1760 \text{ yd}$$

  Let x = number of miles

$$\frac{1 \text{ mi}}{1760 \text{ yd}} = \frac{x \text{ mi}}{20\,240 \text{ yd}}$$

$$x = 1\left(\frac{20\,240}{1760}\right)$$

$$x = 11.5$$

Therefore, 20 240 yd is equivalent to 11.5 mi.

Example

Mary and Ling need to determine the area of a room they wish to paint. The room is rectangular with one window and one door. Mary measures the perimeter of the room to be 52 ft and the window to be $1\frac{1}{2}$ yd by 2 yd. Ling measures the height of the room to be 96 in. and the door to be 78 in. by 42 in. If only the walls are to be painted, what is the area to be painted measured in square feet?

Solution

Convert all measurements to feet. Use unit analysis.

Dimensions of the window:

$1 \text{ yd} = 3 \text{ ft}$

$1\frac{1}{2} \text{ yd} = 1\frac{1}{2} \text{ yd} \left(\frac{3 \text{ ft}}{1 \text{ yd}}\right)$

$1\frac{1}{2} \text{ yd} = 4.5 \text{ ft}$

$2 \text{ yd} = 2 \text{ yd} \left(\frac{3 \text{ ft}}{1 \text{ yd}}\right)$

$2 \text{ yd} = 6 \text{ ft}$

Dimensions of the door:

$78 \text{ in.} = 78 \text{ in.} \left(\frac{1 \text{ ft}}{12 \text{ in.}}\right)$

$78 \text{ in.} = 6.5 \text{ ft}$

$42 \text{ in.} = 42 \text{ in.} \left(\frac{1 \text{ ft}}{12 \text{ in.}}\right)$

$42 \text{ in.} = 3.5 \text{ ft}$

Height of the room:

$1 \text{ ft} = 12 \text{ in}$

$96 \text{ in.} = 96 \text{ in.} \left(\frac{1 \text{ ft}}{12 \text{ in.}}\right)$

$96 \text{ in.} = 8 \text{ ft}$

Calculate the area of the four walls and subtract the area of the window and door.

Area of four walls $= (52 \text{ ft})(8 \text{ ft})$
$= 416 \text{ sq ft}$

Area of window $= (4.5 \text{ ft})(6 \text{ ft})$
$= 27 \text{ sq ft}$

Area of door $= (6.5 \text{ ft})(3.5 \text{ ft})$
$= 22.75 \text{ sq ft}$

Area to be painted $= 416 - (27 + 22.75)$
$= 366.25$

The area to be painted is 366.25 sq ft.

A Practise

1. a) Use a personal referent to estimate the length and width of the rectangle in an appropriate unit.

b) Measure the length and width in inches to the nearest $\frac{1}{16}$ in.

c) What referent did you use in part a)? Justify your choice.

2. Convert each measurement to the unit indicated.

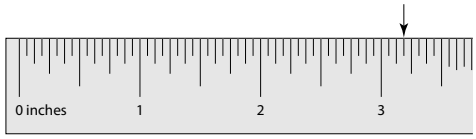
a) The circumference of a pipe is 1 ft 3 in. (nearest inch)

b) The Burj Khalifa in the United Arab Emirates is the world's tallest skyscraper, with a height of $905\frac{1}{3}$ yd. (nearest foot)

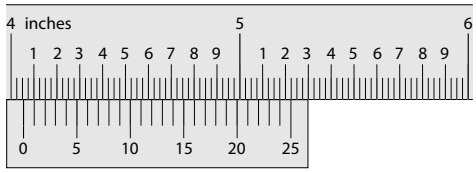
c) The elevation of Mount Robson is 12 972 ft. (nearest tenth of a mile)

3. What reading is shown on each measuring scale? For each measurement, name one item that might have this length.

a)



b)



4. Measure each item to the nearest sixteenth of an inch. What device did you use to measure? Explain your choice of measuring device.

a) length of your calculator

b) width of your calculator

c) depth of a key on your calculator

B Apply

☆5. A snow gauge is a funnel-shaped device to measure snowfall. The device collects falling snow, which is melted and measured. The amount of snowfall in inches is determined by measuring the depth of the water in inches and multiplying that value by 10.

a) A snow gauge gathered snow over a period of 12 h. The melted snow measured $1\frac{1}{2}$ in. What was the average snowfall per hour?

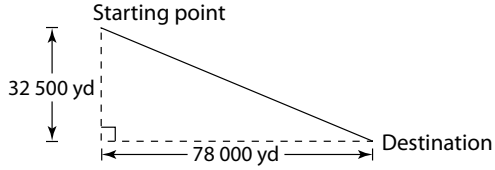
b) In an average ski season, a snow gauge in the Sunshine Village area in Banff National Park will measure 36 in. of water. What is the area's average annual snowfall? If the season lasts approximately six months, what is the average snowfall in inches per week?

6. A draftsperson wishes to produce a scale drawing of a house's floor plan. The actual dimensions of the house are to be 60 ft by 32 ft. The scale rate for the drawing is 1 in. represents 1.25 ft.

a) What is the scale ratio?

b) What are the dimensions of the scale drawing in inches?

☆7. Two snowmobilers leave the same place at the same time heading for the same destination, but take different routes. Josephine follows the trail indicated by dashed lines at a speed of 60 mph. Marcus follows the trail indicated by a solid line at a speed of 45 mph.



a) Who arrives first? Show calculations to justify your answer.

b) How much sooner, to the nearest minute, does the first rider reach the destination?

8. An inchworm is actually a caterpillar of the *Geometridae* moth family. Because an inchworm lacks appendages in the middle of its body, it moves in a looping gait. The inchworm's name describes the length of its smooth, hairless body. If an inchworm can travel the length of its body in 1 s, estimate and then calculate how long it would take to travel one mile. State your answer in seconds, minutes, and hours.

C Extend

9. Line segments MN and PQ are given below.

M _____ N

P _____ Q

a) PQ is longer than MN by ____ mm.

b) You have an unlimited supply of copies of MN and PQ, and are asked to build two lines the same length by placing your line segments end to end, using only one type in each line. What is the smallest number of MN and PQ pieces that you will need?

☆**10.** A new deck is to be 60 ft long by 10 ft wide. Boards of length 12 ft and width 8 in. are to form the surface of the deck with a space of one quarter of an inch between pairs of boards.

a) How many boards are needed? Explain your reasoning.

b) Will there be any wastage? If so, how much will there be?

11. Tabular icebergs have a flat table-top surface. Suppose a large tabular iceberg floating in the Antarctic Ocean has a length of 8480 yd. The iceberg's length to height ratio is 5 to 1 and 11% of its height extends above the water.

a) Calculate the height of the iceberg above sea level. State your answer in yards and in metres.

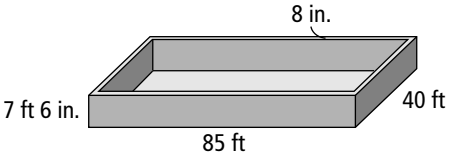
b) How far below sea level does the iceberg extend? Express your answer in yards and in metres.

D Create Connections

12. Concrete is measured and sold by the cubic yard.

a) To the nearest whole cubic yard, how much concrete is needed for the foundation of a rectangular building 40 ft by 85 ft if the foundation walls are 8 in. thick and 7 ft 6 in. high?

b) A contractor charges $1.25 per cubic foot to frame the foundation and pour the concrete. If the cost of the concrete is $200 per cubic yard, what is the total cost of the foundation?



13. In addition to the measurement units described in this section, the imperial system includes other units that came into common usage in the 16th century. These units include the hand, the rod, the chain, and the furlong. Using the stated conversion values, convert each measurement to the unit indicated.

1 hand = 4 in.
1 chain = 22 yd
1 rod = 5.5 yd
1 furlong = 10 chains
1 mi = 8 furlongs

a) 300 furlongs = _____mi

b) 20 hands = _____yd

c) 75 chains = _____mi

d) 15 rods = _____chains

e) 3 furlongs = _____ft

1.3 Converting Between SI and Imperial Systems

KEY IDEAS

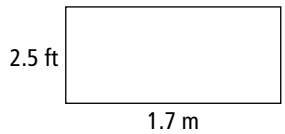
- When solving problems involving measurement, it is necessary to work with the same units.
- You may need to convert units from one measurement system to another.
- Conversion Chart

Imperial	Metric
1 in.	2.54 cm (0.254 m)
1 ft	0.3048 m (30.48 cm)
1 yd	0.9144 m (defined as an exact conversion)
1 mi	1.609 km

Metric	Imperial
1 mm	0.0394 in.
1 cm	0.3937 in.
1 m	3.281 ft (39.37 in. or 1.094 yd)
1 km	0.6214 mi (3 280.84 ft)

- Conversions can be made using unit analysis or proportional reasoning.

Determine the perimeter of the rectangle.



Use unit analysis to convert 1.7 m to feet.

$$1 \text{ m} = 3.281 \text{ ft}$$

$$(1.7 \text{ m})\left(\frac{3.281 \text{ ft}}{1 \text{ m}}\right) = 5.5777 \text{ ft}$$

Therefore, 1.7 m is approximately 5.58 ft.
The perimeter is:
$P = 2(2.5) + 2(5.58)$
$P = 16.16$
The perimeter of the rectangle is approximately 16.16 ft.

or

Use proportional reasoning to convert 2.5 ft to metres.
Let x represent the number of metres in 2.5 ft.

$$1 \text{ ft} = 0.3048 \text{ m}$$

$$\frac{1 \text{ ft}}{0.3048 \text{ m}} = \frac{2.5 \text{ ft}}{x}$$

$$x = 0.762$$

Therefore, 2.5 ft is approximately 0.76 m.
The perimeter is:
$P = 2(1.7) + 2(0.76)$
$P = 4.92$
The perimeter of the rectangle is approximately 4.92 m.

Example

The land speed record is the fastest speed achieved on land by any wheeled vehicle. A turbofan-powered car holds the current record. The car reached a speed of 766.609 mph for one mile, breaking the sound barrier.

a) Express the statement about the car's speed in kilometres per hour.

b) At 15°C, the speed of sound is 1116 ft/s. This speed is given a measurement called Mach 1. How many miles per hour above Mach 1 was the car's top speed? How many kilometres per hour above Mach 1 was that speed?

Solution

a) Convert 766.609 miles to kilometres using proportional reasoning.
1 mi = 1.609 km
Let x = the number of kilometres

$$\frac{1 \text{ mi}}{1.609 \text{ km}} = \frac{766.609 \text{ mi}}{x \text{ km}}$$

$$x \approx 1244.47 \text{ km}$$

Converting the measures to SI units, the statement would read: "The car reached a speed of 1244.47 km/h for 1.609 km, breaking the sound barrier."

b) Convert 1116 ft/s to miles per hour using proportional reasoning.
1 mi = 5280 ft and 1 h = 3600 s.
Let x = the number of feet in one hour or 3600 s.

$$\frac{1116 \text{ ft}}{1 \text{ s}} = \frac{x \text{ ft}}{3600 \text{ s}}$$

$$x = 4\,017\,600 \text{ ft}$$

Convert 4 017 600 ft to miles using unit analysis.
1 mi = 5280 ft

$$4\,017\,600 \text{ ft}\left(\frac{1 \text{ mi}}{5280 \text{ ft}}\right) = 760.91 \text{ mi}$$

Mach 1 is approximately 760.91 mph.
Therefore, the car exceeded Mach 1 by (766.609 mph − 760.91 mph) or 5.699 mph.
Convert 5.699 mi to kilometres using unit analysis.
1 mi = 1.609 km

$$5.699 \text{ mi}\left(\frac{1.609 \text{ km}}{1 \text{ mi}}\right) = 9.170 \text{ km}$$

The top speed of the car exceeded Mach 1 by 9.170 km/h.

A Practise

1. Use your referent for an inch to estimate the total length of each line.

a) _____

b) _____

2. Measure each of the lines in question 1. Express answers to the nearest eighth of an inch.

3. Use the following segment to complete parts a), b), and c).

X ——————————— Y

a) Measure segment XY to the nearest millimetre.

b) Measure segment XY to the nearest $\frac{1}{16}$ in.

c) Convert the answer in part a) to inches. Compare the conversion to your answer in part b). Are the answers the same? If not, explain a reason for the difference.

4. Convert each unit to the unit specified.

a) The average growth rate for a teenage boy can be as high as $4\frac{1}{4}$ in. per year. (millimetre)

b) The official distance of a marathon is 26 mi 385 yd. (hundredth of a kilometre)

c) The length of a basketball court is 28.65 m. (tenth of a foot)

d) The height of the model Easter egg in Vegreville, Alberta, is 163.2 in. (tenth of a centimetre)

5. The table lists tourist attractions in Saskatchewan. Complete the missing size for each item. Choose an appropriate unit for the conversion.

	Attraction	Size in SI	Size in Imperial
a)	Surveyor	height: 3.7 m	
b)	Tomahawk and Teepee		height: 39.4′
c)	Whooping Crane	wingspan: 2100 cm	
d)	Mac the Moose		height: 384″
e)	Wheat	height: 13.1 m	

B Apply

☆**6.** In a triathlon, competitors swim for 1.5 km, run a distance that is $6\frac{2}{3}$ times the length of the swim, and ride a bike for a distance that is 4 times the length of the run.

a) Compute the length of each part of the triathlon to the nearest tenth of a kilometre.

b) Compute the length of each part of the triathlon to the nearest tenth of a mile.

c) What is the total distance of the competition in kilometres? in miles?

7. Use the list of rivers below that flow into the Arctic Ocean to answer the questions.

River	Length
Liard	1 019 556 yd
Smoky	492 000 m
Athabasca	1231 km
Peace	1195 mi

a) Which river is longest?

b) What is the total length, in kilometres, of the four rivers?

c) How many times longer is the longest river than the shortest river?

☆**8.** Molly purchased a pattern to make a coat. The pattern gives the measurements for the amount of material needed in imperial units for two widths of fabric. The coat requires 2 yd of fabric 45″ wide, or $1\frac{3}{4}$ yd of fabric 60″ wide.

a) Convert the measurements to SI units.

b) If Molly chooses the first width, how many square metres of fabric will she buy? What is the area of the wider material? How do the two areas compare? Which width would you choose to end up with a lesser amount of fabric left over?

9. The relay that crisscrossed Canada to bring the torch to Vancouver for the 2010 Olympic Winter Games covered a total distance of approximately 28 000 mi. Torch bearers carried the flame for about 2240 of those miles.

a) If each person in the relay carried the torch for 300 m, approximately how many people took part?

b) The relay started in Victoria on October 30, 2009, and ended in Vancouver on February 12, 2010. Approximately how far, to the nearest kilometre, was the torch carried each day? What assumptions are you making?

C Extend

☆**10.** Savario is driving to Brandon, Manitoba, at a fairly constant speed. At 4:30 p.m., he is 240 km from his destination. At 7:00 p.m., he passes an old highway sign that gives the distance to Brandon as 25 mi. If Savario continues at the same rate of speed, will he arrive by 7:30 p.m.? If not, when will he arrive? What assumptions must you make?

11. a) Your cousins from the United States are driving to visit you in St. Walburg, Saskatchewan. The speedometer in their vehicle shows that they are travelling at 53 mph along a secondary road. Are they within the speed limit if the posted maximum speed is 80 km/h?

b) The route your cousins are taking includes a stretch of four-lane highway where the maximum speed limit is 110 km/h. What will their speed be in miles per hour if they drive at the limit?

c) Your cousins call you when they reach Turtleford. You tell them they are only 34 km from St. Walburg. How long will it take them to drive the remaining distance if they travel at an average speed of 45 mph?

d) Show how you can use mental mathematics to verify the reasonableness of your response in part a).

12. The screen of a cell phone measures 3.84 cm × 2.88 cm.

a) What is the area of the screen in square millimetres? in square inches?

b) If the screen has a resolution of 160 pixels × 120 pixels, what is the size of a pixel in square millimetres? in square inches?

D Create Connections

13. The adult height of a girl can be predicted using the formula:

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

where the height of each parent is given in inches.

A boy's adult height can be predicted using the formula:

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

where the height of each parent is given in inches.

a) Suppose your father's height is 6 ft and your mother's height is 5 ft 5 in. Use the appropriate formula to predict your height as an adult measured in inches.

b) Convert the formula you used to work with SI units. Predict your height as an adult in SI units.

14. Using the conversion factor 1 ft = 30.48 cm, show how to convert from a large imperial unit to a smaller SI unit.

Chapter 1 Review

1.1 SI Measurement

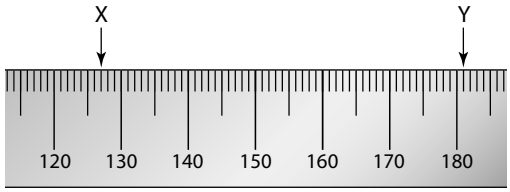
1. Use a personal referent to estimate the diameter of a cylindrical can. Mark off a distance of 2 m on the floor.

a) Predict how many times the can will rotate to roll the distance of 2 m.

b) Measure the diameter of the can and calculate how many times it will roll.

c) Try rolling the can and counting the rotations. Compare your count to your answers in parts a) and b). How do they compare?

2. Determine the distance from X to Y on this SI ruler. Express your answer to the nearest tenth of a centimetre.



3. Explain how to make a reading using an SI caliper. Draw a diagram to support your explanation.

☆**4.** Montgomery ran 100 m in 9.78 s. What was the runner's speed in kilometres per hour?

☆**5.** Radio waves in a vacuum travel a distance equal to seven times the circumference of Earth in 1 s. If the radius of Earth is 6 318 138.7 m, what is the speed of the radio waves in kilometres per hour?

1.2 Imperial Measurement

6. Use your personal referent for an inch to estimate the length and width of your textbook in inches. Measure the length and width using an imperial ruler. Express your answer as a mixed number in simplest form.

7. The greatest rainfall within a 24-hour period occurred in a region of the Indian Ocean. The amount measured was 6′ 1″. Assuming the rain fell at a constant rate, what was the rate in inches per hour?

☆**8.** A 4″ by 6″ photograph is to be enlarged to fit a 16″ by 20″ frame. Is it possible to make the enlargement without distorting or omitting part of the original image? Show your thinking. If it is not possible, determine a frame size that would hold an enlargement of the photograph without distortion.

9. The height of a microwave tower is 210′. A series of platforms and ladders are installed to allow access to the top. A platform is located every 30′ and rungs on the ladders are 12″ apart.

a) How many platforms are there? How many ladder rungs are there? What assumptions did you make?

b) Once a platform is reached, it is necessary to take three steps to reach the next ladder. Including steps on each ladder, how many steps must be taken to reach the top of the tower? What assumptions did you make?

☆**10.** Drywall is to be used to cover the walls and ceiling of a bedroom. The room is 20′ long by 15′ wide by 10′ high.

a) Drywall is sold in sheets sized 4′ by 6′, 4′ by 10′, and 4′ by 12′. Which sheet size would be most suitable for the room?

b) Guidelines for buying drywall recommend that you increase the required amount by 5% to allow for waste, deduct one third of a sheet for each door, and deduct one quarter of a sheet for each window. Using the sheet size from part a), compute how many sheets are needed for the walls and ceiling if the room has two doors and one window.

1.3 Converting Between SI and Imperial Systems

11. Convert each unit to the unit specified.

a) The men's record for javelin throw is 323′ 1″. (hundredth of metre)

b) The fastest land mammal is the cheetah, with a speed of 101 km/h. (miles per hour)

c) A spool contains 274 m of thread. (feet)

12. The fastest time for a 440-yd drag bike race is 7.05 s. Discounting acceleration at the start of the race, what average speed did this bike maintain

a) in kilometres per hour?

b) in miles per hour?

13. Bethany and Matt travel with their families to Calgary, AB, for the Calgary Stampede. When the friends arrive, they compare how far they travelled.

- Bethany lives in Conrad, Montana, and travelled 227 mi.
- Matt lives in North Battleford, SK, and travelled 439 km.

a) Bethany is not familiar with SI distances. Explain how to determine the approximate conversion from kilometres to miles.

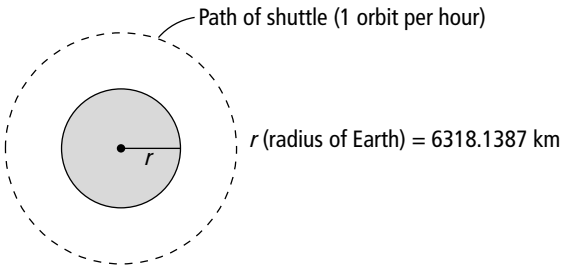
b) Who travelled the greater distance?

14. You are hiking in Banff National Park from Lake Louise to the Plain of Six Glaciers. The trail is 5.5 km in length.

a) How long will it take to reach the plain if you are walking at a speed of 2 mph?

b) The vertical climb along the trail is 370 m. If Lake Louise is 5675 ft above sea level, what is the elevation at the upper end of the trail? Express your answer in meters and in feet?

☆**15.** If a space shuttle makes one complete orbit of Earth at a rate of 25 500 mph in a time of 1 h, how far above Earth is the ship orbiting in miles? in kilometres? (Use 6318.1387 km as the radius of Earth.)



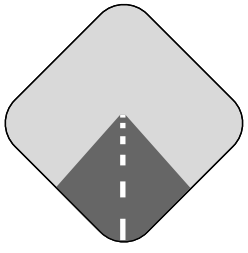
16. The passing lines on a highway consist of dashed yellow-painted segments, alternating with unpainted sections. A 13-m stretch of road that begins and ends with painted sections contains five painted segments. The length of each painted segment is 1.8 times the length of each unpainted segment.

a) How many painted segments are there in a 1-km stretch of highway?

b) What is the length of each painted segment in centimetres?

c) How many painted segments are there in a 1-mi stretch of highway?

d) What is the length of each painted segment in inches?

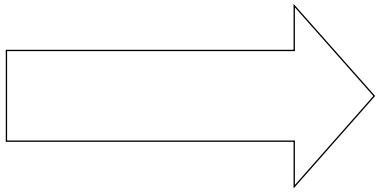


e) Show how you can use mental mathematics to show the reasonableness of your answer to part d).

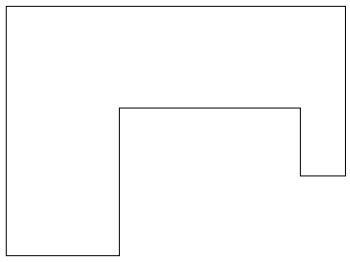
Chapter 1 Cumulative Review

1. Use a personal referent to estimate the perimeter of each figure in an appropriate SI unit.

a)



b)



2. Measure the perimeter of each figure in question 1. Convert each measurement into an appropriate imperial unit. Justify your choice of unit.

3. Convert each measurement to the unit specified.

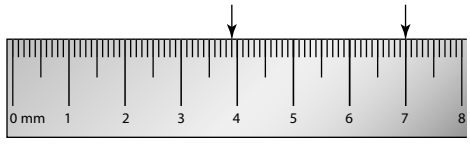
a) The thickness of a penny is 0.06 in. (hundredth of a millimetre)

b) The length of a CFL football field is 137.16 m. (feet)

c) The length of the West Coast Trail in British Columbia is 46 mi 1061 yd. (hundredth of a kilometre)

d) A computer speaker has a height of $8\frac{3}{4}$ in. (hundredth of a centimetre)

4. Determine the distance from A to B on this SI ruler. Express your answer to the nearest tenth of a centimetre.



a) What is the reading in SI units?

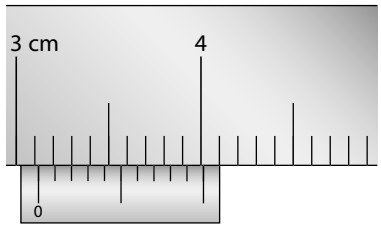
b) What is the reading in imperial units?

c) Name an object that could be this length.

5. **a)** The Calgary Tower is 626 ft $\frac{1}{5}$ in. Suppose the tower's height is stated to be 191 m. Would this be an approximate or an exact measurement? Justify your answer.

b) If the height of the tower in a photograph is 4.6 cm, by what scale factor has the picture been reduced?

6. **a)** What is the reading on this SI caliper? Name an object that could be this length.



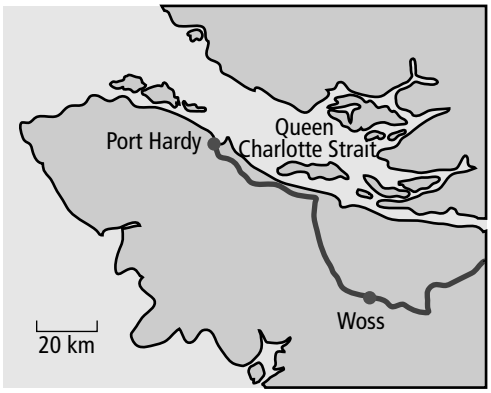
b) Estimate and then calculate the equivalent measurement in the imperial system.

c) Use unit analysis to verify your answer to part b).

7. Read the following paragraph about Mount Logan. Convert each SI measurement to an equivalent imperial measurement. Round to the nearest unit.

Mount Logan is the highest mountain in Canada. Mount Logan is located within Kluane National Park and Reserve in southwestern Yukon. Due to active tectonic uplifting, Mount Logan is still rising in elevation. Before 1992, the exact height of Mount Logan was unknown and measurements ranged from 5959 m to 6050 m. In May 1992, an expedition climbed Mount Logan and fixed the current height of 5959 m. Minimal snow melt leads to a significant ice cap, reaching almost 300 m in certain spots.

8. Use the map of Vancouver Island to help answer the following questions.

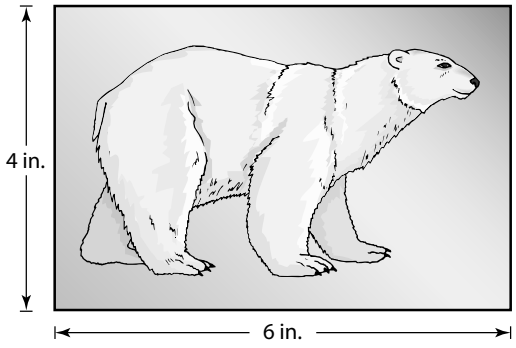


a) Express the scale of the map as a ratio in lowest terms.

b) How many kilometres are represented by 1 cm?

c) Estimate the distance from Woss to Port Hardy.

9. Chelsea wants to enlarge this 4″ by 6″ picture to fit into a 9″ by 12″ frame.



a) Can the photograph be enlarged proportionately to fill the new frame? Explain using measurements and ratios.

b) If not, which frame size would work so that the picture would not need to be cropped? 5″ by 7″, 8″ by 10″, $8\frac{1}{2}$″ by 11″, 11″ by 14″, 10″ by 15″, 14″ by 18″, 16″ by 20″

10. Jason wants to build a trundle wheel. He wants the wheel to go around once for every 50 cm the trundle is pushed. What will be the radius of his trundle wheel? Round your answer to the nearest hundredth of a centimetre.

11. Jeremy wants to lay laminate flooring in his room. The room measures 9 ft by $11\frac{1}{4}$ ft.

a) What is the area that needs to be covered?

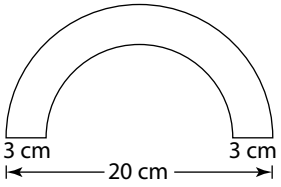
b) The laminate Jeremy selects is $4\frac{1}{2}$ ft by 4 in. How many pieces of laminate are needed to cover his bedroom floor?

c) If the laminate costs $4.59 per square foot, how much will it cost to cover the room?

12. a) The Grand Canyon in Arizona is 6000 ft deep at its deepest point. At Hell's Gate, near Boston Bar, British Columbia, the Fraser Canyon's walls rise about 1000 m. Compare the depth of the Grand Canyon with the depth of the Fraser Canyon at Hell's Gate. Which canyon is deeper, and by how much? Give your answer to the nearest tenth of a metre.

b) Use another method to verify your answer to part a).

13. a) Calculate the perimeter of the following figure. Express your answer to the nearest quarter of an inch.



b) Show how you can use mental mathematics to check the reasonableness of your answer to part a).

Chapter 1 Extend It Further

1. How many metres are there in 0.74 km 36 m 79 cm?

A 117.9 m **B** 189 m

C 776.79 m **D** 783.9 m

2. Which of the following is the smallest measurement?

A 1 m 56 cm **B** 149 cm

C 0.001 09 km **D** 0.0099 km

3. _____ is longer than 16 feet 7 inches by 8 yards 2 feet and 9 inches.

A 12 yards 2 feet 4 inches

B 13 yards 4 feet 4 inches

C 14 yards 1 foot 4 inches

D 24 yards 2 feet 4 inches

4. Peter ran a distance of 3 km 435 m in 12 min 30 s. What is his speed in metres per second?

A 4.58 m/s **B** 5.12 m/s

C 5.34 m/s **D** 6.14 m/s

5. To commemorate the 1996 Olympic Summer Games in Atlanta, Georgia, a company made a hot dog that was 1996 feet long. About how many regular-sized (15-cm) hot dogs could be made from the large hot dog?

A 3992 **B** 4014

C 4023 **D** 4055

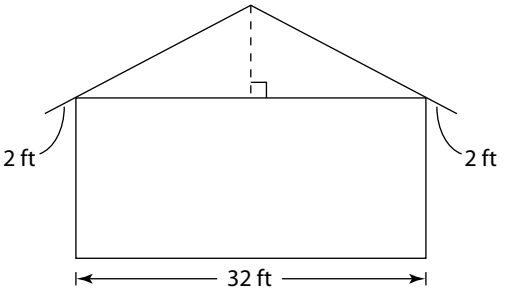
6. A marathon is a long-distance foot race with an official distance of 42.196 km.

a) Express the distance in terms of miles and yards.

b) For a marathon course to be certified, the length must not be less than 42.195 km and the uncertainty in measurement shall not exceed 0.1%. Express the length in metres as well as in feet.

7. A 2″ by 4″ by 8′ piece of lumber is actually 1.5″ by 3.5″ by 8′. Each cut from a table saw will remove $\frac{1}{8}''$ of wood. You need to cut smaller pieces that are 1.5′ long. How many smaller pieces at most can be cut from a single piece of lumber?

8. The incline on the roof of a house is 8 : 12. This means that for every 8 units of vertical change there are 12 units of horizontal change. The width of a house is 32 ft. How many yards of trim are needed on the roof ends, which have an overhang of 2 ft?



9. George is taller than Mandy by 8 cm. Mandy is shorter than Cindy by 3 in. Who is taller, Cindy or George? by how much? Justify your choice of unit.

10. A decorative block is about 7 in. high. A section of a garden retaining wall is 8 blocks high with 2.5 blocks covered by soil. Measured in feet and inches, how high is the retaining wall above ground?

11. Calculate the total cost of material for the three suits including any retail sales tax in your province or territory.

Suit 1: fabric – 3 yd at $4.50/yd with 40% off

Suit 2: first fabric – 1 yd at $4.50/yd; second fabric – 2 yd at $8.50/yd; lining – 2 yd at $2.00/yd

Suit 3: fabric – 3 yd at $8.00/yd with 25% off

Chapter 1 Study Check

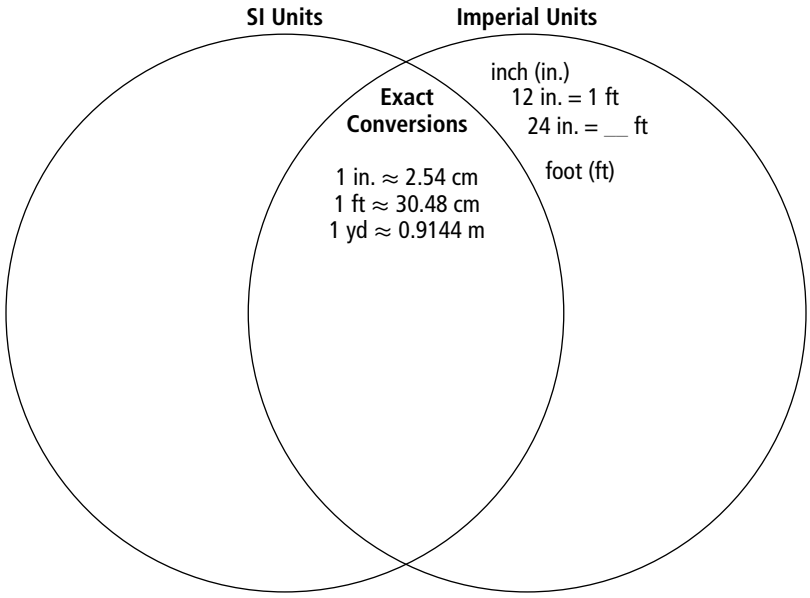
Use the chart below to help you assess the skills and processes you have developed during Chapter 1. The references in italics direct you to pages in *Mathematics 10 Exercise and Homework Book* where you could review the skill. How can you show that you have gained each skill? What can you do to improve?

Big Idea	Skills	This Shows I Know	This Is How I Can Improve
Solve linear measurement problems involving SI and imperial units of measure, estimation, and measurement *pages 1–8, 11, 13, 15–16*	✓ Provide referents for linear measurements *pages 3–4, 6–7, 13, 15*	Example: page 3, #1	Example: I need to review personal referents for imperial units
	✓ Use a referent to estimate a linear measurement and justify the choice of units *pages 3–4, 6–7, 13, 15*		
	✓ Choose and use instruments such as rulers, calipers, or tape measures to complete linear measurements *pages 3–4, 6–8, 11, 13, 15–16*		
	✓ Choose and justify units to use for a linear measurement *pages 3–4, 7–8, 11–13, 15, 17*		
Apply proportional reasoning to convert between SI and imperial units of measure in order to solve problems *pages 9–12, 14–17*	✓ Convert within and between SI and imperial units of measurement *pages 11–12, 14–17*		
	✓ Use mental math to check the reasonableness of conversion results *pages 11–12, 14–16*		
	✓ Use unit analysis to verify conversion results *pages 11–12, 14–16*		

Organizing the Ideas

In the Venn diagram below, show the common linear units of measure in each system. Show how to convert from one unit to another within each system. One example is provided.

How can you use this Venn diagram to help you convert from SI units to imperial? from imperial units to SI?



Study Guide

Review the types of problems you handled in Chapter 1. What do you need to remember to help you do similar problems?

Things to Remember

Perimeter Problems

Speed Problems

Working With Scale