

Math at Work 10: Chapter 2

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2

Measuring Length



Danny fishes on the Grand Banks. His work often involves estimating and measuring length and distance. Danny says that his ability to “eyeball measurements” is as important as his ability to measure with accuracy.

1. What activities do you see that might involve length measurements?
2. What kinds of estimates might Danny make on the job?
3. What kinds of accurate length measurements might Danny take on the job?
4. What other jobs or careers requires these skills?

Key Words

inch
foot
yard
perimeter
dimensions
diameter
circumference

Career Link

Brenda is a professional tailor who repairs and makes clothing. She enjoys using patterns to make clothing from a variety of fabrics, including leather and fur. Her work often involves estimating and making precise measurements.



Multiplication Patterns

- Write each amount in dollar notation.
 - 75¢
 - 30¢
 - 5¢
 - 138¢
- Express each amount in cents.
 - \$0.99
 - \$3.49
 - \$0.07
 - \$0.50
- What is the rule for converting from cents to dollars?
 - What is the rule for converting from dollars to cents?
- Evaluate without using a calculator.
 - 14×1
 - 14×10
 - 14×100
 - 14×1000
- Describe a pattern when multiplying by 10, 100, or 1000.
 - Explain to a classmate how to mentally determine $346 \times 10\,000$.
 - Ask your classmate to explain how to mentally determine $22 \times 100\,000$.
- Evaluate without using a calculator.
 - 0.355×1000
 - 1.89×1000
 - 0.75×100
 - 2.63×100
- The sign at a gasoline station shows the price per litre as 122.8. How much would you pay for each amount of gasoline?
 - 1 L
 - 2 L
 - 10 L
 - 20 L
 - 100 L
 - 200 L

Division Patterns

- Evaluate without using a calculator.
 - $26\,000 \div 1$
 - $26\,000 \div 10$
 - $26\,000 \div 100$
 - $26\,000 \div 1000$
- Describe a pattern when dividing by 10, 100, or 1000.
 - Explain to a classmate how to mentally determine $700\,000 \div 100\,000$.
 - Ask your classmate to explain how to mentally determine $1\,600\,000 \div 100\,000$.
- Evaluate without using a calculator.
 - $473 \div 1$
 - $473 \div 10$
 - $473 \div 100$
 - $473 \div 1000$

Unit Price

- Determine the better buy: 250 mL for \$1.99 or 2 L for \$9.99.
 - Explain your answer to part a).

Work With Multiples

- List the multiples of 12 between 0 and 120.

A multiple is the product of a given number and a number like 1, 2, 3, and so on.

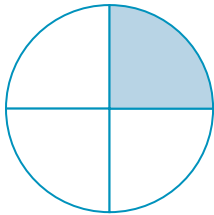
- List the multiples of 6 between 0 and 60.
- Explain why some answers in parts a) and b) are the same.

13. List two different pairs of numbers, other than 12 and 1, whose product is 12.

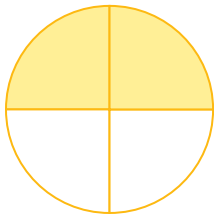
Fractions

14. Express the shaded part of each circle as a fraction.

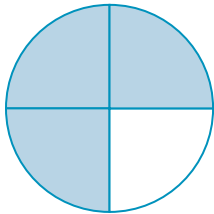
a)



b)



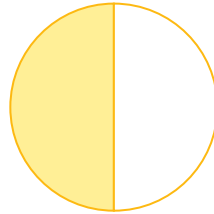
c)



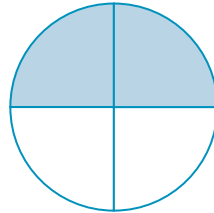
15. a) What is half of one half?
 b) What is half of one quarter?
 c) What is half of one eighth?
 d) What are the next two fractions in the pattern?
16. One bottle contains 500 mL of water. How many litres of water are there in a pack of 35 bottles?

17. Express the shaded part of each circle as a fraction.

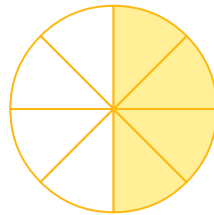
a)



b)



c)



- d) State three other fractions that are equivalent to the fractions above.

Decimals and Fractions

18. Express the shaded part of each bar as a fraction and as a decimal.

a)



b)



c)



d)



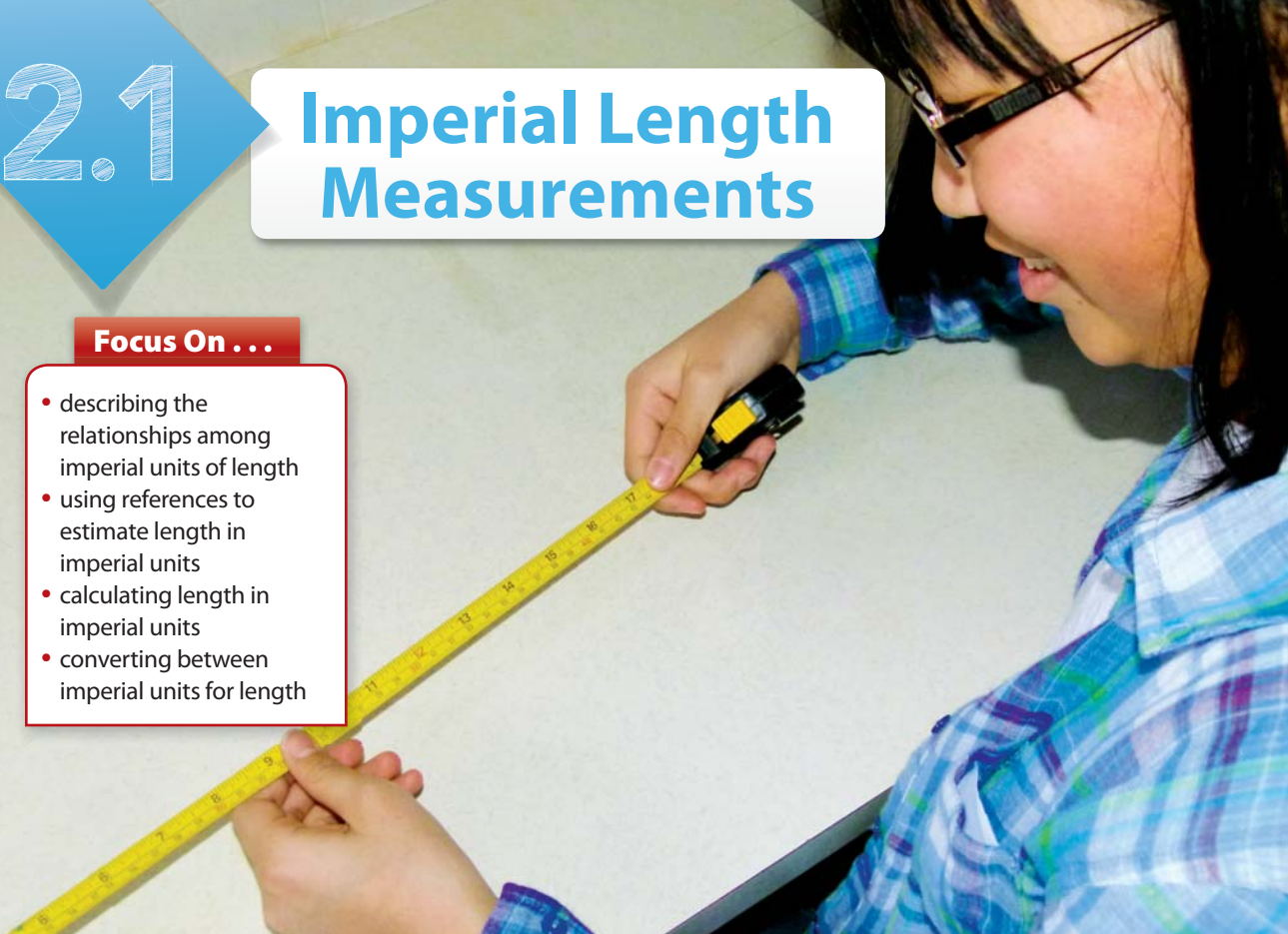
19. One fraction in #18 can be expressed in lower terms. Which one is it? Express this fraction in lowest terms.

2.1

Imperial Length Measurements

Focus On ...

- describing the relationships among imperial units of length
- using references to estimate length in imperial units
- calculating length in imperial units
- converting between imperial units for length



Canadians learn SI measurements at school. But many people know their height and weight only in the imperial system. Where else have you used imperial units?

Explore Imperial Lengths

Materials

- measuring tape

inch

- a unit of length in the imperial system
- 12 inches = 1 foot
- the abbreviation is in. or "

Use a measuring tape to explore imperial units.

Part 1: The Inch and Beyond

1. a) Extend a measuring tape across your desk. Use the tape lock to keep the tape from retracting.

Notice that one side of the tape, usually the top numbers, measures inches.

The other side of the tape, usually the bottom numbers, measures centimetres.

b) Why is the 12 on the measuring tape coloured red?



foot

- the basic unit of length in the imperial system
- the abbreviation is ft or '

yard

- a unit of length in the imperial system
- 1 yard = 3 feet
- the abbreviation is yd

F.Y.I.

The abbreviation for mile is mi.

12 inches is 1 **foot**.

- c) Extend the measuring tape to 2 feet. How many inches is this?
d) Extend the measuring tape to 3 feet. How many inches is this?

3 feet is equal to 1 **yard**.
In football, distances are measured in yards.

2. **Reflect** Without extending the measuring tape any farther, answer the following questions.

- a) How many inches are in 4 feet?
b) How many inches are in 5 ft?
c) How many inches are in 6'?

3. **Extend Your Understanding** The imperial unit for measuring long distances is the mile. One mile is 1760 yards.

- a) How many feet are in 1 mi?
b) How many inches are in 1 mi?

Part 2: Fractions of an Inch

4. Extend a measuring tape so that you can see inches 13 and 14. Lock the measuring tape so it does not retract.



5. a) Locate the point halfway between the marks for 13 in. and 14 in. Notice the length of the mark at this point. How does this mark compare to the length of the mark at 14 inches?
b) Express the distance covered by each bracket in the photo above as a fraction of one inch.

6. a) Locate the point halfway between the marks for 13 in. and $13\frac{1}{2}$ in.
 b) Express this distance as a fraction of one inch.



- c) How many of these distances does it take to make 1 full inch?
 d) Notice the length of the mark at this point. How does this mark compare to the length of the mark at 13 inches? at $13\frac{1}{2}$ inches?
 e) What is the measure of the other mark within this inch that is the same length?
7. a) Locate the point halfway between the marks for 13 in. and $13\frac{1}{4}$ in.
 b) Express this distance as a fraction of one inch.
 c) How many of these distances does it take to make 1 full inch?
 d) Notice the length of the mark at this point. How does this mark compare to the length of the other marks that you have looked at?
 e) What are the measures of the other marks within this inch that are the same length?
8. a) Locate the point halfway between the marks for 13 in. and $13\frac{1}{8}$ in.
 b) Express this distance as a fraction of one inch.
 c) How many of these distances does it take to make 1 full inch?
 d) Notice the length of the mark at this point. How does this mark compare to the length of the other marks that you have looked at?
 e) What are the measures of the other marks within this inch that are the same length?
9. **Reflect** Why do the lengths $\frac{2}{16}$ ", $\frac{4}{16}$ ", and $\frac{8}{16}$ " have different marks than the mark for $\frac{1}{16}$ " ?
10. **Extend Your Understanding** The first 6 in. on most measuring tapes are divided into even smaller units.
 a) What is the smallest division within the first 6 in. of your measuring tape?
 b) Express the smallest unit as a fraction of an inch.

On the Job 1

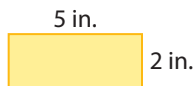
Add Imperial Lengths

Tim is setting up a temporary fence around a building site. How many feet of fencing does he need for a site that is 31 ft 3 in. by 29 ft 8 in.? Round your answer to the nearest foot.



perimeter

- the distance around the outside of an object
- the abbreviation is P



The perimeter of the rectangle is $2 + 5 + 2 + 5$, or 14 in.

dimensions

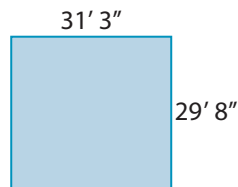
- measurements such as the length, width, and height of an object

Solution

Tim decides to calculate the **perimeter** of the building site.

He adds the **dimensions** of the four sides of the site.

$$\begin{array}{r} 31 \quad 3 \\ 29 \quad 8 \\ 31 \quad 3 \\ \hline 120 \quad 22 \end{array}$$



$$12'' = 1'$$

$$22'' = 1' 10''$$

$$P = 120' + 1' 10''$$

$$P = 121 \text{ ft } 10 \text{ in.}$$

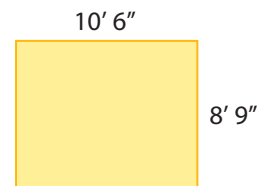
Tim will need to buy at least 122 feet of fencing.

Estimate using mental math:
 $30 \times 4 = 120$
The perimeter is about 120 ft.

Tim compared his estimate and calculation.
The answer is reasonable.

Your Turn

Julie wants to put a wallpaper border around the walls of her bedroom. The bedroom measures 10' 6" by 8' 9". Estimate and then calculate the perimeter of the room.



Check Your Understanding

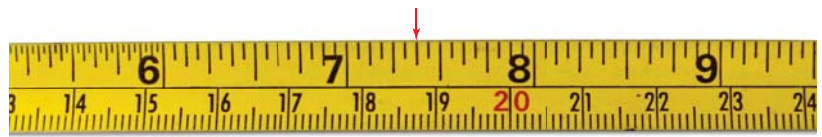
Try It

1. Estimate, and then measure, any four items from the list.
Round each measurement to the nearest foot.
 - a) the height of the classroom door
 - b) the length of a three-ring binder
 - c) the length of your shoe
 - d) the width of a recycling bin
 - e) the length of a metre stick
2. Measure any four items from the list, to the nearest inch.
 - a) a classmate's height
 - b) the height of your desk
 - c) the width of a classroom window
 - d) the height of an electrical outlet
 - e) the height of a light switch
 - f) the width of the classroom door
 - g) the height of the seat of your chair
 - h) the width of a display board in your school
3. Express each measurement in #2 as a combination of feet and inches. Example: 19" can be expressed as 1' 7".
4. Express each answer in feet and inches.
 - a) 8 in. + 9 in.
 - b) 10" + 11"
 - c) 2' 10" + 3'
 - d) (6 ft 8 in.) \times 2
5. Give the distance from the beginning of the measuring tape to the red arrow.
 - a)



6. What is the distance from the beginning of the measuring tape to the red arrow?

a)



b)



c)



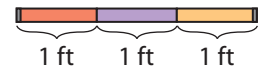
d)



7. List the basic units of imperial measurement from shortest to longest length.

Apply It

8. a) Extend a measuring tape to 3 feet.



- b) Estimate the width of your classroom in yards. Explain your reasoning.

9. In football, a team earns a “first down” when it advances the ball 10 yd toward the opposing team’s goal line.
- a) How many feet are in 10 yards?
- b) A football team advances the ball 8 yards. Extend a measuring tape to show the distance needed to earn a first down.
10. Phil is installing baseboard along four walls in a living room. He measures the length and width of the room to be approximately 14 ft by 11 ft.
- a) Sketch the floor plan of the room. Include a door that is 3 ft wide. Label all the given measures.
- b) What is the total length of baseboard needed?
- c) Baseboard is sold in lengths of 8 ft and 12 ft. Give two combinations of baseboard that Phil can buy.

Baseboard is not installed along the door.

On the Job 2

Develop and Use Imperial Measurement References

Ryan recently got a part-time job at a local home improvement store. Some items are sold in imperial units while other items are sold in SI units. Sometimes Ryan helps customers by measuring materials. At other times, his job requires him to estimate lengths.

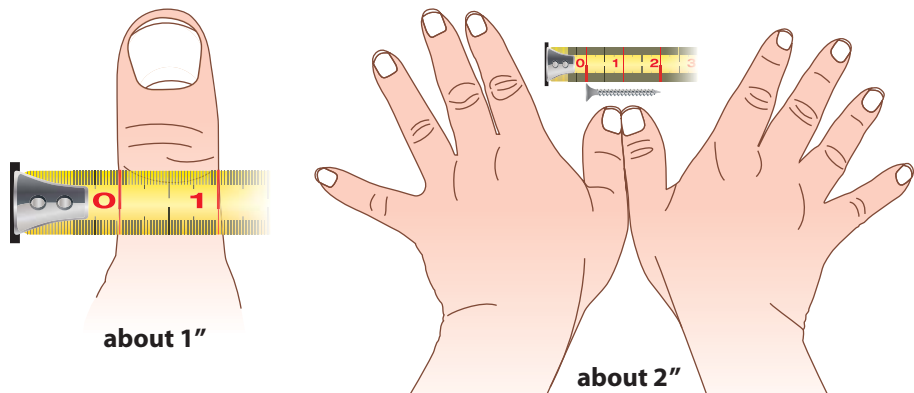
A customer has a wood screw. She wants a box of screws the same size. How can Ryan estimate the length of the screw so he can search for an exact match?



Solution

Ryan knows that it is easier to estimate a length using a “personal reference.” Using a measuring tape, Ryan has developed several personal references for imperial units.

The width of his thumb is close to 1 in.



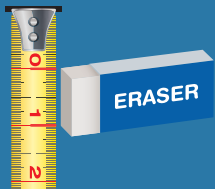
The length of the screw is about two of Ryan’s thumb widths.

Therefore, he estimates that the wood screw is about 2 in. long.

Ryan uses his estimate to begin searching the bin that contains 2-in. wood screws.

F.Y.I.

A “personal reference” can be used to estimate the length of imperial units. A reference can be a part of the body or an object. For example, the width of the eraser is close to 1 in.



Your Turn

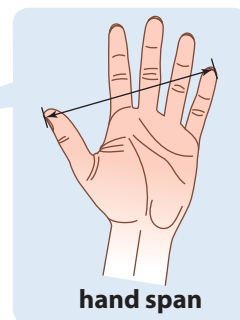
Develop a set of personal references that you can use to approximate imperial lengths.

- a) Use a ruler and a measuring tape. What could you use as a personal reference for each measurement? Record your answers in a table similar to this one.

Measurement	Reference
1 inch	
2 inches	
1 foot	
2 feet	
3 feet	

- b) You can use parts of the body as references for measuring length. Work with a partner. Measure each reference. Record your answers in a table similar to this one.

Reference	Measurement
My hand span	
My arm span	
My foot length	
My height	
My stride length	



Your stride is the distance between your heels when you take a step while walking.

Measure your height in inches, or in feet and inches.

F.Y.I.

When fishers measure rope length, they use their arm span to approximate 1 fathom. One fathom is about 6 ft.

arm span

- c) You can use objects at school or at home as references for measuring length. Work with a partner. Measure as many of the following items as possible. Record your answers in a table similar to this one.

Reference	Measurement
Length and width of a floor tile	
Length and width of a ceiling tile	
Height of a door	
Height of a table	
Height of a ceiling	

Check Your Understanding

Try It

1. Use your personal reference for 1 in. to approximate each length.
 - a) the width of this book
 - b) the length of an eyeglass case
 - c) the length of a pencil
 - d) the width of a calculator
2. Measure each item in #1. How close were your approximations to the actual measurements?
3. Use your personal reference for 1 ft to estimate each of the following lengths.
 - a) the width of a desk
 - b) the height of an electrical outlet
 - c) the width of the classroom door
 - d) the height of a light switch
4. You may have measured some of the items in #3 already. If not, measure each item now. How close were your estimates to the actual measurements?
5. Use measurement references to approximate each distance.
 - a) the length of a hallway at school
 - b) the length of a car
 - c) the length of a gym or other large room in the school
6.
 - a) Estimate the perimeter of the figure using an appropriate imperial unit.



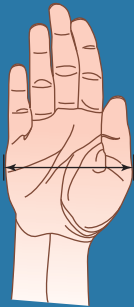
- b) Measure the perimeter.
- c) How close was your estimate to the actual perimeter?

F.Y.I.

The forearm is the part of the arm between the elbow and the wrist.

**F.Y.I.**

A “hand” represents the width of the palm. It may include the thumb.

**Tools of the Trade**

Sheet metal workers measure and cut sheet metal using power tools or by hand. They use metalworking machines to cut, punch, or straighten sheet metal. To learn more about sheet metal workers, go to www.mhrmathatwork10.ca and follow the links.

Apply It

7. Charlotte uses her forearm as a reference for 1 foot. Using her forearm, estimate the width of the table.



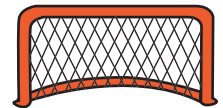
8. Estimate, to the nearest foot, the perimeter of your classroom.
9. People often use parts of the body for measuring length. For example, the height of a horse is often stated by the number of “hands.” One hand is the equivalent of 4 in. Work with a partner.

- a) Estimate and then measure the span of your hand.
- b) How many of your hand spans are needed to measure the length of your desk?
- c) Estimate and then measure your stride. To be more accurate, measure 10 strides and calculate the average distance.
- d) How many of your strides would it take to walk a mile?

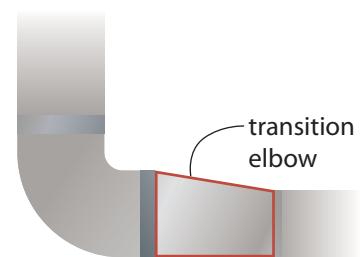
The average distance is the sum of the measures divided by 10.

$$1 \text{ mi} = 5280 \text{ ft}$$

10. A hockey net is 6' wide. How could you use personal references to mark off a width of approximately 6 ft?



11. George is a sheet metal worker and is installing ducts for a new furnace. He needs to install a piece to connect two different sizes of ducts. He measures the distance between the two ducts shown as $6\frac{5}{16}$ ''.



- a) Draw a line $6\frac{5}{16}$ '' long.
- b) George plans to cut the piece just a little bit longer than $6\frac{5}{16}$ '' to ensure a proper fit. He can trim the piece when he is installing it. How long should he cut the piece? Explain your reasoning.

Work With It

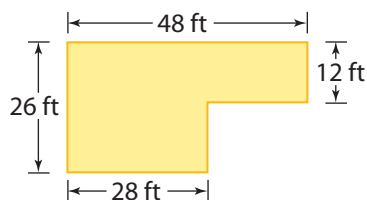
1. Judy works in a shop that replaces and repairs exhaust systems on vehicles. A certain exhaust pipe needs to be cut to a length of $17\frac{3}{4}$ ". Extend a measuring tape and lock it at this length. Compare your measurement with the one of a classmate. Are they the same? Explain.

2. Wood trim goes around three sides of a door opening.
 - a) Use personal references to estimate the height and width of a door.
 - b) What is your estimate of the total length of trim needed?
 - c) Wood trim is sold in 8-ft and 12-ft lengths. How much trim would you buy?



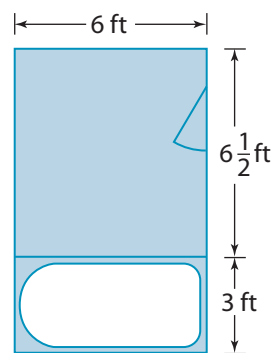
3. A carpenter is framing the outside walls of a building. How many studs will he need to frame the walls, if he uses 1 stud every 2 ft? Use the formula to estimate the number of studs. Add one end stud for each wall.

$$\text{Number of studs for a wall} = \frac{\text{length}}{2} + 1$$



4. Diego is calculating the perimeter of his bathroom floor. He plans to install tiles along the base of the walls that do not include the bathtub. He measures the width of the room to be 6 ft and the length to be $9\frac{1}{2}$ ft. The door opening measures $2\frac{1}{2}$ ft.

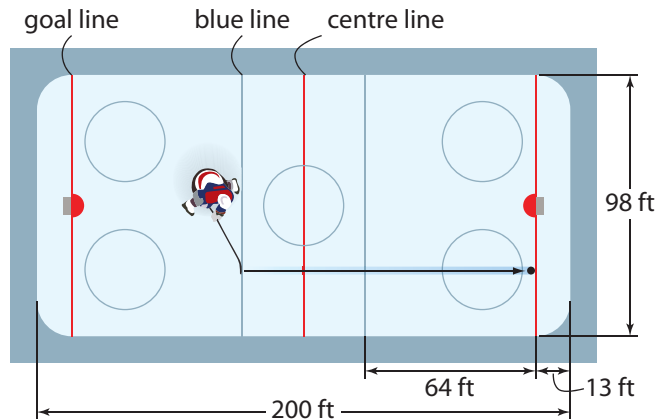
- a) Diego calculates the total length that he needs to cover with tiles to be 25 ft. Is he correct? Explain.
- b) The tiles Diego selects are 6 in. by 6 in. How many tiles does he need?



5. A hockey rink at the Olympics is 200 ft long and 98 ft wide. The goal lines are red and are 13 ft from each end. The blue lines are 64 ft from each goal line. A player hit the puck from the blue line and across centre to the goal line on the opposite end of the rink.

a) How far did the puck travel?

b) What is this distance in inches?



Discuss It

6. Kelly jokingly says that she is “four-feet-nineteen.” How tall is she?

7. Explain how you might add $6' 11''$ and $8' 3''$.

8. On the imperial measuring tape, the marks that indicate fractions of an inch are different lengths. Explain.



9. a) State three lengths that are often measured in imperial units. Include the units.

b) For each length, state whether it is more appropriate to use an exact measurement or an approximate measurement. Justify your thinking.

2.2

SI Length Measurements

Focus On ...

- describing the relationships among SI units of length
- using references to estimate length in SI units
- calculating length in SI units
- converting between SI units for length



Some sports use imperial units while other sports use SI units. Most Olympic events are measured in SI units. What sports do you know that use SI units?

Explore SI Lengths

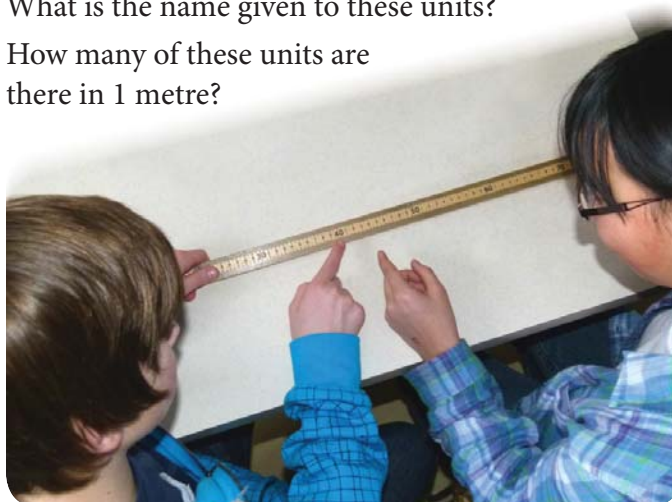
Materials

- metre stick or measuring tape

F.Y.I.

The French word for 100 is *cent*.

1. a) What length does each number printed on the metre stick represent?
b) What is the name given to these units?
c) How many of these units are there in 1 metre?



F.Y.I.

The French word for 1000 is *mille*.

F.Y.I.

The abbreviation for metres is m.

The abbreviation for centimetres is cm.

The abbreviation for millimetres is mm.

- 2. a)** Each numbered unit on the metre stick is divided into smaller units. How many of these smaller units are there?
- b)** What is the name given to this unit of length?
- c)** How many of these small units make up 1 metre?
- 3. Reflect** Use only one metre stick to help answer these questions.
- a)** How many centimetres are in 2 m?
- b)** How many centimetres are in 5 m?
- c)** How many millimetres are in 5 m?
- 4. Extend Your Understanding** A rarely used SI measure is the “decimetre.” A decimetre measures 10 cm.
- a)** How many decimetres are in 1 metre?
- b)** What percent of a metre is a decimetre?
- c)** Express 1 dm as a fraction of 1 m.
- d)** Express your answer to part c) as a decimal.
- e)** How do you think the words “decimetre” and “decimal” are related?
- 5. a)** What is the SI unit most commonly used for measuring long distances?
- b)** How many metres are in one of these longer units?
- c)** Why do you think metres are not used to measure long distances?

The abbreviation for decimetre is dm.

On the Job 1

Add SI Lengths

Janet loves making clothes. She is making four bridesmaids' dresses and a dress for a flower girl. Janet is using a pattern that gives measurements in SI units.

Janet takes measurements and determines the lengths of the straps needed. The strap lengths for the bridesmaids' dresses are 38 cm, 38 cm, 41 cm, and 36 cm. The strap length for the flower girl's dress is 25 cm. Each dress has two straps.

How much ribbon does Janet need for the straps?



Solution

Janet adds the measurements.

Janet estimates the amount of ribbon needed.

4 bridesmaids: $40 \times 2 \times 4 = 320$

1 flower girl: $25 \times 2 = 50$

Janet needs about 370 cm of ribbon.

$$38 + 38 + 41 + 36 + 25 = 178$$

Each dress requires two straps, so Janet doubles her calculation.

$$178 \times 2 = 366$$

Janet needs 366 cm of ribbon to make the straps.

Janet needs to allow for extra ribbon to attach the ribbon to each dress. She estimates she will need 3 cm extra for each strap. Since there are 5 dresses, that is 30 cm extra.

$$366 + 30 = 396$$

Janet needs 396 cm of ribbon.

The ribbon is sold by the metre.

$$1 \text{ m} = 100 \text{ cm}$$

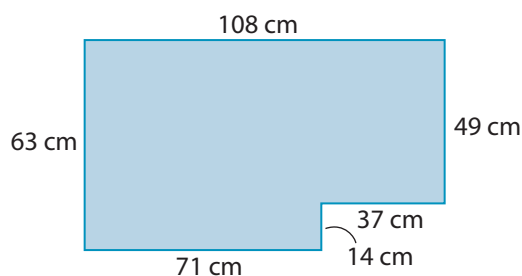
Janet plans to buy 400 cm, or 4 m.

Janet compares the estimate and the calculation.

The amount of ribbon needed seems reasonable.

Your Turn

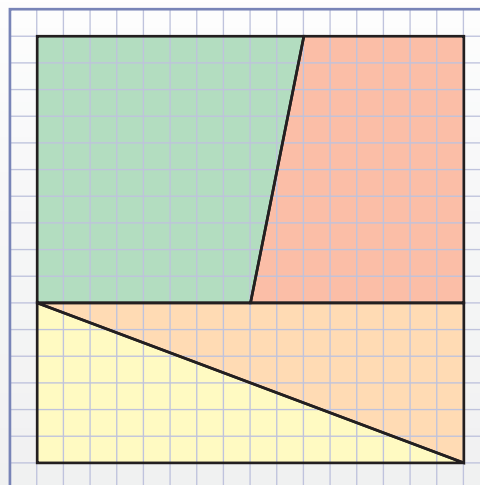
- a) Add the SI lengths shown.



- b) Round the total to the nearest metre.

Puzzler

- Copy the square onto grid paper.
- Cut out the four pieces and rearrange them to form a rectangle.
- What is the perimeter of the square?
- What is the perimeter of the rectangle?
- Why are the perimeters different?



Check Your Understanding

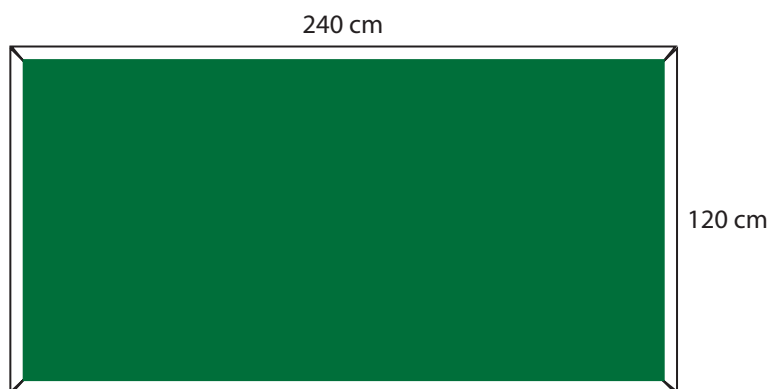
Try It

1. Measure each item in millimetres.
 - a) the width of a calculator
 - b) the width of a page of this book
 - c) the width of a belt
 - d) the thickness of the cover of this book
2. Use your measurements from #1. Calculate
 - a) the width of 4 calculators
 - b) the width of 6 pages of this book
 - c) the width of 3 belts the same size
 - d) the thickness of 5 covers of this book
3. In the last section, you measured four items from the list below. Use SI units to measure the same items you measured earlier. Round each measurement to the nearest centimetre.
 - a) a classmate's height
 - b) the height of your desk
 - c) the width of a classroom window
 - d) the height of an electrical outlet
 - e) the height of a light switch
 - f) the width of the classroom door
 - g) the height of the seat of your chair
 - h) the width of a display board in your school
4. Measure each item. Round the measurements to the nearest metre.
 - a) the width of a hallway
 - b) the length of a hallway
 - c) the width of a parking space
 - d) the length of a parking space
 - e) the width of a bookshelf
 - f) the width of a section of lockers
5. List the basic units of SI measurement from shortest to longest length.

Apply It

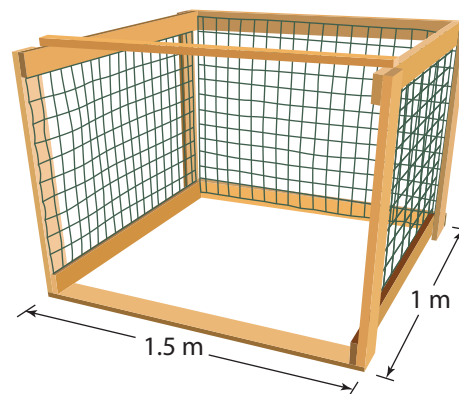


6. The pattern for a cloth bag calls for rope handles that are 9 mm wide and 24 cm long. Draw a rectangle 9 mm wide and 24 cm long.
7.
 - a) Measure the length and width of the top of your desk. Round each measurement to the nearest centimetre.
 - b) Sketch a diagram of the top of your desk on centimetre grid paper. Let 1 square represent 10 cm of the edge of your desk.
8. A display board is enclosed in an aluminum frame. What is the length of aluminum frame needed to enclose the board shown?



9. David wants to compost leaves and grass clippings. He is trying to decide where to install a compost bin. He wants a bin that is 1.5 m by 1 m.

- a) If the compost bin is in the middle of his backyard, what length of fencing will he need to buy?
- b) If the compost bin is in one corner of his fenced backyard, what length of fencing will he need to buy? **Hint:** How many sides will he need to build?
- c) If David uses his shed for one of the sides measuring 1.5 m, what length of fencing will he need to buy?



On the Job 2

Develop and Use SI Measurement References

F.Y.I.

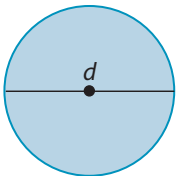
A drill ship is fitted with drilling equipment to drill for new oil in deep water. In 2010, a drill ship in Orphan Bay began sinking a well that will be more than 2.5 km deep. This is expected to be the deepest oil well ever drilled in Canadian waters.



A ship deck crane loads supplies onto an oil drilling ship in St John's. The crane requires 6-strand wire rope with a diameter of 28 mm. Derek is responsible for checking the supply of wire rope. He finds a full spool of wire rope. He knows that wire rope comes in two **diameters**: 10 mm and 28 mm. How can Derek estimate the diameter of the wire rope, so he can either use that spool or order the kind he needs?

diameter

- the distance across the centre of a circle
- the abbreviation is d



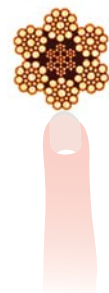
Solution

Derek uses the width of his fingernail as a reference for 10 mm.

The diameter of the wire rope is about three fingernail widths.

Therefore, he estimates that the diameter of the wire rope is about 30 mm.

Derek concludes that he can use the spool on hand.



Your Turn

Develop a set of personal references that you can use to approximate SI lengths.

- a) Use a ruler and a metre stick or measuring tape. What could you use as a personal reference for each measurement? Record your answers in a table similar to this one.

Measurement	Reference
1 cm	
10 cm	
1 m	

- b) You can use parts of the body as references for measuring length. Work with a partner. Measure each reference. Record your answers in a table similar to this one.

Reference	Measurement
My hand span	
My arm span	
My foot length	
My height	
My stride length	

Measure your height in centimetres, or in metres and centimetres.

- c) You can use objects at school or at home as references for measuring length. Work with a partner. Measure as many of the following items as possible. Record your answers in a table similar to this one.

Reference	Measurement
Length and width of a floor tile	
Length and width of a ceiling tile	
Height of a door	
Height of a table	
Height of a ceiling	

Check Your Understanding

Try It

1. Use your personal references for 1 cm, 10 cm, or both to approximate each length.
 - a) the width of this book
 - b) the length of an eyeglass case
 - c) the length of a pencil
 - d) the width of a calculator
2. Measure each item in #1. How close were your approximations to the actual measurements?
3. Use your reference for 1 metre to estimate each of the following lengths.
 - a) the length of a bookshelf
 - b) the width of a section of lockers
 - c) the width of the classroom door
 - d) the height of a light switch
4. You may have measured some of the items in #3 already. If not, measure each item now. How close were your estimates to the actual measurements?
5. Use measurement references to approximate each distance.
 - a) the length of a hallway at school
 - b) the length of a car
 - c) the length of a gym or other large room in the school
6.
 - a) Estimate the perimeter of the figure in an appropriate SI unit.



- b) Measure the perimeter.
- c) How close was your estimate to the actual perimeter?

F.Y.I.

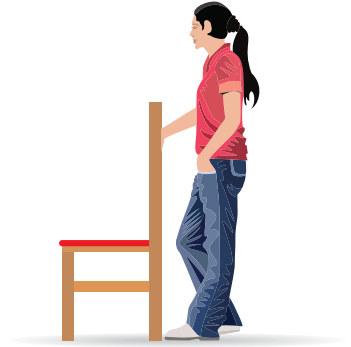
Curve length is the length between the beginning and ending points of the letter.

Materials

- SI measuring tape
- chalk
- watch
- outdoor measuring tool, such as an odometer, pedometer, trundle wheel, or measuring tape

Apply It

7. Estimate, to the nearest metre, the perimeter of your classroom.
8. Diane uses waist height as a reference for 1 metre. Using her waist height, estimate the height of the seat of the chair.
9. a) On a plain sheet of paper, draw a letter S whose curve length you estimate to be 20 cm.
b) Explain how you could measure the length of the curved letter you drew.
c) Measure the S you drew. Compare your measurement with 20 cm. If you are out by more than 2 cm, try drawing the letter again.



10. A basketball hoop is 3 m above the ground. Without measuring, use personal references to mark off approximately 3 m.



11. **MINI LAB** Work in a small group to establish a personal reference for 1 kilometre. Use chalk to mark off a square on the ground that has side lengths of 25 m. For each group member, measure the time it takes to walk around the square once.

STEP 1

Estimate how long it might take to walk 1 km.

STEP 2

Measure actual times by having each group member walk at a normal pace 10 times around the square. Why might your estimate not be close to the actual time?

STEP 3

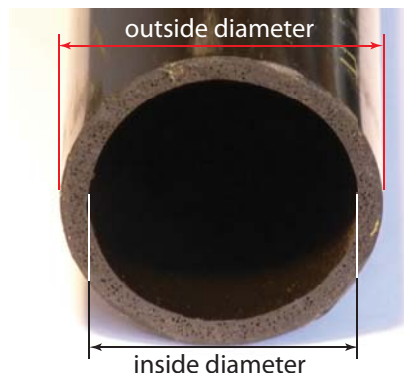
Walk along a street or road for the same length of time that you took in step 2. Measure the distance using an outdoor measuring tool.

STEP 4

List some places that are about 1 km from your school or home.

Work With It

1. **a)** Without measuring, estimate the thickness of the pipe shown. What personal reference did you use?
- b)** Measure the outside diameter of the pipe in millimetres. Then, measure the inside diameter.
- c)** What is the thickness of the pipe? How reasonable was your estimate?



2. The man in the photo is 180 cm tall. Estimate the length of the salmon. Explain your reasoning.



3. **a)** What reference could you use to estimate how much snow fell after a snowstorm? **Hint:** How much snow would knee-high represent?
- b)** The table shows the average monthly snowfall in centimetres for Gander. Express the total average snowfall in metres.

Average Monthly Snowfall in Gander (cm)

October	15
November	40
December	82
January	90
February	80
March	78
April	45
May	15

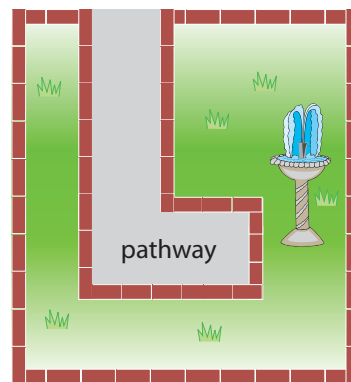
F.Y.I.

Sport fishing in Newfoundland and Labrador involves three main kinds of fish: Atlantic salmon, brook trout, and lake trout. The most popular is Atlantic salmon. About 60% of North America's Atlantic salmon rivers are found in Newfoundland and Labrador.

Discuss It

4. A pathway leads to a fountain in a park. The park and the pathway are lined with a brick border.

- Estimate the perimeter of the brick border in the diagram using SI units. Explain how you estimated your answer.
- Calculate the perimeter. How close was your estimate to the actual measure?
- Draw a new diagram for the same park but make the pathway to the fountain half the width of the one shown in the diagram. What is the perimeter of the border in your diagram?
- Predict how the perimeter of the border changes as the width of the pathway changes. Check your prediction. Use words and diagrams to support your answer.



Scale: 1 cm represents 1 m

5. Look at an SI ruler and notice the marks within each centimetre. Unlike the fractions of an inch, which have many different lengths, these marks are almost all the same length.

- Why do you think this is so?
- Which mark has a different length?
- Why do you think this is so?



6. When you convert between SI units, for example, from 5 cm to 50 mm, the digits stay the same. Only the decimal point appears in a different location. Explain why this happens.

7. Discuss with a partner.

- Which length measurement system do you prefer to use? Explain why.
- Are you comfortable using both the SI and imperial systems for length measurements? Explain.
- Do you use a different system at home than at school? Use examples to help explain.

8. Give two examples of measuring tools you use to measure distance around your home or a workplace. Describe the units on each tool. Explain how and when you use it.

2.3

Length Conversions


Focus On ...

- approximating measurements between SI and imperial units for length
- converting between SI and imperial units for length
- solving problems that involve conversions between SI and imperial units of length

One lap of a running track in the inside lane is 400 m. Four laps are 1600 m or 1.6 km. One mile is approximately equal to 1609 m or 1.609 km. Why is the 1600-m race sometimes called “the metric mile?”

Explore Length Conversions

Materials

- measuring tape
- Explore Length Conversions worksheet 

Sometimes, people convert between SI units and imperial units of measurement. For example, they may change metres to feet. Often, people convert among SI units or among imperial units. For example, it is common to convert feet to inches or metres to centimetres.

In section 2.1, you measured four items in inches. In section 2.2, you measured the same items in centimetres.

- a classmate’s height
- the height of your desk
- the width of a classroom window
- the height of an electrical outlet
- the height of a light switch
- the width of the classroom door
- the height of the seat of your chair
- the width of a display board in your school

1. Compare the SI measure and the imperial measure of the same items. Record the measures in a table similar to this one.

Item	SI Measure (in centimetres)	Imperial Measure (in inches)	Divide SI by Imperial Measure

2.
 - a) For each item, divide the SI measure by the imperial measure.
 - b) Enter each answer from part a) into the last column of your table.
3.
 - a) Is there a pattern to your answers to #2? Explain.
 - b) What can you conclude about the approximate number of centimetres in one inch?
4. Extend a measuring tape to 100 inches.
 - a) How many centimetres is equivalent to 100 inches?
 - b) Return to #3. What is a more accurate SI conversion for 1 inch?

5. Reflect

- a) How can you use your answer from #4 to help you convert a measurement in inches to centimetres?
- b) How can you use it to help you convert a measurement in centimetres to inches?

6. **Extend Your Understanding** Convert the following measurements to the alternative system. Show your strategy.

a) Newfoundland pony



b) northern gannet



F.Y.I.

The Newfoundland pony is a heritage animal. There were no horses in North America when European settlers first arrived. The ancestors of the Newfoundland pony came from Great Britain. Today there are fewer than 400 members of the Newfoundland pony breed. Enthusiasts across Canada are working to promote the hardy little animal that used to haul fishing nets, kelp, and wood.

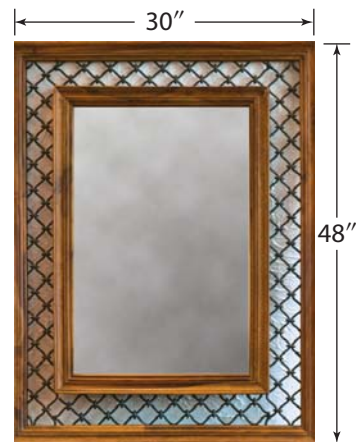
On the Job 1

Convert Lengths

Carrie works in a St. John's home decor store that sells products from all over the world. Some items are sold in imperial units. Other items are sold in SI units. One of Carrie's jobs is to make display tags. The tags give information in SI and imperial measurements. Often, she needs to convert measurements between SI and imperial units for length.

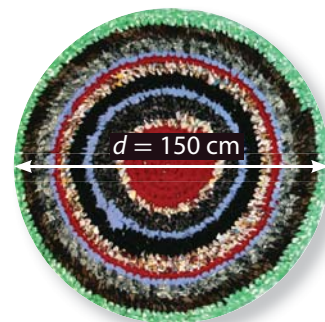
A rectangular mirror imported from the United States has dimensions 30" by 48".

- How can Carrie estimate these dimensions in centimetres?
- How can she convert the dimensions to the nearest centimetre?



A circular area rug imported from India has a diameter of 150 cm.

- How can Carrie estimate the diameter of the rug in inches?
- How can she convert 150 cm to the nearest inch?



Solution

- Carrie knows that 1 inch is about 2.5 centimetres.

$$1 \text{ in.} \approx 2.5 \text{ cm}$$

She estimates using mental math.

Approximate Width

$$2 \times 30 = 60$$

$$\frac{1}{2} \text{ of } 30 = 15$$

$$60 + 15 = 75$$

Approximate Length

$$2 \times 48 = 96$$

$$\frac{1}{2} \text{ of } 48 = 24$$

$$96 + 24 = 120$$

The mirror is approximately 75 cm by 120 cm.

b) $1 \text{ in.} = 2.54 \text{ cm}$

1 in. = 2.54 cm is an exact conversion.

Width

$$30 \times 2.54 = 76.2$$

Length

$$48 \times 2.54 = 121.92$$

The dimensions are 76 cm and 122 cm to the nearest centimetre.

Carrie makes a tag that gives the SI measurements of the mirror as 76 cm by 122 cm.

MIRROR

**76 cm by 122 cm
30 in. by 48 in.**

c) There are about 2.5 cm in 1 in.

Approximate Diameter

$$x \times 2.5 = 150$$

$$x = 150 \div 2.5$$

$$x = 60$$

Carrie converts $2\frac{1}{2}$ to 2.5.

The rug has an approximate diameter of 60 inches.

d) There are exactly 2.54 cm in 1 in.

$$150 \div 2.54 = 59.055\dots$$

The diameter of the rug is 59 in. to the nearest inch.

CIRCULAR RUG

**Diameter:
150 cm
59 in.**

Carrie makes a tag that gives the imperial measurement as 59 in.

What other strategies could you use to do these conversions?

Your Turn

- a) A square table made in Canada has a side length of 36 in. Give the approximate side length in centimetres. Then, convert 36 in. to centimetres. Round to the nearest centimetre.



- b) A glass vase imported from Spain has a height of 60 cm. State the approximate height in inches. Then, convert 60 cm to inches. Round to the nearest inch.



Check Your Understanding

Try It

1. Approximate each length in centimetres.
a) 4 inches b) 6 inches c) 10 inches d) 12 inches
2. Convert each length in #1 to centimetres.
3. Convert each answer in #2 to millimetres. 1 mm = 0.1 cm
4. Use a ruler or a measuring tape and approximate each SI length to the closest fraction of an inch.
a) 10 cm b) 20 cm c) 30 cm d) 40 cm
5. a) How many centimetres are in 1 foot?
b) Jim rounds the answer to part a) to 30 cm. Will rounds the answer to 30.5 cm. Mitchell leaves the answer that is displayed on his calculator. Which do you prefer? Explain.
c) Use Jim's method to determine the number of centimetres in 6 ft.
d) Use Will's method to determine the number of centimetres in 6 ft.
e) Use the exact conversion to calculate the SI equivalent to 6 ft.
f) When might it be appropriate to use an approximate conversion? Give an example.
g) When might you need an exact conversion? Give an example.

F.Y.I.

1 in. = 2.54 cm

Apply It

6. A nurse says that a newborn baby is about 53 cm long. What is the approximate length of the baby in inches?
7. An osprey's wingspan can reach up to 1.8 m.
 - a) Use a personal reference to estimate this wingspan.
 - b) Measure your estimate. How close were you to 1.8 m?
 - c) What is 1.8 m in imperial units? Give your answer to the nearest inch.



F.Y.I.

The osprey is a predatory bird that looks like an eagle. Ospreys nest close to the ocean, where they feed on fish. Ospreys can be seen around the coasts of the province.

8. Moose can stand about 2 to 2.5 m high at the shoulder. What is the height range of moose in feet and inches?
9. A traditional Inuit dogsled is called a komatik. A komatik uses teams of qimmiq or sled dogs on separate lines. The lines are tied directly to the komatik. Each dog has a harness with an average length of $3\frac{1}{2}$ ft. Suppose a dogsled team includes 13 dogs.
- What is the approximate total length of rope needed to harness the team?
 - What is the total length needed in SI units?
 - Explain why you chose the units you did.



10. Some students are researching the cost of maple hardwood for a woodworking project. Callie reports that boards measuring $3\frac{1}{2}$ in. by $\frac{3}{4}$ in. are on sale. Ben finds boards measuring 90 mm by 18 mm at the same price. Did one student find a better deal? Justify your answer.
11. Lori is looking at knitting patterns on an American web site. The pattern for a sweater calls for 115 yards of wool.
- Estimate the number of metres of wool needed. Show your work.
 - Lori is good at converting units within the same system. She knows that 1 in. is equal to 2.54 cm. Lori decides to convert from yards to feet to inches, and then to centimetres and to metres. How many metres of wool are needed?

F.Y.I.

1 yd \approx 0.9 m



On the Job 2

Convert Longer Distances

Rhys lives in Corner Brook. Next month he will be driving in the U.S.A. He wants to get familiar with “thinking in miles” before he travels south.



He researches the conversion between miles and kilometres.

$$1 \text{ mi} \approx 1.609 \text{ km}$$

$$1 \text{ km} \approx 0.6214 \text{ mi}$$

- Some major highways have a speed limit of 70 mph. How can Rhys estimate the SI equivalent of 70 mph?
- How can he calculate the SI equivalent of 70 mph?
- The speed on the Trans-Canada Highway outside Corner Brook is 80 km/h. What is the imperial equivalent to this speed limit?

F.Y.I.

The abbreviation for miles per hour is mph.

Solution

- a) Rhys estimates the number of kilometres in 70 miles.

$$1 \text{ mi} \approx 1.6 \text{ km}$$

1.6 is close to $1\frac{1}{2}$.

Half of 70 is 35.

$$70 \text{ mi is close to } 70 + 35 = 105 \text{ km.}$$

So, 70 mph is close to 105 km/h.

- b) Rhys converts 70 mi to kilometres.

$$70 \text{ mi} \times 1.609 \approx 112.63 \text{ km}$$

So, 70 mph is about 113 km/h.

- c) Rhys converts 80 km to miles.

$$80 \text{ km} \times 0.6214 \approx 49.712 \text{ mi}$$

So, 80 km/h is approximately equal to 50 mph.

Your Turn

- a) The speed limit in many American towns and cities is 30 mph. Estimate and then calculate the SI equivalent.
- b) The speed limit on a private road is 50 km/h. Estimate and then calculate the imperial equivalent.



Check Your Understanding

Try It

1. Convert each SI distance to imperial units. Express each answer to the nearest tenth of a unit.

$$1 \text{ km} \approx 0.6214 \text{ mi}$$

- | | |
|-----------|-----------|
| a) 10 km | b) 25 km |
| c) 60 km | d) 90 km |
| e) 350 km | f) 750 km |

2. Convert each imperial distance to SI units. Express each answer to the nearest tenth of a unit.

$$1 \text{ mi} \approx 1.609 \text{ km}$$

- | | |
|-----------|-----------|
| a) 10 mi | b) 25 mi |
| c) 60 mi | d) 90 mi |
| e) 350 mi | f) 750 mi |

Apply It

3. Lily's car measures distance in kilometres. Approximately how long will it take her to drive each distance in #2 if she travels at 100 km/h?
4. Jonah is preparing a brochure for a snowmobile club. He needs to convert some trail distances from kilometres to miles for American visitors. What is each distance in miles?

- | | |
|-------------------------------------|--------|
| a) Corner Brook to Gallants | 42 km |
| b) Corner Brook to Deer Lake | 66 km |
| c) Corner Brook to Glenburnie | 87 km |
| d) Corner Brook to Hampden Junction | 132 km |
| e) Corner Brook to Pollard's Point | 172 km |



F.Y.I.

The Newfoundland and Labrador Snowmobile Federation (NLSF) governs 16 volunteer snowmobile clubs across the island portion of the province. The NLSF maintains and grooms a trail network of approximately 3700 km. How many miles is this?

5. Noah is training for a long distance event. In one week, he ran the following distances.

- a) What is the total distance Noah ran in kilometres?
- b) What is the total distance he ran in miles?

Day	Distance
Sunday	10.2 km
Monday	15.6 km
Tuesday	12.1 km
Wednesday	17.5 km
Thursday	15.7 km
Friday	19.2 km
Saturday	20.4 km

6. Micaela is researching the lengths of rivers in Newfoundland and Labrador. What is each length in kilometres?

- a) Churchill River 532 mi
- b) Exploits River 153 mi
- c) Gander River 110 mi
- d) Fraser River 65 mi

7. Jack lives in Stephenville and drives a truck throughout much of the east coast of Canada and the United States. While approaching the Canadian border into New Brunswick from Maine, he sees the following sign. Convert this distance to metres.



8. Sherry's car consumes about 7 L of fuel per 100 km. The gas tank holds 50 L.

- a) Estimate the distance in kilometres that Sherry could travel with one full tank of gas.
- b) Estimate the distance in miles.
- c) Sherry's gas warning light goes on. She fills up the gas tank just after crossing into the United States. How many gallons of gas does the fuel tank hold?
- d) At US\$3.10 per gallon, how much will the gasoline cost?
- e) On that day, US\$1 = C\$1.05. How much does the gas cost Sherry in Canadian dollars?

1 gallon \approx 3.785 L

Work With It

1. Provincial fishing regulations state that all salmon over 63 cm in length must be released.



- a) Use your collection of personal references to estimate 63 cm.
 - b) Ask a classmate to measure your estimate. How close were you to 63 cm?
 - c) What is 63 cm in imperial units?
 - d) What imperial references could you use to estimate this length?
2. After a blizzard, vehicles drove through a snow tunnel on the Trans-Canada Highway.



- a) Use the vehicle as a reference and estimate the height of the snow bank on the left, in either metres or feet.
 - b) Convert your estimate from part a) to the measurement unit you did not select.
3. Read the information about the East Coast Trail located on the Avalon Peninsula. Convert each SI measurement to an equivalent imperial measurement.

The East Coast Trail is 540 km long. A 254-km section of the trail meets world class hiking standards. This section of the trail runs 34 km north of Quidi Vidi Village, in St John's, to Pouch Cove. It stretches 220 km from Fort Amherst, St. John's, to Cappahayden on the southern shore. About 296 km of the trail are under development.

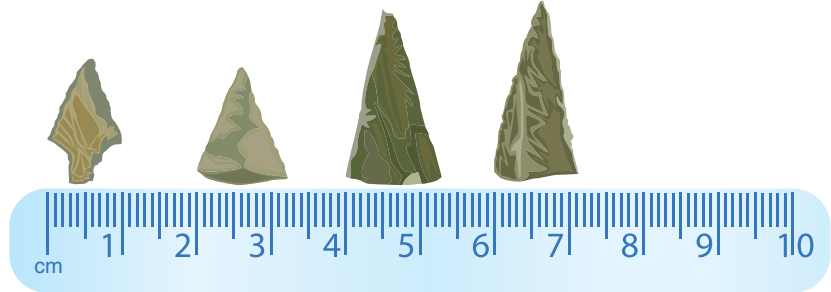
F.Y.I.

In 2010, *National Geographic* ranked the Avalon Peninsula as the top coastal destination in the world.

F.Y.I.

Since the 1990s, archaeologists have been excavating the site of the Colony of Avalon. They are also finding traces of the Beothuk, and of the fishers from Europe who visited seasonally.

4. The Beothuk stone tools shown were found at the Colony of Avalon. The object with a small stem is an arrow point. The other objects may have been used as knives.



- Estimate the length of the arrowhead in imperial units.
 - Estimate the length of the longest knife in imperial units.
 - Explain how to convert between SI and imperial units.
5. The following rivers flow into the Atlantic Ocean.
- Which river is the longest?
 - What is the total length of the four rivers, in kilometres?
 - What is the total length of the four rivers, in miles?

River	Length
Churchill	856 000 m
Saint John	736 000 yd
St Lawrence	1 900 mi
Ottawa	1 270 km

Discuss It

- State three distances that are often measured in SI units. Then, state three distances that are often measured in imperial units. Include the units.
 - For each distance in part a), state whether it is more appropriate to use an exact measurement or an approximate measurement. Justify your answers.
- If someone asked you how tall you are, would you give your answer in imperial units or in SI units?
 - If someone asked you for the approximate distance between St. John's and Clarenville, would you give your answer in imperial units or in SI units?
 - Did you answer parts a) and b) differently? If so, why?
- Li-ying says that when measuring a short distance, you usually need to be more precise. Harry says that you need to be more precise when measuring a long distance. Who is correct? Explain your reasoning.

2.4

Working With Length

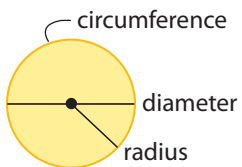
Focus On ...

- calculating the circumference of a circle
- working with formulas using SI and imperial units of length
- solving and verifying problems that involve formulas related to perimeter



circumference

- the perimeter of a circle
- the abbreviation is C



Materials

- cylindrical objects
- flexible measuring tape or string
- calculator

*Workers in many jobs often need to add, subtract, divide, or multiply measurements. They may need to convert measurements or work with formulas. It all depends on what they are doing. What jobs might involve working with the **circumference of a circle**?*

Explore the Circumference of a Circle

Explore the circumference and diameter of at least four cylindrical objects.

1. In your notebook, set up a table as shown.

Object	Circumference	Diameter	Circumference ÷ Diameter

F.Y.I.

Mathematicians use the Greek letter pi to calculate the circumference of a circle. Pi represents the ratio of circumference to diameter. The symbol for pi is π . A good approximation for the value of π is 3.14.

Pi is a number without an end. Computers have calculated pi to billions of decimal places without finding any pattern!

2. Record the answers in your table. Include the units.
 - a) Use the measuring tape to measure the circumference and diameter of one object, in millimetres.
 - b) Divide the circumference by the diameter. Round your answer to the nearest hundredth of a unit.
3. Repeat step 2 with at least three more objects.
4. **Reflect**
 - a) Compare your results in the last column of the table. How close to 3.14 were your answers?
 - b) What do you think might explain any difference?

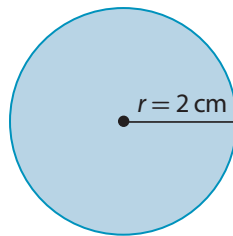
5. **Extend Your Understanding** There are two formulas for the circumference of a circle:

- $C = \pi \times \text{diameter}$
 $= \pi d$
- $C = \pi \times 2 \times \text{radius}$
 $= \pi 2r$

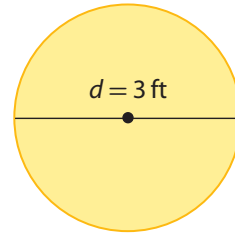
The radius is one half the measure of the diameter.

Try each formula to calculate the circumference of each circle. Express each answer to the nearest hundredth of a unit.

a)



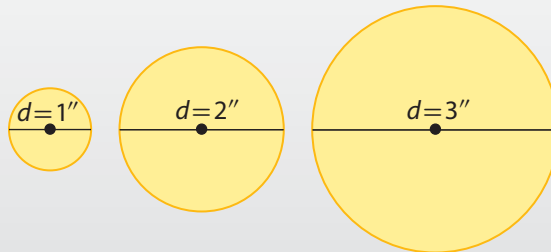
b)



c) Explain why the two formulas give the same answers.

Puzzler

- a) What is the circumference of a 1-inch circle? a 2-inch circle? a 3-inch circle? Round your answer to the nearest hundredth of an inch.
- b) What patterns do you notice?
- c) Use your pattern to predict the circumference of a 7-inch circle.
- d) Check your prediction. How close were you? Explain any differences.



On the Job 1

Work With Formulas

Most items are imported into Newfoundland and Labrador on planes and ships. Sometimes, the cost to ship a package is determined by its weight. Other times, the cost is determined by the dimensions of the package.

Erica uses a formula to help determine the cost of different shipping packages. In the formula $l + g$, l is the length of the longest side and g is the “girth” or distance around the package.

- a) Erica has two rectangular packages. She knows the length, width, and height measures.

Package 1 measures 2.5 m by 1.5 m by 1 m. What is the length + girth measurement?

Package 2 measures 3 ft by 3 ft by 10 in. In inches, what is the $l + g$ measurement?

- b) A shipping tube has diameter 1.5 m and length 4.5 m. What is the $l + g$ measurement, to the nearest tenth of a metre?

Solution

- a) For Package 1, Erica sketches a diagram.

$$\begin{aligned}\text{length} &= \text{longest side} = 2.5 \\ \text{girth} &= 1.5 + 1 + 1.5 + 1 \\ &= 5\end{aligned}$$

$$5 + 2.5 = 7.5$$

The length + girth measurement of the package is 7.5 metres.

- For Package 2, Erica sketches a diagram.

1 foot = 12 inches,
so 3 feet = 36 inches.

$$l = 36$$

$$g = 2(36 + 10)$$

$$g = 2 \times 46$$

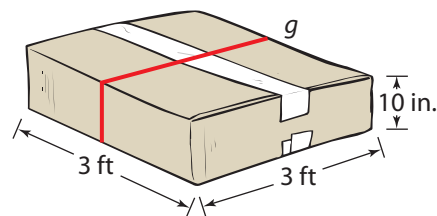
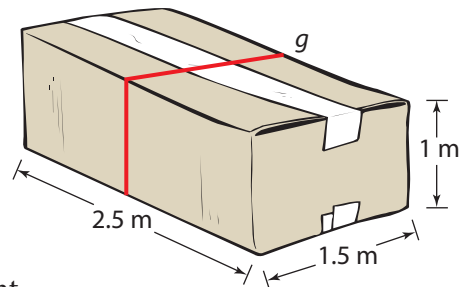
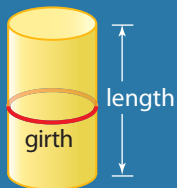
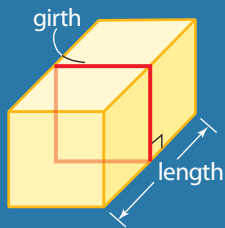
$$g = 92$$

$$92 + 36 = 128$$

The length + girth measurement is 128 inches.

F.Y.I.

“Girth” is the distance around an object at a 90° angle to the length.



Tech Link

If your calculator has a π button,

Press C π \times measurement of diameter $=$.

- b) Erica sketches a diagram.

Since girth = circumference, she uses the formula πd to calculate the circumference.

$$l = 4.5$$

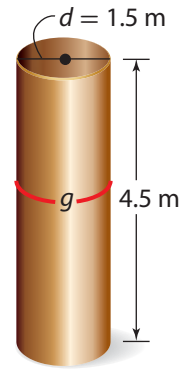
$$g = \pi d$$

$$g = \pi \times 1.5$$

$$g = 4.712 \dots$$

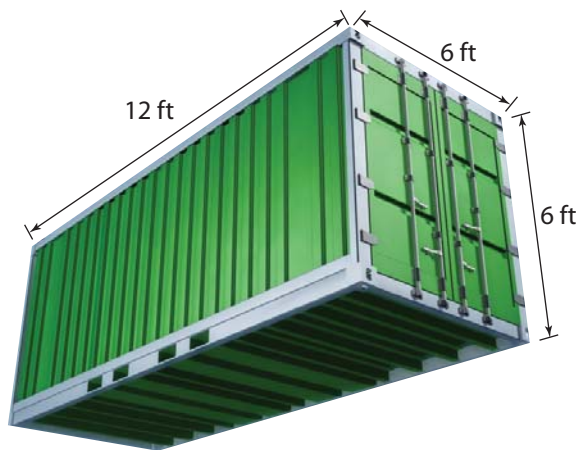
$$4.5 + 4.7 = 9.2$$

The length + girth measurement is 9.2 metres.

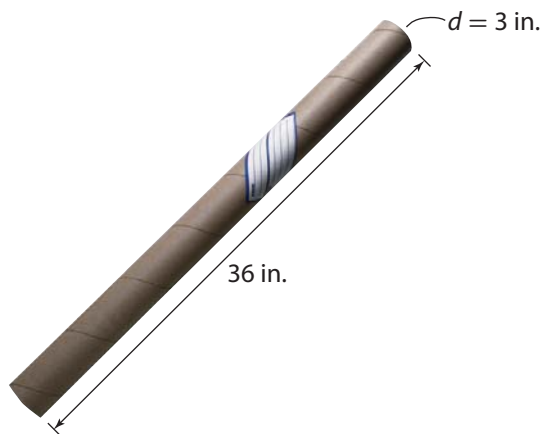


Your Turn

- a) A shipping container has dimensions 12 ft by 6 ft by 6 ft. What is the length + girth measurement for the container?



- b) A mailing tube has diameter 3 in. and length 36 in. Determine the length + girth measurement of the mailing tube, to the nearest inch.

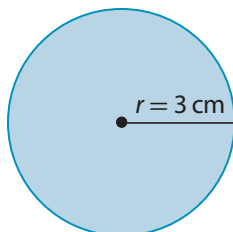


Check Your Understanding

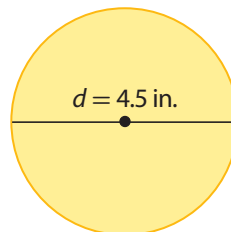
Try It

1. What is the circumference of each circle, to the nearest unit?

a)



b)



2. Calculate the perimeter of each rectangle.

a) $l = 30$ cm, $w = 48$ cm

b) $l = 11$ in., $w = 8\frac{1}{2}$ in.

c) $l = 2.4$ m, $w = 3.4$ m

3. For #2a), Jaime converts 30 cm to $2\frac{1}{2}$ feet, and 48 cm to 4 feet.

$$P = 2\frac{1}{2} + 2\frac{1}{2} + 4 + 4$$

$$P = 13$$

The perimeter is 13 ft.

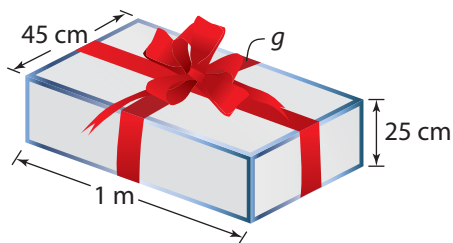
What error did Jaime make?

4. Recalculate #2b) using the formula $P = 2l + 2w$. Explain why you get the same answer.

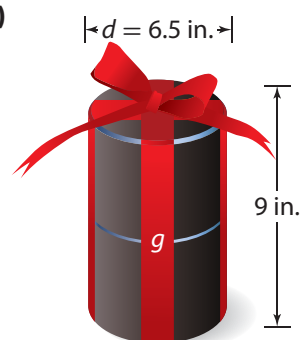
5. Recalculate #2c) using the formula $P = l + w + l + w$. Explain why you get the same answer.

6. Determine the length + girth measurement of each gift box.

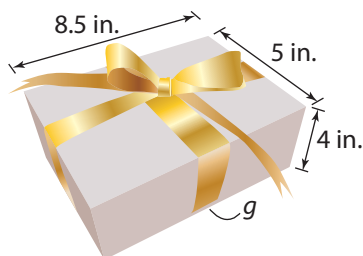
a)



b)

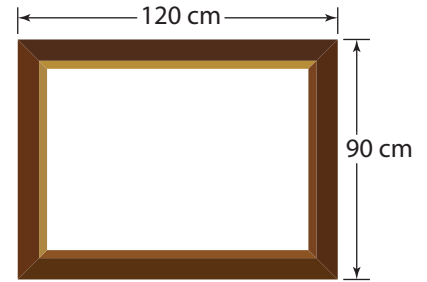


c)



Apply It

7. Enzo works in a framing store and makes custom frames. He is making a frame for a collage that will have dimensions 120 cm by 90 cm. Calculate the total amount of framing needed. Express your answer in metres and in centimetres.



8. The diameter of the tires on a haul truck at a mine site is 30 ft. What is the circumference of each tire?



9. A salon hair dryer has a metal band around the outside of the hood. The diameter of the hood is 14 in. What is the length of the metal band?



10. Deanne Fitzpatrick created the rug called From Sea to Sky. To hook the rug, she pulled strips of cloth through burlap backing one loop at a time. To finish a rug, she often sews $1\frac{1}{2}$ in. twill tape around the edge of the pattern. The tape does not overlap at the corners. What length of twill tape is needed for the perimeter of a rug that measures 40 in. by 52 in.?



F.Y.I.

People believe that primitive rug hooking began in North America. Early settlers facing cold winds needed to keep their homes warm. They covered their floors with rugs made of worn out clothing.

On the Job 2

Determine the Midpoint

Steve is hanging a mirror in his bathroom. He wants the mirror centred on a 46-inch wide section of one wall. The mirror came with a hook built into the back of each top corner. The hooks are $28\frac{1}{2}$ in. apart. Steve needs to put two screws in the wall to support the mirror.

- How will Steve determine the centre point on the wall?
- How will he determine the position of the screws?

Solution

- a) The wall is 46 inches wide.

$$46 \div 2 = 23$$

The centre of the wall is 23 inches from the end of the wall. Steve marks the midpoint of the wall.



- b) The hooks are $28\frac{1}{2}$ inches apart.

Method 1: Use Multiplication

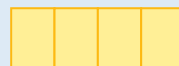
$$\begin{aligned}\frac{1}{2} \text{ of } 28 &= \frac{1}{2} \times 28 \\ &= \frac{28}{2} \\ &= 14\end{aligned}$$

$$\begin{aligned}\frac{1}{2} \div 2 &= \frac{1}{2} \times \frac{1}{2} \\ &= \frac{1}{4}\end{aligned}$$

$$14 + \frac{1}{4} = 14\frac{1}{4}$$

$$\text{Half of } 28\frac{1}{2} \text{ is } 14\frac{1}{4}.$$

To show $\frac{1}{2} \div 2$, cut each $\frac{1}{2}$ into two equal pieces.



$$\frac{1}{4} \quad \frac{1}{4} \quad \frac{1}{4} \quad \frac{1}{4}$$

$$\frac{1}{2} \div 2 = \frac{1}{4}$$

Method 2: Use Logic

$$28 \div 2 = 14$$

$$\frac{1}{2} \div 2 = \frac{1}{4}$$

$$14 + \frac{1}{4} = 14\frac{1}{4}$$

Half of $28\frac{1}{2}$ is $14\frac{1}{4}$.

Steve marks a spot on the wall $14\frac{1}{4}$ in. to the left and $14\frac{1}{4}$ in. to the right of the midpoint.



Your Turn

A poster of a pitcher plant is 13 in. wide. It needs only one nail to support it. Where is the midpoint of the width of the poster?



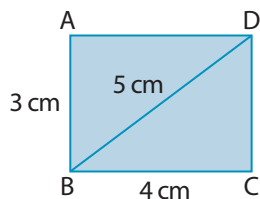
F.Y.I.

The pitcher plant is the official flower of Newfoundland and Labrador. It grows in bogs and marshes throughout the province. The pitcher plant feeds on insects.

Check Your Understanding

Try It

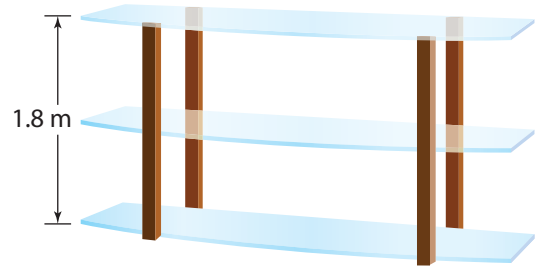
- Determine the midpoint of each length measurement.
 - 5"
 - 134 cm
 - 37 in.
 - 20.6 cm
 - $16\frac{1}{2}$ in.
 - $8\frac{3}{4}$ in.
- Double each of the following measures.
 - 7 in.
 - 83 cm
 - 37 in.
 - 110.6 cm
 - $21\frac{1}{2}$ in.
 - $9\frac{3}{4}$ in.
- Convert each imperial answer from #2 to feet and inches.
Convert each SI answer to metres.
- Determine the midpoint of each measurement.



- Determine the midpoint of the diameter of each circle.
 - A yellow circle with a horizontal diameter line passing through the center. The diameter is labeled $d = 13$ cm.
 - A blue circle with a horizontal radius line from the center to the right edge. The radius is labeled $r = 8$ in.
- Calculate. Express each answer in the units indicated.
 - half of 9 in. (inches)
 - 3×62 cm (metres)
 - $2(17$ in. $+ 14$ in.) (feet and inches)
 - 2 m $- 32.5$ cm (centimetres)
 - half of $6\frac{3}{4}$ in. (inches)
 - $4\frac{1}{2}$ ft (inches)

Apply It

7. The vertical supports of a shelving unit stand 1.8 metres tall. There are three evenly spaced shelves in the unit. How far up the support is the middle shelf?



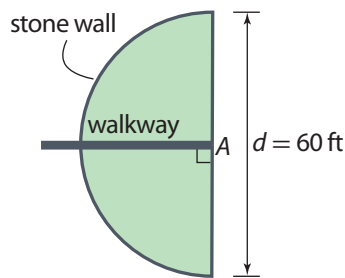
8. Gwen is building a table for table tennis that is 9 ft long by 5 ft wide. She plans to use two equal-sized pieces of wood so the table can fold.
- What will be the length and width of each piece of wood?
 - What strategy did you use to determine your answer in part a)?



Tools of the Trade

Masons build and repair walls, arches, fireplaces, chimneys, and other structures. They often work with stone, bricks, concrete blocks, and tiles. Masons use string, stakes to hold string, measuring tapes, and a builder's level to construct straight and level structures. Accuracy is very important in this trade. To learn more about masons, go to www.mhrmathatwork10.ca and follow the links.

9. Mark is designing a semicircular dry stone wall. He needs to plan for a walkway. The diameter of the wall will be 60 ft.



A dry stone wall has no mortar holding the stones together.

- The walkway will end at A. This represents the midpoint of the diameter of the wall. Where is the midpoint of the diameter?
- The walkway will be 2 ft wide and it will divide the wall in half. Approximately how far along the wall will the walkway edges be? Round your answers to the nearest foot.
- Explain the strategy you used to determine the midpoint of the wall for part b).



Tools of the Trade

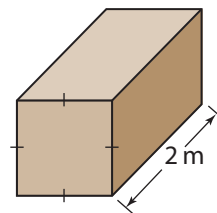
Surveyor's wheels are useful for approximating distances. They are often used by road workers, utility workers, and farmers for quick measures over distances that are not easy to measure with a measuring tape. To learn more about surveyor's wheels, go to www.mhrmathatwork10.ca and follow the links.

F.Y.I.

Newfoundland dogs were originally working dogs for fishers. Their strength, webbed feet, and water-resistant coat help them excel at water rescue. The largest Newfoundland on record measured 6 ft from nose to tail and weighed 120 kg.

Work With It

1. The box shown meets the postal regulations. According to Canada Post, the combined length and girth of the box cannot be more than 3 m.



- a) If the box is 2 m long, what is the girth of the box?
b) What is the width of the box?

2. A surveyor's wheel can be used to measure distances along a road under construction. A counter attached to the wheel shows the distance that the wheel travels along the ground. The diameter of one wheel is 0.32 m. How far does the wheel turn in one complete turn? Round your answer to the nearest tenth of a metre.

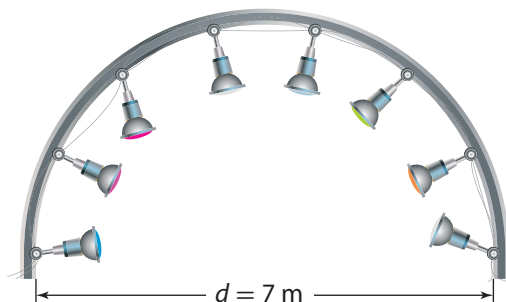


3. Rachel wants to hang a print that is 27 in. wide on a wall that is 37 in. wide. The back of the print has built-in hooks 19 in. apart.



- a) Where is the midpoint of the wall?
b) How far to the left and the right of the midpoint will Rachel need to insert nails into the wall?

4. An electrician is installing a lighting track for an exhibit in an art gallery. The track will have a semicircular shape as shown. What length of lighting track does the electrician need?

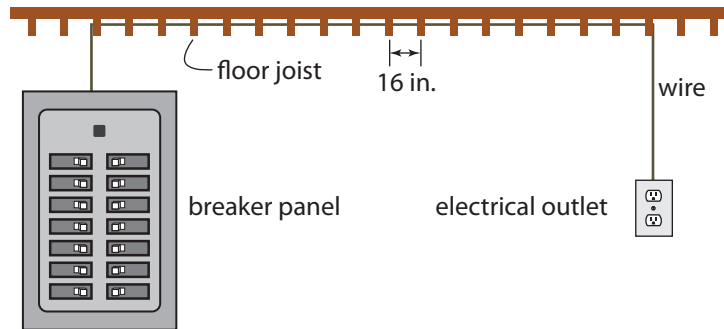




Tools of the Trade

Electrician is a Red Seal trade. Electricians install, connect, test, and repair electrical controls and panel boxes. They splice and connect wires and troubleshoot problems. Electricians also test and measure circuits. To learn more about electricians, go to www.mhrmathatwork10.ca and follow the links.

5. Carl is an electrician. He needs to estimate the distance from the breaker panel in a house to a new electrical outlet.



- The electrical wire runs along the floor joists. The space between the floor joists is 16 inches. Carl counts 17 spaces to the approximate location of the electrical outlet. Calculate the approximate total distance for the 17 spaces.
- Convert the total distance in part a) to feet. Round your answer to the nearest foot.
- Use personal references to estimate the vertical distance between the electrical outlet and the 8-foot ceiling.
- The breaker panel is about 3 feet from the ceiling. What is the approximate total length of wire that Carl needs?

Discuss It

6. Ultimate is a sport played with a flying disc. The flying discs vary in diameter from 20 to 25 cm.

- Determine the circumference of the smallest and largest discs.
- Which disc would be easier to catch? Explain why.



7. Describe a strategy for determining the midpoint of a picture frame that is $27\frac{1}{2}$ in. wide. Discuss your strategy with several classmates. Which strategies different from yours give the same result?
8. Describe how the formula $P = 2(l + w)$ might be used in a job.
9. Do you find it easier to determine the midpoint of whole numbers, fractions, or decimals? Explain why.

What You Need to Know

Section After this section, I know how to . . .

- 2.1**
- describe the relationships among imperial units of length
 - use references to estimate length in imperial units
 - calculate length in imperial units
 - convert between imperial units for length
- 2.2**
- describe the relationships among SI units of length
 - use references to estimate length in SI units
 - calculate length in SI units
 - convert between SI units for length
- 2.3**
- approximate measurements between SI and imperial units for length
 - convert between SI and imperial units for length
 - solve problems that involve conversions between SI and imperial units of length
- 2.4**
- calculate the circumference of a circle
 - work with formulas using SI and imperial units of length
 - solve and verify problems that involve formulas related to perimeter

If you are unsure about any of these questions, review the appropriate section or sections of this chapter.

2.1 Imperial Length Measurements, pages 58–69

1. **a)** Use your references for imperial lengths to draw a line 5 in. long.
b) Measure the line. How close was your estimate?
2. Draw a line to represent each length.
a) 3 in. **b)** $4\frac{1}{2}$ in. **c)** $2\frac{1}{4}$ in. **d)** $3\frac{1}{8}$ in. **e)** $4\frac{1}{16}$ in.

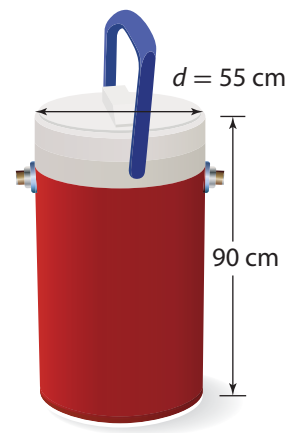
2.2 SI Length Measurements, pages 70–81

3. **a)** Use your references for SI lengths to draw a line 18 cm long.
b) Measure the line. How close was your estimate?

4. Draw a line to represent each length.
- a) 6 cm b) 6 mm c) 8.7 cm d) 48 mm
5. Convert 48 mm to centimetres.

2.3 Length Conversions, pages 82–93

6. The biggest lobster ever caught was about $3\frac{1}{2}$ ft to 4 ft long.
- a) State this range in inches.
- b) Suppose a cylindrical cooler was used to transport the lobster. If the cooler had a height of 90 cm and a diameter of 55 cm, would the lobster fit end to end? Justify your answer.
7. A boat has a rope ladder hanging over its side with the end touching the water. Becky needs to replace the rope ladder. She estimates that the railing is 5 m above the water. She has a rope ladder that is 20 ft long. Will the ladder reach the water once she installs it at the top of the railing? Show your work.



2.4 Working With Length, pages 94–105

8. Jan needs to ship her guitar case home. What is the length and girth measurement of the case?

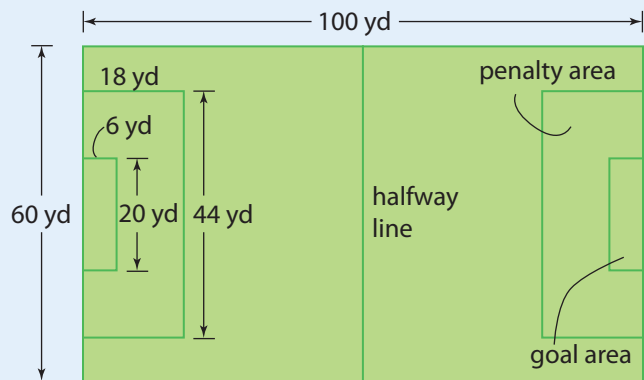


9. John is decorating for a school dance. He wants to put flashing lights around the circular speakers in the gymnasium. The speakers have a diameter of 0.75 m. He has a 12-m strand of lights. Will he have enough for 6 speakers? Justify your answer.

For #1 to #6, select the best answer.

- Which length is between $\frac{1}{2}$ in. and $\frac{3}{4}$ in.?
 - $\frac{7}{16}$
 - $\frac{5}{8}$
 - $\frac{7}{8}$
 - $\frac{15}{16}$
- Which length is shorter than 3 cm?
 - 2.5 km
 - 2.5 m
 - 0.25 m
 - 25 mm
- Which list is in order from shortest to longest length?
 - 1 in., 1 mm, 1 cm, 1 yd
 - 1 mm, 1 cm, 1 in., 1 ft
 - 1 mm, 1 cm, 1 yd, 1 ft
 - 1 mm, 1 in., 1 cm, 1 ft
- Which imperial length is equal to 8' 5"?
 - 40 inches
 - 85 inches
 - 101 inches
 - 850 inches
- Which SI length is equal to 8.5 m?
 - 40 cm
 - 85 cm
 - 101 cm
 - 850 cm
- Which pair of measures is equivalent?
 - 1 cm and 2.54 in.
 - 1 in. and 2.54 cm
 - 1 km and $\frac{1}{2}$ mi
 - 1 mi and 1.5 km

- Liam is a park manager and needs to paint the lines on the soccer field. He will paint the perimeter, the halfway line, the goal areas, and the penalty areas.
 - What is the total distance that needs to be painted?
 - One can of white-line spray paint paints a distance of about 360 ft. How many cans of spray paint will Liam need?



8. Estimate the shoulder height of the polar bear cub. Explain how you determined the estimate.



9. Nick and Amanda want to plant a maple tree on their property. They chose a site where hydro wires pass overhead. Nick estimates that the wires are 20 ft above the ground. Amanda reads the tag on the tree, which says that the tree will grow to a height of 8 to 10 m. Should they plant the tree on this site? Justify your answer.

10. Charlene and her brother are hanging a painting. They want to centre the painting under the wall light. The wall light is $27\frac{1}{2}$ in. long. The painting is 4 ft 3 in. wide.



- a) How far from the edge of the wall light is the midpoint of the wall light?
- b) After the painting is in place, how far will the edge of the painting extend beyond the edge of the wall light?

11. An official NHL puck is 7.6 cm in diameter.

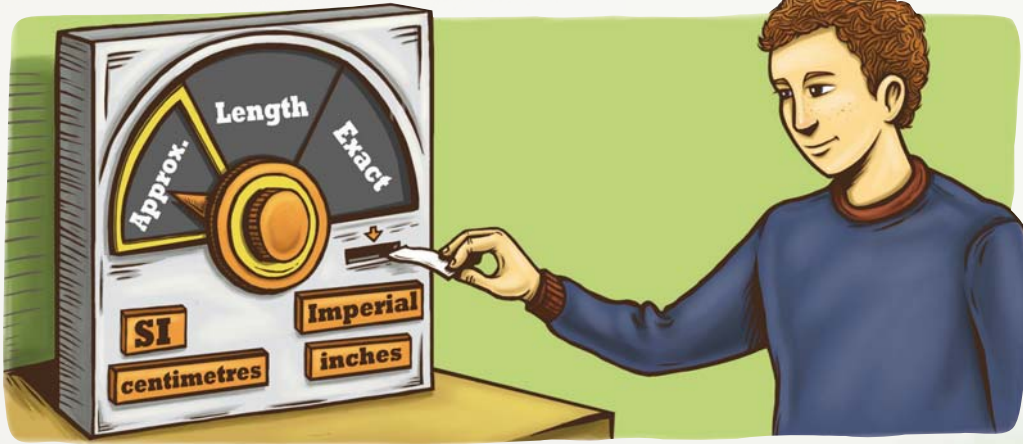
- a) What is the circumference of the puck, to the nearest tenth of a centimetre?
- b) Sometimes a puck rolls on its edge down the ice. Suppose the puck rolls 15 times. How many metres did it travel in 15 rotations? Round your answer to the nearest metre.





Create a Unit Converter

Make your own unit converter.



1. **a)** Select one SI and one imperial length measurement unit.
- b)** Create a unit converter. Decide if you want to show converting from SI to imperial or from imperial to SI.

For example:

From	To	Approximate	Exact
Centimetres	Inches	Divide centimetres by 2.5.	

2. **a)** Select at least four length measurements to convert.
 - b)** Test your unit converter.
 - c)** What improvements can you make to your converter?
Make any needed changes.
3. **a)** Exchange your unit converter with the one of a classmate. Use the converter to convert the length measurements in #2a).
 - b)** How useful was your partner's converter? If it does not work, suggest how it could be improved.
 - c)** Make any necessary fixes to your own converter.
- Use your unit converter for the rest of the course!

GAMES AND PUZZLES

Win 10

Materials

- deck of playing cards
- calculator

- Play cards with a partner or in a small group. These are the rules:
 - Remove the face cards from a deck of cards.
 - The dealer shuffles the cards and deals three cards, face up, to each player.
 - Players use the values of their cards as the dimensions, in centimetres, of a rectangular prism.
 - Calculate the length and girth of your rectangular prism.
 - Each player who makes the calculation correctly scores a point. (You will need to check each other's work.)
 - The player with the greatest length and girth measurement scores an extra point for that round. If there is a tie, each of the tied players scores an extra point.
 - The first player to reach 10 points wins the game. If more than one player earns 10 points in the same game, these players continue playing until one of them pulls ahead.
- Play a different version and use the cards to calculate the length and girth of a cylinder.
 - Deal only two cards to each player.
 - Use the values as the dimensions of a cylinder. The first card gives the radius. The second card gives the length.
 - Use a calculator to determine the length and girth measurement of your cylinder, to the nearest centimetre.
 - Award points and decide the winner in the same way as before.
- Play a round of each version in which players need to convert centimetres to inches before calculating.
- Discuss strategies you can use to help you win the game. Try your strategy.

My cards are a 5, a 3, and an 8.

$$l = 8$$

$$g = 2(5 + 3)$$

$$l + g = 24 \text{ cm}$$



My cards are a 4 and then a 6.

$$r = 4$$

$$l = 6$$

$$g = 25.13$$

$$l + g = 31 \text{ cm}$$

