

Unit 6

Measurement

Topic A: Why Metric?

This unit will help you explore the system of metric measurement.

First, why metric?

- Over 98% of the world's population uses the metric system of measurement or is in the process of converting to it.
- The *International System of Units (SI)* was established in 1960 as a result of a long series of international discussions. The **SI** sets the standards for the modern metric system. Because of **SI**, the use of the metric system provides exact measurements which have the same meaning worldwide.
- The metric system is patterned after the decimal number system – which means that the metric system focuses on **10**. The calculations within the metric system are done with factors such as 10, 100, 1000. **Many such calculations can be done by simply moving the decimal point.**
- The metric system uses the same prefixes with all the units. Once you understand the prefixes and the units, your knowledge can be applied to all the metric measures used in science, technology, and everyday life.
- The **SI** provides certain rules of style. Some of these are listed for your reference on the next two pages. Read them over now and then look back at them often as you work with metric measurement.

The end of this unit will look at how metric measurement (metres, litres, grams, etc) and imperial measurement (inches, feet, cups, ounces, pounds, etc) compare to each other.

A Review of Measurement Units

The metre:

The metre is the base unit used to measure **length, height, and distance**.

Here are some ways we use length, height and distance measurement in our everyday lives:

- A. I drove 58 km from Vernon to Salmon Arm.
- B. It is 1 755 km from Dease Lake to Vancouver.
- C. The height of a newborn baby is 50 cm.
- D. An average adult male is about 1.8 m tall.
- E. A standard doorway is 2 m high.
- F. A brand new pencil is about 18 cm long.
- G. The base of a pencil is about 8 mm in length.

The gram

The gram is the unit for measuring **mass**. (We use the words mass and weight in the same way.)

Here are some ways we use the measurement of mass in our everyday lives:

- A. 1 paper clip is 1 g.
- B. 1 000 paper clips is 1 kg, or 1000 g.
- C. A medium sized raisin is about 1 g.
- D. A block of butter (known as 1 pound in the imperial system) is 453.5 g.
- E. An adult woman can weigh about 63 kg.
- F. A baby might weight about 3.5 kg when born.
- G. A semi – trailer transport truck weighs about 425 000 kg.

The litre

Litres are the everyday unit that we use to measure volume or capacity.

Volume or capacity tells how much a container can hold. For example, the volume of the classroom would be represented by the amount of air in the room. The capacity of a container would be the amount of liquid it could hold. We use **litres** to measure liquids and gases such as air.

Here are some ways we use volume measurement in our everyday lives:

- A. A big plastic milk jug is 4 L.
- B. A juice box that goes in a child's lunch is 250 ml.
- C. There is 355 ml of pop in a regular pop can.
- D. Gas tanks can hold about 50 L of gasoline.
- E. The average person has about 3.8 L of blood in his or her body.

Degree Celsius °C

Degrees Celsius is the common unit for measuring temperature. The symbol is °C.

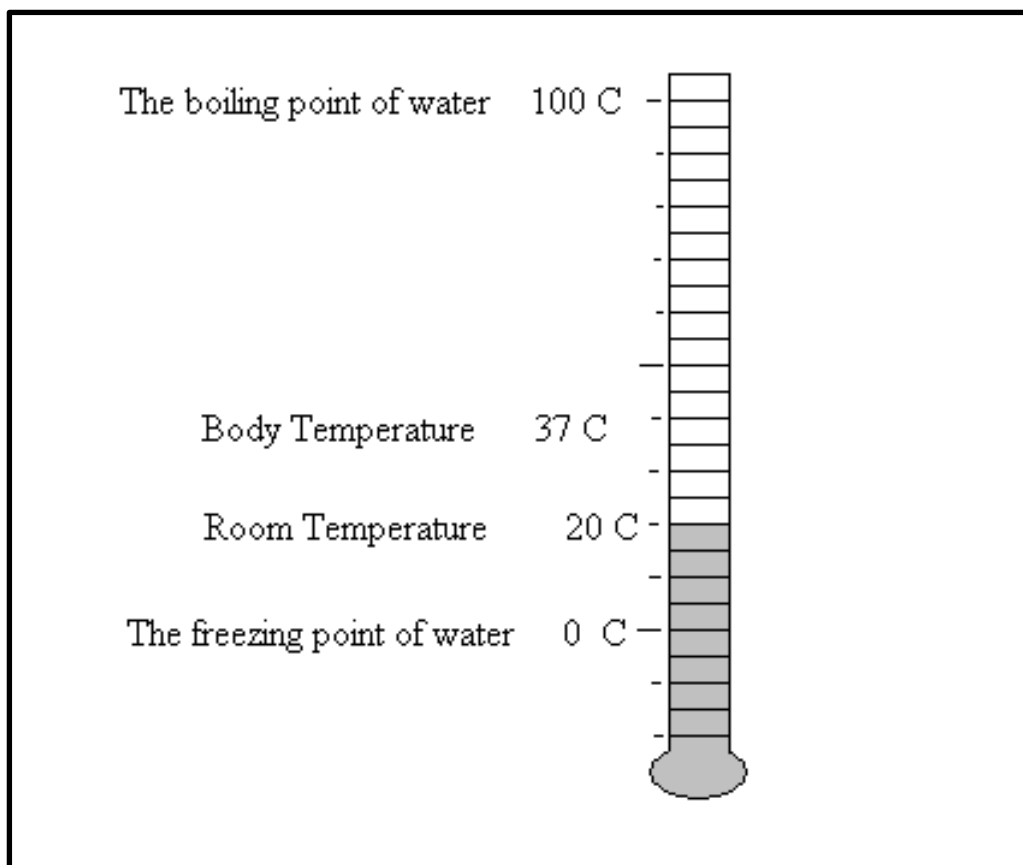
The Celsius temperature scale was determined by

- setting the freezing point of water at **0°C**
- setting the boiling point of water at **100°C**
- dividing the interval between freezing and boiling of water into **100 equal parts known as degrees Celsius**
(The name is from the 18th century Swedish scientist, Anders Celsius.)

Temperatures colder than the freezing point of water are “below zero” or “below freezing” and are indicated with a minus sign in front of the number.

five and a half degrees below freezing is written **-5.5°C**

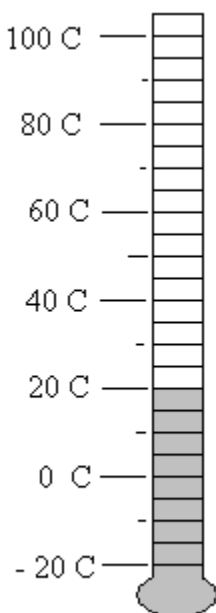
forty degrees below zero is written **-40°C**



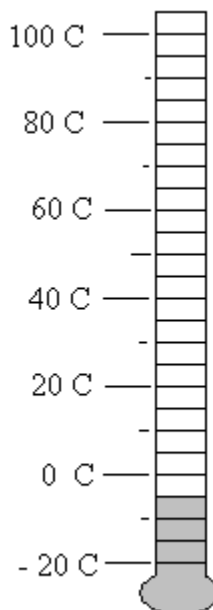
Exercise One

Read the temperatures on the thermometers pictured on the page.

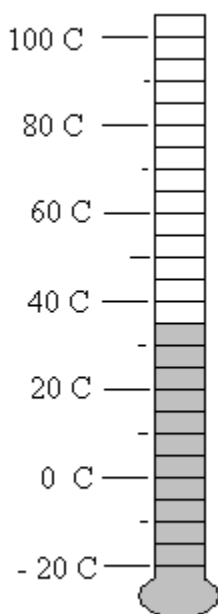
a)



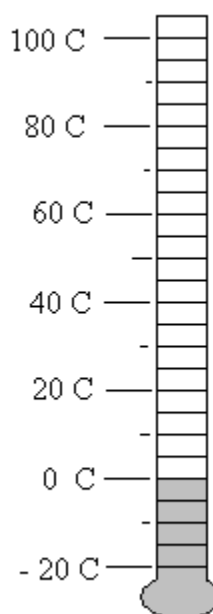
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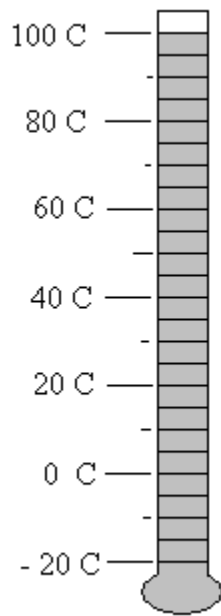
c)



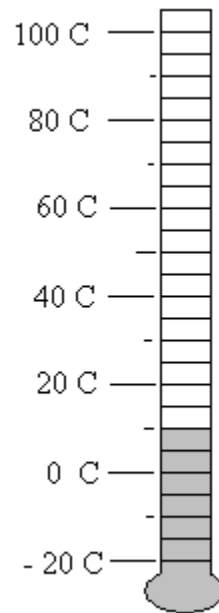
d)



e)



f)



Answers to Exercise One

a) 20°C

b) - 5°C

c) 35°C

d) 0°C

e) 100°C

f) 10°C

Body Temperatures

37 °C	normal
38 °C	feverish, you might consider calling a doctor
39 °C	very feverish
40 °C	dangerously high body temperature (equal to 104 °F)

Air Temperatures

40 °C	too hot – sit down in the shade and relax!
30 °C	very warm summer's day
20 °C	pleasant temperature for outdoor activities
10 °C	quite cool, you need a coat
0 °C	water is freezing
-10 °C	brisk winter's day
-20 °C	cold, watch for frostbite
-30 °C	very cold
-40 °C	extremely cold!!!

Exercise Two

Keep track of the morning temperatures each day for a week. Put a thermometer outside your window and fill in the following chart. This is a great activity to do with your kids. The purpose of this activity is to get familiar with reading a thermometer, which is practicing a scientific measurement.

Day of week	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Temperature in °C							

Rules of Style

Names of Units

- The name of a unit starts with a lower case (small) letter except at the beginning of a sentence and except for degrees Celsius.

gram metre litre second

- Use only one prefix at a time with a base unit. Do not use a hyphen (-) between the prefix and the base unit.

kilogram centimetre millilitre

Symbols

- With numerals, use the symbols for the metric units, not the full name.

For example, 67 km, **not** 67 kilometres

2.1 L, **not** 2.1 litres

- Write the full name of the unit and prefix if no numeral is used.

For example, milk is measured in litres.

- Do not use a period after the symbols. A period is only used if the symbol is at the end of a sentence.

For example, Matt drove 457 **km** yesterday.

Yesterday, Matt drove 457 **km**.

- Do not use an “s” with the symbols to mean more than one unit.

For example, four kilograms is written **4 kg** (no “s” and no period)

- Do not start a sentence with a symbol; write out the full name at the beginning of a sentence.

- If a unit is squared, an *exponent* is used. For example, five square metres is written as **5 m²**.

Numerals

- Leave a space between the last digit of the numeral and the symbol.

For example, 45 km 2.5 L

An exception is degrees Celsius, which is written as 27°C with no space.

- Use decimal fractions with metric units, not common fractions.

For example, 10.75 km, **not** $10\frac{3}{4}$ km

- If a number is greater than ten, the preferred **SI** form is to use numerals, not the written-out number name.

For example, 15 L, **not** fifteen litres

- **If** the number name is written out, write the full name of the metric unit also.

For example, two kilometres, twenty-five metres

Topic B: The Prefixes

The metric system uses base units, some of which you have just studied. It would not be practical to use only the base units because sometimes the unit would be far too large and other times it would be too small.

- If your weight was written in grams, it might be 60 000 g – that sounds massive!
- The distance from Vancouver to Montreal is approximately 4 800 000 m.
- To measure a sewing seam or to select a wrench using only metres would mean using decimal amounts such as 0.007 m for a wrench and 0.015 m for the seam allowance on a dress.

These measures would all be correct but inconvenient to use. They would be easier to understand as:

- Your weight is 60 kg.
- The distance from Vancouver to Montreal is approximately 4800 km
- A 7 mm wrench and 1.5 cm for a seam allowance.

The metric prefixes are similar to the place values in our number system. The prefix in front of a base unit tells **how many** of the base unit.

For example, the prefix **kilo** means **1000**, so

- a **kilometre** is 1000 metres
- a **kilogram** is 1000 grams
- a **kilolitre** is 1000 litres

Each prefix can be combined with almost any unit. You will need to memorize the most common prefixes, their symbol and their meaning.



On the next page is a chart of most of the prefixes used in **SI**. In our everyday life and studies we use only a few of these prefixes. However, it is interesting to look at the pattern of the prefixes and compare their pattern to the place value that you know so well. The ones to memorize are written in **bold** type and marked with an *.

A Chart of the SI Prefixes

Prefix	Symbol	Number of Base Units
terra	T	1 000 000 000 000
giga	G	1 000 000 000
mega	M	1 000 000
kilo*	k	1 000
hecto*	h	100
deca*	da	10
no prefix	base unit	1
deci*	d	0.1
centi*	c	0.01
milli*	m	0.001
micro	μ	0.000 001
nano	n	0.000 000 001
pico	p	0.000 000 000 001

Exercise Three

Use the Prefix Chart to answer these questions.

- a) Give the meaning and symbol for *deca* *Deca means ten base units. da*
- b) Give the meaning and symbol for *hecto* _____
- c) Give the meaning and symbol for *kilo* _____
- d) Write the symbols for these units: metre , gram , litre _____

e) Look at the prefixes *deci*, *centi*, *milli*, (and also *micro*, *nano*, *pico*). These prefixes tell you that the measurement is **less than the base unit**; they give a fraction of the base unit.

i) deci means one tenth of the unit

ii) centi means _____

iii) milli means _____

As a memory helper, notice that these three units which give a fraction of the base unit, all end with the letter **i**. You already know that *centi* is the Latin word for “one hundredth” and that one cent is one hundredth of a dollar.

f) Prefixes have been combined with base units in this exercise. Write the meaning and the symbol. The first two questions are done as examples.

i) centimetre one hundredth of a metre cm

ii) decagram ten grams dag

iii) kilogram _____

iv) hectometre _____

v) millilitre _____

vi) decimetre _____

vii) centigram _____

viii) kilometre _____

ix) hectolitre _____

x) decametre _____

Answers to Exercise Three

- | | |
|--|--|
| a) deca means ten base units. da | b) hecto means 100 base units. h |
| c) kilo means 1000 base units. k | d) metre m gram g litre L |
| e) i) deci means one tenth of the unit | |
| ii) centi means one-hundredth of the unit | |
| iii) milli means one thousandth of the unit | |
|
f) i) one hundredth of a metre cm | ii) ten grams dag |
| iii) thousand grams kg | iv) hundred metres hm |
| v) one-thousandth of a litre mL | vi) one-tenth of a metre dm |
| vii) one-hundredth of a gram cg | viii) thousand metres km |
| ix) hundred litres hL | x) ten metres dam |

Exercise Four

Complete the chart. The first three are done for you.

Symbol	Word Name	Meaning	Measures
kL	<i>kilolitre</i>	<i>one thousand litres</i>	<i>capacity</i>
hm	<i>hectometer</i>	<i>one hundred metres</i>	<i>distance (length)</i>
dg	<i>decigram</i>	<i>one tenth of a gram</i>	<i>mass</i>
mm			
daL			
kg			
m			
mL			
dag			
cL			
cm			
hL			
hg			
L			
dam			
mg			
dL			
g			
km			
cg			
dm			

Answers to Exercise Four

Symbol	Word Name	Meaning	Measures
kL	<i>kilolitre</i>	<i>one thousand litres</i>	<i>capacity</i>
hm	<i>hectometer</i>	<i>one hundred metres</i>	<i>distance (length)</i>
dg	<i>decigram</i>	<i>one tenth of a gram</i>	<i>mass</i>
mm	millimetre	one-thousandth of a metre	distance
daL	decalitre	ten litres	capacity or volume
kg	kilogram	thousand grams	mass
m	metre	one metre	distance
mL	millilitre	one-thousandth of a litre	capacity
dag	decagram	ten grams	mass
cL	centilitre	one-hundredth of a litre	capacity
cm	centimetre	one-hundredth of a metre	distance
hL	hectoliter	hundred litres	capacity
hg	hectogram	hundred grams	mass
L	litre	one litre	capacity
dam	decametre	ten metres	distance
mg	milligram	one-thousandth of a gram	mass
dL	decilitre	one-tenth of a litre	capacity
g	gram	one gram	mass
km	kilometre	thousand metres	distance
cg	centigram	one-hundredth of a gram	mass
dm	decimetre	one-tenth of a metre	distance

Topic B: Measuring

The metre is the base unit for this purpose. In Topic C, all the prefixes were combined with the base unit *metre*. But for everyday purposes, we use only kilo, centi and milli with metre.

Use...	To Measure
kilometres	long distances, such as road distances, length of rivers, to measure car speed per hour, highway signs
metres	medium lengths, such as room size, track and field events, size of building lots, rope, extension cords, fabric, carpeting
centimetres	common, smaller things such as a person's height, waist measurement, size of furniture, length of pants, width of wax paper, shoelaces, skis
millimeters	very small things such as postage stamps, size of precise tools, length of screws and nails, fine sewing measurements, thickness of plywood and glass

Exercise Five

Get a metre stick or tape measure. If you have problems, your instructor will assist you in reading the measuring tool that you use and will check your work.

- a) Find the centimetre markings on the metre stick or tape measure. Remember that one centimetre is one hundredth of a metre, so there are 100 centimetres in each metre.
- b) Using the centimetre markings, measure the following:
 - i) your desk or table top, in both directions
 - ii) the distance from the floor to your desk top (its height)
 - iii) the cover of this book
 - iv) the covers of two different-sized books
 - v) the thickness of a fat dictionary
 - vi) the height of your chair seat from the floor

- vii) the length of your foot
- viii) the length of your hand from your wrist to your fingertips
- ix) your hand span; that is, how far you can stretch from the tip of your thumb to the tip of your little finger.



Your hand span is a **handy** measurement to know because you can use it as a measuring tool to make quick measurements of smaller objects. Knowing the length of your pace is useful for quick measurements of room size, etc.

- c) You will need a flexible tape measure for these measurements to be taken in centimetres. These are personal measurements which you may keep private if you wish.
 - i) your height
 - ii) your waist
 - iii) your chest
 - iv) your hips
 - v) around your head
 - vi) around your neck
 - vii) your pant length, usually done on the inside seam

Exercise Six

The answers to questions a) and c) are listed below; your instructor will check your other measurements and assist you as needed.

- a) Look carefully at the measuring tool you have been using. Find the millimeter markings **if** they have been written on the tape or stick. You may have to look at a shorter ruler to find the millimeters marked.
 - i) A millimeter is one thousandth of a metre.
 - ii) _____ millimeters equal one metre.
 - iii) _____ millimeters equal one centimetre.

b) Now measure these items in your classroom, first in centimetres and then in millimeters:

i) the length of a pen

ii) the length of a pencil

iii) the length of an eraser

iv) the length of a paperclip

v) the length of your thumb

vi) the distance across a dime

vii) the distance across a quarter

viii) the height of a quarter when it is laying flat on the table – you will probably just use millimeters for this one!

ix) the length of two different pieces of chalk

x) the length of your longest fingernail

xi) the width of the fingernail on your small finger

c) Measure the longest (or widest) part of each picture in cm and in mm.

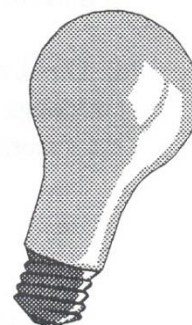
i)



ii)



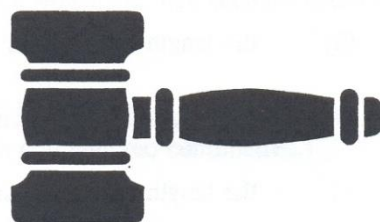
iii)



iv)



v)



i) ____ cm ii) ____ cm iii) ____ cm iv) ____ cm v) ____ cm

i) ____ mm ii) ____ mm iii) ____ mm iv) ____ mm v) ____ mm

Answers to Exercise Six

- a) i) A millimetre is one thousandth of a metre.
ii) 1000 millimetres equal one metre.
iii) 10 millimetres equal one centimetre.
- c) i) 4.5 cm 45 mm (wing tip to wing tip) ii) 3.1 cm 31 mm
iii) 4.1 cm 41 mm iv) 7.8 cm 78 mm
v) 5 cm 50 mm

Exercise Seven

Make the following measurements. Choose the most convenient unit (metres, centimetres, or millimetres) for each question. Draw a sketch of the shapes. Record your results carefully because you will use them at the end of the Unit Two.

- a) Measure the length and width of your classroom.
- b) Measure the length and width of the desk or table top that you use.
- c) **Estimate** the length and width of the hallway outside your classroom. Make this estimate by counting the number of **paces** you must take. Your instructor will demonstrate how to do this if you are not sure of the method.
- d) Measure the length and width of the top of a rectangular eraser. Find one that is not round.

Measuring Mass

Mass measures the weight of something. The unit for mass to which prefixes are attached is the gram – a very small mass. We use the kilogram (1000 g) for many everyday purposes. In fact, **SI** uses the kilogram as the official base unit because it is the most used, most practical amount. Let's look at the use of the common measurements for mass.

Use...	To Measure
tonne (t)	Very large amounts such as trucks and farm crops; loads on trucks, trains, and ships; coal; factory production
kilogram	Common amounts such as our body mass, meat and vegetables, packaged foods, packaged household supplies
gram	Small amounts of mass such as breakfast cereals, light packaged food, newborn babies, ingredients in some recipes. The amount of certain nutrients that we should eat. Bulk and delicatessen foods may be priced per 100 g.
milligram	Extremely small amounts of mass such as in medicines (“3 mg of pain-reliever in every tablet!”); the vitamins and minerals in foods (check the nutrient information on a package); the recommended dose of daily vitamins

The **tonne**, symbol **t**, has not been mentioned before. Notice that the name does not use a prefix or a base unit. Say “tun” for *tonne*.

$$1 \text{ tonne} = 1\,000 \text{ kg}$$

$$1 \text{ tonne} = 1\,000\,000 \text{ g (Can you imagine the mass of one million raisins?)}$$

Exercise Eight

Use a scale marked in kilograms at a supermarket for b) to e).

- a) Find your own mass in kg. _____
- b) Find the mass of a large turkey. _____
- c) Find the mass of 4 L of milk. _____
- d) Find the mass of 12 carrots. _____
- e) Find the mass of any vegetables and fruit you buy in the next week. _____

Measuring Capacity (Volume)

The base unit for capacity is the litre. Capacity measures how much fluid a container will hold. The fluid might be liquids such as milk, water, and blood or it might be a gas such as air or oxygen. The litre and the millilitre are the everyday measurements for capacity.

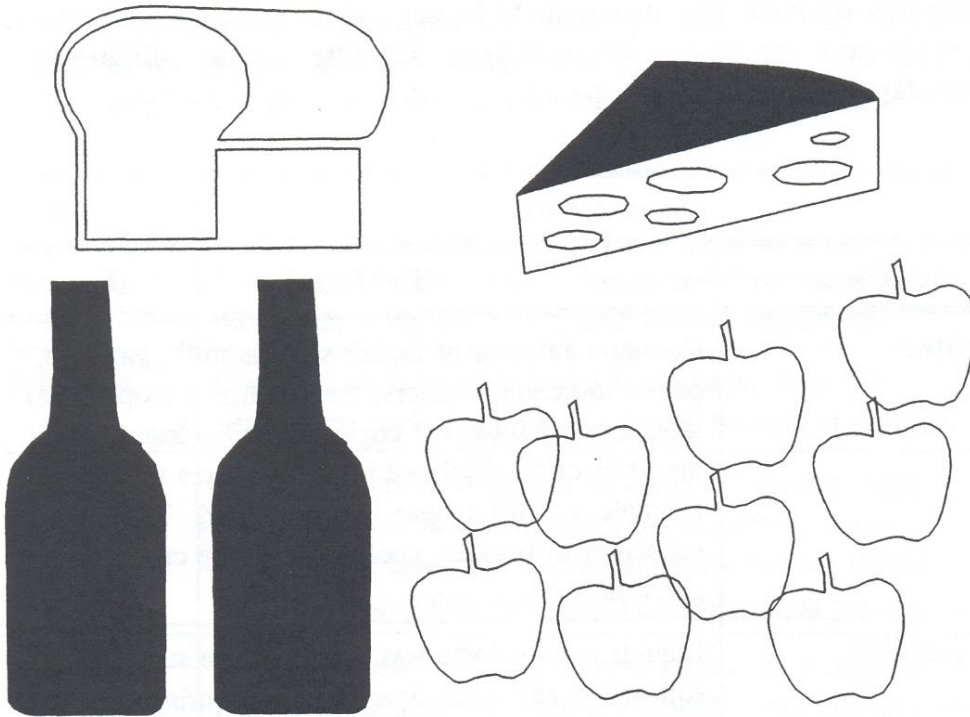
Use...	To Measure
litre	Common amounts of liquids such as milk, gasoline, paint, household cleaners, bottled drinks (pop, juice, etc.), large cans of food; car engines may be described by the litres of air displaced in the cylinders (for example, a 1.5 L engine in a small car). The capacities of buckets, cookware and ice cream are given in litres.
millilitre	Liquids in containers less than one litre such as food, soft drinks, and wine. Spices and flavouring for cooking (one teaspoon $\approx$ 5 mL). Measuring cups are often 250 mL or 500 mL.

Look at your home and around the grocery store to find items measured in litres and items measured in millimetres. Look at measuring spoons to help you get a feeling for small amounts measured in millilitres.

Exercise Nine

Write the measurement (prefix and unit) which would be most practical to measure these objects in real life.
Answer every part of each question.

a)



a)

Example:

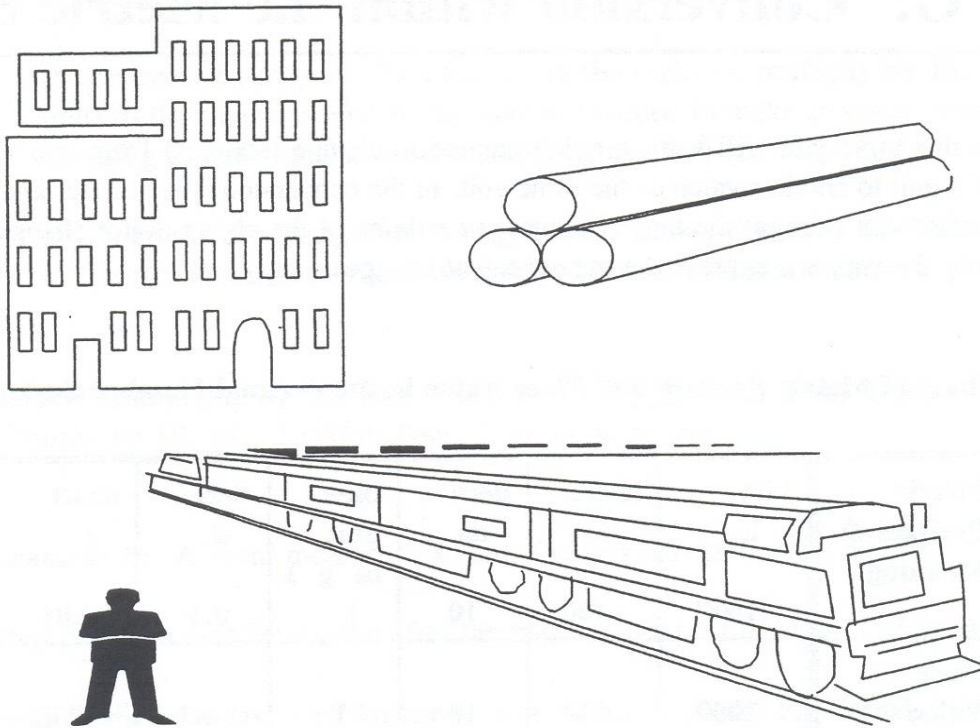
i) bread mass grams (g) length centimeters (cm)

ii) apples mass _____ distance around _____

iii) wine mass _____ height _____ capacity _____

iv) cheese mass _____ height _____

b)



b)

i) person mass _____ height _____ lung capacity _____

ii) building height _____ width _____

iii) train length _____ mass _____

distance the train travels per hour _____

iv) logs length _____ mass _____

distance across the cut end of one log _____

Answers to Exercise Nine

- | | |
|--|------------------------------------|
| a) i) bread: grams, centimetres | ii) apples: kilograms, centimetres |
| iii) wine: kilogram, centimetre, litre | iv) cheese: kilograms, cm or mm |
| b) i) person: kilograms, centimetres, litres | ii) building: metres, metres |
| iii) train: metres, tonnes, kilometres | iv) logs: metres, kg or tonnes, cm |

Topic C: Conversion within the Metric System

In this topic you will learn a quick method to change (convert) between different units with the same base. In the conversion, the number and the prefix both change; the length or mass or volume of the object is **not** changed – only the way we express the measurement changes.

☆ Are you a visual learner? If you are, then ask your instructor to show you the next skill. It will save you a lot of frustration. You may learn this skill much faster with a real life example.

Chart of Metric Prefixes and Place Value in the Decimal Number System

Metric Prefixes	kilo	hecto	deca	base unit	deci	centi	milli
Mass	kg	hg	dag	g	dg	cg	mg
Volume	kL	hL	daL	L	dL	cL	mL
Length	km	hm	dam	m	dm	cm	mm
Place Value	1000	100	10	1	0.1	0.01	0.001

Converting within the Metric System using the Chart

Example A: A cigar weighs 12 g. Convert this amount to mg.

- Step 1** If there is no decimal point in the amount, place a . after the amount.
 $12\text{ g} = 12.\text{ g}$
- Step 2** Locate the prefix of the known amount. If no prefix is given, find the base unit (gram in the example) in the centre of the chart.
- Step 3** Find the prefix that you are changing to (**milligram** in this example). It is to the right of the gram. Count the number of bars (|) between gram and milli. You **cross three bars to move three places to the right**.
- Step 4** **Move the decimal point the same number of places in the same direction** as you moved on the chart. Add zeros as needed.
 $12.\rightarrow\text{g} = 12\,000.\text{ mg}$ The cigar is 12 000 mg.

On the chart, every time you cross over a bar (|), the factor is **10**.

- If you cross a bar going from the left **to the right** $\rightarrow$, **multiply by 10**. The units to the right are smaller, so more are needed to make an equal amount. Crossing 3 bars is the same as multiplying by 1000 ($10 \times 10 \times 10$).
- If you cross a bar going from the right **to the left** $\leftarrow$, **divide by 10**. The units to the left are larger, so less are needed to make an equal amount.



Review Multiplying by 10, 100, 1 000.

Example B: The length of a room measures 450 cm. Convert this amount to metres.

Step 1 Place a decimal point after the known amount if needed. 450. cm

Step 2 Find the **prefix** of the known amount on the chart. Find **centi**.

Step 3 Find the prefix or the base unit (if no prefix was used) of the unit you are changing to. Is it left or right of centi? Count the bars between cm and metre. You cross two bars to move **two places to the left**. That is the same as dividing by 100.

Step 4 **Move the decimal point the same number of places in the same direction** as you moved on the chart. Add zeros as needed.

$$450.\leftarrow \text{ cm} = 4.50 \text{ m} \qquad 450 \text{ cm} = 4.5 \text{ m}$$

Example C: The container holds 45.5 dL. Write this amount in daL.

Step 1 and 2 A decimal point is already in the amount. Find **deci** on the chart.

Step 3 Find **deca** on the chart. Count the number of bars you cross going from deci to deca – 2 bars to move 2 places to the left. (divide by 100)

Step 4 Move the decimal point 2 places to the left.

$$45.5 \text{ dL} = 0.455 \text{ daL (less than 1 daL)}$$

Exercise Ten

Complete the metric conversions. Some units are not common, but the practice in conversion is useful.

- a) From memory, put the metric prefixes on the chart according to their place value. Check that your chart is correct before you use it.

_____ | _____ | _____ | base units | _____ | _____ | _____

b) $42 \text{ cm} = \underline{\hspace{2cm}} \text{ m}$ $8\,241 \text{ m} = \underline{\hspace{2cm}} \text{ km}$

c) $23 \text{ mm} = \underline{\hspace{2cm}} \text{ m}$ $2.86 \text{ m} = \underline{\hspace{2cm}} \text{ cm}$

d) $358 \text{ mm} = \underline{\hspace{2cm}} \text{ cm}$ $5 \text{ hm} = \underline{\hspace{2cm}} \text{ m}$

e) $0.87 \text{ m} = \underline{\hspace{2cm}} \text{ mm}$ $0.5 \text{ kg} = \underline{\hspace{2cm}} \text{ g}$

f) $33 \text{ kg} = \underline{\hspace{2cm}} \text{ cg}$ $500 \text{ mL} = \underline{\hspace{2cm}} \text{ L}$

g) $197 \text{ cm} = \underline{\hspace{2cm}} \text{ m}$ $4.5 \text{ kg} = \underline{\hspace{2cm}} \text{ dag}$

h) $28 \text{ m} = \underline{\hspace{2cm}} \text{ km}$ $890 \text{ dL} = \underline{\hspace{2cm}} \text{ kL}$

i) $8 \text{ L} = \underline{\hspace{2cm}} \text{ mL}$ $85 \text{ km} = \underline{\hspace{2cm}} \text{ m}$

j) $100 \text{ mm} = \underline{\hspace{2cm}} \text{ m}$ $78 \text{ mm} = \underline{\hspace{2cm}} \text{ cm}$

k) $45 \text{ cm} = \underline{\hspace{2cm}} \text{ mm}$ $3 \text{ hL} = \underline{\hspace{2cm}} \text{ mL}$

- l) Add 45 cm and 92 cm. Express the sum in metres.

$$45 \text{ cm} + 92 \text{ cm} = 137 \text{ cm} \qquad 137 \text{ cm} = 1.37 \text{ m}$$

- m) Add 245 m, 689 m, and 124 m. Express the sum in kilometres.

- n) Multiply 250 mL by 6. Express the product in litres.

Answers to Exercise Ten

a) kilo | hecto | deca | BASE UNIT | deci | centi | milli

b) 0.42 m 8.241 km

c) 0.023 m 286 cm

d) 35.8 cm 500 m

e) 870 mm 500 g

f) 3 300 000 cg 0.5 L

g) 1.97 m 450 dag

h) 0.028 km 0.089 kL

i) 8 000 mL 85 000 m

j) 0.1 m 7.8 cm

k) 450 mm 300 000 mL

m) 1.058 km

n) 1.5 L

Why Do We Need to Convert Measurements?

The skill of converting within the metric system is very useful.

- Before we can work with measurements we must **be sure the measurements are all in the same unit value**. For example, subtract litres from litres, multiply metres by metres, add milligram to milligrams.
- Measurements are usually written with small whole numbers. This is the *simple form* of the measurement. For example,
instead of 4 587 g, write 4.587 kg
instead of 52 000 mL, write 52 L
instead of 0.0065 m, write 6.5 mm

Before doing any calculations with measurements, convert them as needed so that the unit values are the same.

Example A: 50 g – 275 mg = ?

Convert 50 g to mg
50 g = 50 000 mg

Subtract	50 000 mg	
	<u>- 275 mg</u>	
	49 725 mg	which is 49.725 g

OR

Convert 275 mg to g
275 mg = 0.275 g

Subtract (add a decimal and zeros to make subtraction easier)

50.000 g
<u>- 0.275 g</u>
49.725 g

Example B: The bottom of the square dance skirt measures 2.6 m around. The lace trim is packaged in 75 cm lengths. How many packages of lace will Jill need to trim the buy?

First, convert the measurements to the same values.

$$2.6 \text{ m} = 260 \text{ cm}$$

This is a division problem. How many groups of 75 cm are in 260 cm?

$$260 \text{ cm} \div 75 \text{ cm} = 3.47 \text{ times}$$

She will need to buy 4 packages because she needs more than 3 packages and cannot buy a part of a package.



NOTE: When dividing you are finding out how many times something goes into something else, so you DO NOT use units in the answer.

Exercise Eleven

Convert as needed to solve these problems.

a) Complete the chart from memory for your use. Check that it is correct.

_____ | _____ | _____ | base units | _____ | _____ | _____

b) Harold is making frames for six of his favourite photos from his last hiking trip. Each photo needs 85 cm of framing wood. How many centimetres of wood does Harold need? The wood is sold by the metre so how many metres should Harold buy?

c) The new refrigerator is 175 cm high. The directions say that 10 cm must be left above the refrigerator for air circulation. The height of the space for the refrigerator is 1.9 m. Will the refrigerator fit?

d) The nutrition information on the cereal box says each serving contains 2.5 g of protein, 1.2 g of fat, 24.4 g of carbohydrate, 240 mg of sodium, and 97 mg of potassium. What is the total weight of one serving of cereal?

e) The stairway is 89 cm wide. How much must be trimmed from the side of the carpet runner that is 1 m wide?

f) Miah is calculating how much wine to buy for the banquet. She needs to fill glasses for the after-dinner *toasts* to the guests. How many 250 mL glasses will she be able to fill from a 4 L bottle of wine?

g) Jasmine bought snacks in the bulk food section for the class party. When her items were weighed, she had 430 g of taco chips, 621 g of peanuts, 356 g of cheesies, and 1.2 kilograms of fresh vegetables. How many kilograms of snacks, including the vegetables, did she buy?

h) Aarav is 1.67 m tall. His wife Chandani is 145 cm tall. How much taller is Aarav than his wife?

Answers to Exercise Eleven

a) kilo | hecto | deca | BASE UNIT | deci | centi | milli

b) 5.1 m

c) Yes, with 5 cm to spare

d) 28.437 g

e) 11 cm

f) 16 glasses

g) 2.607 kg

h) 22 cm taller

Write one unit for a measurement.

For example, use

2.75 m **not** 2 m, 75 cm

60.5 kg **not** 60 kg, 500 g

4.25 L **not** 4 L, 250 mL

When there is a mixed measurement such as shown in the examples, do this:

- convert the amount with the smaller unit value to the larger unit value (it will often be a decimal)
- add the amounts together

Example A: 16 cm, 4 mm

$$4 \text{ mm} = 0.4 \text{ cm}$$

$$16 \text{ cm} + 0.4 \text{ cm} = 16.4 \text{ cm}$$

Example B: 1 km, 350 m

$$350 \text{ m} = 0.350 \text{ km}$$

$$1 \text{ km} + 0.35 \text{ km} = 1.35 \text{ km}$$

Exercise Twelve

Write these measurements using only one unit.

a) 5 L, 750 mL = _____

b) 8 m, 45 cm = _____

c) 3 kg, 150 g = _____

d) 60 cm, 4 mm = _____

e) 1 m, 5 cm = _____

f) 1 km, 75 m = _____

g) 5 m, 7 dm = _____

h) 89 km, 5 hm = _____

i) 6 m, 345 cm = _____

j) 125 g, 590 mg = _____

Answers to Exercise Twelve

a) 5.75 L

b) 8.45 m

c) 3.15 kg

d) 60.4 cm

e) 1.05 m

f) 1.075 km

g) 5.7 m

h) 89.5 km

i) 9.45 m

j) 125.59 g

Exercise Thirteen

Here is more conversion practice; perhaps do half the questions now and save the rest for review.

a) _____ | _____ | _____ | base units | _____ | _____ | _____

b) 3.2 km = _____ m

c) 8.7 hm = _____ m

d) 0.006 m = _____ mm

e) 45.5 cm = _____ m

f) 1.64 kg = _____ g

g) 45.5 L = _____ kL

h) 155 g = _____ hg

i) 0.086 cm = _____ mm

j) 2 m + 16 cm = _____ m

k) 4 mm = _____ cm

l) 1 L + 50 mL = _____ L

m) 5 000 000 m = _____ km

n) 89 m = _____ km

o) 78 dg = _____ mg

p) 457 m = _____ hm

q) 12.5 kg = _____ dag

Watch for different units! Use the simplest form for the answer.r) 674 mm
+ 86 cms) 589 km
- 975 mt) 5.5 g
- 40 dgu) 45 mL
+ 16 cL

v) 9954 mL - 8.9 L = _____

w) 128 hm + 4 km = _____

Answers to Exercise Thirteen

a) kilo hecto deca BASE UNIT deci centi milli				
b) 3 200 m	c) 870 m	d) 6 mm	e) 0.455 m	f) 1 640 g
g) 0.0455 kL	h) 1.55 hg	i) 0.86 mm	j) 2.16 m	k) 0.4 cm
l) 1.05 L	m) 5 000 km	n) 0.089 km	o) 7 800 mg	p) 4.57 hm
q) 1 250 dag	r) 153.4 cm (1.534 m)	s) 588.025 km	t) 1.5 g (15 dg)	u) 205 mL
v) 1.054 L	w) 16.8 km			(20.5 cL)

Heads up on a new little twist for you!

When you are dividing two items of the same units, the units ‘cancel’ themselves out. This means that your answer will not have a unit written in after the number.

Follow this example:

a) $5000 \text{ g} \div 40 \text{ g} = 125$ (no units written!)

b) $880 \text{ cm} \div 11 \text{ mm} = 8\,800 \text{ mm} \div 11 \text{ mm} = 800$ (no units!)

Exercise Fourteen

a) $6\,000\text{g} \div 250 \text{ g} =$ _____ b) $7\,800 \text{ km} \div 5 \text{ km} =$ _____

c) $3.38 \text{ m} \div 13 \text{ cm} =$ _____ d) $110 \text{ kL} \div 80 \text{ L} =$ _____

e) $6 \text{ km} \div 300 \text{ m} =$ _____ f) $660 \text{ cm} \div 11 \text{ mm} =$ _____

Answers to Exercise Fourteen

a) 24	b) 1560	c) 26	d) 1375	e) 20	f) 600
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Topic C: Self-Test

Mark /28 Aim 23/28

A. Give the measurement (unit with prefix as needed) that would be most practical to measure these items. **11 Marks**

- | | |
|---|---------------------------------|
| a) a child's height | b) the grain shipment to Russia |
| c) a big bag of flour | d) a jug of cream |
| e) the distance from Ottawa to Toronto | f) the temperature of the room |
| g) a box of oranges | h) a box of crispy potato chips |
| i) the distance from your seat to the door | j) a can of house paint |
| k) the flavouring to put in the cake batter | |

B. Complete the metric conversions.

10 Marks

- | | |
|-----------------------|-----------------------|
| a) 8 m = _____ cm | b) 6 L = _____ mL |
| c) 5.2 hm = _____ km | d) 8 dL = _____ daL |
| e) 4.2 kg = _____ g | f) 26 mg = _____ g |
| g) 242 dag = _____ kg | h) 45.2 cm = _____ mm |
| i) 28 mm = _____ cm | j) 94 mg = _____ dg |

C. Calculate. Express the answer in simplest form. Watch the prefixes! 7 marks

a) $8.2 \text{ L} - 48 \text{ mL} = \underline{\hspace{2cm}}$

b) $526 \text{ m} - 0.5 \text{ km} = \underline{\hspace{2cm}}$

c) $42 \text{ mg} + 2 \text{ dg} = \underline{\hspace{2cm}}$

d) $67 \text{ km} + 13 \text{ hm} = \underline{\hspace{2cm}}$

e) $0.8 \text{ m} \div 20 \text{ cm} = \underline{\hspace{2cm}}$

f) $108 \text{ g} \div 54 \text{ mg} = \underline{\hspace{2cm}}$

- g) You need a strip of metal that is 97 cm in length. The piece of metal that you found in the workshop is 1.3 m. How much must be cut off the end to give you a 97 cm strip?

Answers to Topic C Self-Test

A)

a) cm

b) tonne

c) kg

d) mL

e) km

f) °C

g) kg

h) g

i) m

j) L

k) mL

B)

a) 800 cm

b) 6 000 mL

c) 0.52 km

d) 0.08 daL

e) 4 200 g

f) 0.026 g

g) 2.42 kg

h) 452 mm

i) 2.8 cm

j) 0.94 dg

C)

a) 8.152 L

b) 0.026 km

c) 242 mg

d) 68.3 km

e) 4 cm

f) 2 000 mg

g) 33 cm

Weights and Measures

Originally, people would measure things compared to their body parts.

- In French, the word for **inch** is *pouce*, which means thumb. So, really, an inch came from the measurement of a thumb.
- We still use the **foot** for measurement. It came from the measurement of an average person's foot.
- If you have ever heard anyone talking about horses, you may have heard about a horse being a certain number of '**hands**' tall. But, measuring things with your own body is not practical because we are all different shapes.

The original system of using body parts to talk about measurements was replaced in England by **the Imperial System**. This became a popular set of measurements that many countries followed. It made trading goods easier, because people were using the same units of measure. But, this imperial system has problems. If you have ever tried to divide a foot into 5 equal parts, you will know that it is not easily done. (A foot is 12 inches, which is not easily divided into 5 equal parts). This problem is found with almost all measurements in the imperial system.

Then, the **International System** (also known as **Metric**) was created to make it even easier for people to work with measurements. It is made on a **Base Ten System**. The Base Ten System is another name for the decimal number system that we use every day. Because we already use the Base Ten System as our decimal system, which many cultures around the world use, it is easy to measure things and divide them up or add them together.

Here are some of the measurements that you may see in the Imperial System and the International System (Metric):

	Imperial System:	International System (Metric)
Length	Inch, foot, yard, mile	Millimetre, centimetre, metre, kilometre
Mass	Ounce, pound, ton	Milligram, gram, kilogram
Volume	Fluid ounce, cup, pint, quart, gallon	Millilitre, litre, kilolitre

Here are some conversions between the two systems:

	Imperial System:	International System (Metric)
Length	1 inch	2.54 cm
	1 foot	0.30 m
	1 mile	1.61 km
	1.09 yards or 3.28 feet	1 m
	0.62 miles	1 km
Mass	1 ounce	28.35 g
	1 pound	0.45 kg
	0.04 ounces	1 g
	2.20 pounds	1 kg
Volume	1 fluid ounce	29.57 ml
	1 quart	0.95 L
	1 gallon	3.79 L
	0.03 fluid ounces	1 ml
	1.06 quarts	1 L

This is information you may find useful. It is not necessary to learn or memorize any of the above numbers.

Unit 6 Review

1) Complete these metric conversions:

a) 5 m = _____ cm

q) 37.63g = _____ kg

b) 3.3 dam = _____ mm

r) 400.3 kg = _____ hg

c) 53 mm = _____ dm

s) 333 mg = _____ g

d) 1 km = _____ m

t) 0.34 g = _____ mg

e) 38 cm = _____ dam

u) 17 L = _____ mL

f) 47.39 m = _____ hm

v) 3.9 kL = _____ dL

g) 3.734 km = _____ mm

w) 3 hL = _____ mL

h) 47.32 m = _____ dm

x) 500 mL = _____ L

i) 15 dam = _____ hm

y) 28 mL = _____ dL

j) 0.53 cm _____ mm

z) 19.7 cL = _____ L

k) 7 cg = _____ mg

aa) 5 hL = _____ kL

l) 218 dag = _____ g

bb) 500 L = _____ daL

m) 31.4 hg = _____ dg

cc) 38.943 L = _____ kL

n) 3.843 kg = _____ g

dd) 4.329 dL = _____ mL

o) 47.1 cg = _____ mg

p) 42 mg = _____ g

2) Write these measurements using only the larger unit.

a) 6 L and 650 mL = _____ g) 55 mL and 1 L = _____

b) 8 g and 45 cg = _____ h) 60 cm and 4 mm = _____

c) 1 kg and 45 g = _____ i) 1 m and 50 cm = _____

d) 9 km and 35013 cm = _____ j) 5 km and 7 hm = _____

e) 5 m and 8 dm = _____

f) 6 g and 345 cg = _____

3) Solve the following word problems:

a) Bamboo is a fast growing plant. It can grow 2 cm per hour. In 5 weeks, a bamboo reaches adult height of 18 m. If Frank planted a bamboo seedling that was 7 cm high, how much did it grow to reach 18m?

b) The sediment at the bottom of a creek is usually 17 cm thick. Recent winter flooding washed 22 mm of the sediment away. How thick is it now?

c) A logging company needs to cut a 70 m long mountain pine beetle killed tree into 20 equal pieces before loading it onto a truck for shipping. How long will each piece be?

d) An elevator has a weight limit of 1 500 kg. The maximum capacity of the elevator is 20 people. What is the average weight of each passenger?

e) One box of hot chocolate mix weighs 0.478 kg, but 37 grams of this weight is the packaging. What is the actual weight of the hot chocolate mix?

f) Cousin Jim used to drink 1.33L of milk each day as a teenager. How much milk did he drink each week?

g) Julie's car has a 50.4 L gas tank. She just bought 48.7 L of gas, how much did she have left in the tank before she filled up?

h) Deepa drank 368 mL of tea from her two litre teapot. How much tea is left in the pot?

Answers to Review

1)

- | | | |
|-----------------|---------------|-----------------|
| a) 500 cm | k) 70 mg | v) 39 000 dL |
| b) 33 000 mm | l) 2 180 g | w) 300 000 mL |
| c) 0.53 dm | m) 31 400 dg | x) 0.5 L |
| d) 1 000 m | n) 3 843 g | y) 0.28 dL |
| e) 0.038 dam | o) 471 mg | z) 0.197 L |
| f) 0.4739 hm | p) 0.042 g | aa) 0.5 kL |
| g) 3 734 000 mm | q) 0.03763 kg | bb) 50 daL |
| h) 473.2 dm | r) 4 003 hg | cc) 0.038943 kL |
| i) 1.5 hm | s) 0.333 g | dd) 432.9 mL |
| j) 5.3 mm | t) 340 mg | |
| | u) 17 000mL | |

2)

- | | |
|---------------|------------|
| a) 6.65 L | f) 9.45 g |
| b) 8.45 g | g) 1.055 L |
| c) 1.045 kg | h) 60.4 cm |
| d) 9.35013 km | i) 1.5 m |
| e) 5.8 m | j) 5.7 km |

3)

- a) It grew 17.93 m.
- b) The sediment is now 14.8 cm.
- c) The log will be cut into 3.5 m pieces.
- d) The average weight of each passenger can be 75 kg each.
- e) The actual weight of the mix is 0.441kg or 441g.
- f) He would drink 9.31 L of milk each week.
- g) Julie had 1.7 L of gas left in her tank before she filled up.
- h) Deepa has 1.632 L of tea left in her pot.

Test time!

Please see your instructor to get
your practice test.

When you are confident, you can write
your unit 6 test.

Final Test Time too!

This is the last unit of your course, so,
now is the time to write the final test too!

See your instructor for the practice final,
and when you are confident,
you can write the final.

Congratulations!