Mathematics 10-3 Unit 4 Measurement Systems







Lesson A Imperial and Metric Systems Introduction





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Mathematics 10-3

Unit 4 Measurement Systems



Unit 1: Money Math

Unit 2: Personal Finances

Unit 3: Linear Measurements

Unit 48 Measurement Systems

Unit 5: 2-D and 3-D Measurements

Unit 6: Lines, Angles, and Shapes

Unit 7:

Pythagorean Theorem and Right Triangles

> Unit 8: Introduction to Trigonometry

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Mathematics 10-3 Unit 4, Lesson A

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Lesson A Imperial and Metric Systems Introduction



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Lesson As Imperial and Metric

Imperial and Metrio Systems Introduction

Lesson B: Imperial and Metric Measurements

Lesson C:

Conversions between Imperial and Metric Measurements

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The following icons will guide you through the course.



Lesson A:

Imperial and Metric Systems Introduction



Tristine loves to get involved in sports. Her latest interest is the triathlon. She has been running lots in gym class, and every Saturday morning she goes for a long distance run, usually about 45 minutes long. Swim club helps her to keep her stamina in the pool, and she does the front crawl very well.

The only tricky event for her to practise is the biking. She doesn't have much time to just go for a bike ride. Tristine's family lives in the country, and she decided that if she biked into town to school every day in May and June, she should be well prepared for her first triathlon on Canada Day.



Treasure Chest

A triathlon involves 3 sports: running, swimming, and biking. In what order must the athletes do the three sports?

Call your instructor to give your treasure chest answer and earn coins towards bonus marks.



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Now, the next problem is that her bike needs a good tune-up after the winter. Tristine and her dad work on the bike together to get it ready for her to train for the triathlon. While Tristine pumps some air into the tires, her dad oils the chain and then checks her brakes.



He notices that one of the screws on the hand brake is loose and asks Tristine to get a ½ inch wrench from his tool box for him so he can tighten the screw. She goes to get it and notices another wrench that looks to be about the same size but has 130 mm on it.



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"Hey Dad, why do these two wrenches look like they are the same size but they are marked with different numbers?"

Tristine's dad looks up and explains that one is an Imperial wrench and the other is a metric wrench.

"What's the difference?" Tristine asks...and perhaps you would like to know as well.







Let's Get Messy

Here are the items you need for this activity:

- Some small items (Choose **one** item from the list.)
 - sticks of gum
 - band-aids (They must be the same size, not different sizes.)
 - dice
 - Lego pieces
 - sugar cubes
 - Smarties, Skittles, or M&Ms
 - Perhaps you can think of something else. Remember this is like the referents you learned about in Unit 3. The object you choose has to be uniform in size.
- paper and pencil
- calculator
- discussion participants (teacher, parents, classmates, friends)



In this Get Messy activity, you will develop your own system of measurement. Here is some background to help you get the idea.



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In the Imperial system, the inch is the smallest whole number linear measurement. Remember that 1 inch is about as wide as an adult thumb. So, a thumb width is a referent for the Imperial linear unit of 1 inch.

You may recall from previous Math classes that 12 inches make 1 foot and 3 feet make 1 yard, and then there are miles. All the linear measurements used in the Imperial system started with one small unit, and the rest of the units developed from there.

A referent for 1 centimetre in the metric system was the width of a pinky finger. In previous Math classes, you have learned that 10 centimetres are a decimetre, 100 centimetres are 1 metre and 1000 metres are 1 kilometre. Again, the system started with a referent. Then, a small unit and the bigger units developed from there.



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In this lesson, you will learn how those two systems developed, but before you get to that, you can develop your own system.



Lesson A: Imperial and Metric Systems Introduction

Task 1

Choose your base unit from the list of small items. Or, you can choose an item of your own. Remember that your item has to be something that is always the same size.

Record the item that you will use for your base unit:

Task 2

Choose a name for your base unit:

Here is an example: The inch is the name for the smallest whole linear unit in the Imperial system of measurement.

Maybe if you choose a stick of gum as a referent for your base unit, you could name the base unit a 'sticket'. That word doesn't exist in the English language (at least I don't think it does) and wouldn't be confused with anything else, so it could be the name of a unit of measure in a new system.



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Task 3

Decide how many small units will make the next larger unit. Remember that 12 inches = 1 foot. Inches are handy units for measuring smaller things, feet are good for measuring longer things, such as a desk or a wall in a room. It is a good **medium-sized** unit of length.

12 inches = 1 foot



```
My example is 15 stickets = 1 schteck. (Yes, that is a made
up word too!)
```

Ok, your turn:

_____ = 1 _____

(amount of your small unit) (the name of your next bigger unit)

You are inventing a new system of measurement. Pick good names for the units and useful sizes for each unit.

Task 4

Keep going. Make as many length units as you like. Be clear on how many of each previous unit makes up the new one.



Task 5

Here is a little calculation for you to do. Using Imperial units again, 1 inch is the smallest whole unit. 12 inches is 1 foot and 3 feet is 1 yard.

Now, how many inches are in one yard?

Set up a ratio as an equation.

 $\times 3 \quad \begin{array}{c} 12 \text{ inches} = 1 \text{ foot} \\ ? \text{ inches} = 3 \text{ feet (1 yard)} \\ \end{array} \\ \times 3 \\ ? = 12 \times 3 \\ ? = 36 \\ 36 \text{ inches} = 1 \text{ yard} \end{array}$

To complete task 5, calculate how many of your base units are in one of the larger units, but not the next larger one, of course.



Task 6

Discussion time and opportunity to earn coins towards your bonus marks in the course!

You need to have at least two other people to participate in your discussion. Answer the following questions for your discussion and ask your discussion participants to comment on your answers.

1. What type of measuring tools or measuring devices could be built based on your system of measurement? Will rulers be used, etc.? List the measuring items that you would make for your system.

Your list of measurement tools.

Ask discussion participant #1 to comment on your choice of measurement tools and record his or her comments.

Do y Wou your	ou think your measuring system is useful? ld people find it easy to measure lengths with system?
Your	answer:
Disc	ussion participant #1's comments:
Disc	ussion participant #2's comments:

another in yo	ur system would be ea	.sy:
Your answer:		
Discussion pa	urticipant #1's comme	nts:
I .		
Discussion pa	articipant #2's comme	nts:



5.	Assume you want our government to use your system
	of measurement. Why would they pass legislation
	to use your system as our national measurement
	system?

Would you need to change or add to your system?

Your answer:

Discussion participant #1's comments:

Discussion participant #2's comments:

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How Does It Work?

We often switch back and forth between systems of measurement. Sometimes a common unit of measure used in real life is a SI or metric unit, and others that we use in real life might be from the Imperial system.



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When we talk about how much we weigh, we still commonly say our weight in pounds. Pounds are a common unit in the Imperial system.



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However, when we speak of how fast we drive, we talk in kilometres per hour. Kilometres are a common unit in the **SI metric system**.

We need to be familiar with the commonly used units in each system and how the two systems were developed. Think back to Lesson 3A. Remember that a 'hand' was referent to determine the height of a horse. The hand eventually became a standard unit of measure.



In the Get Messy activity **you** developed a system of measurement that started with a referent.



In ancient Egypt, referents were first used to measure things. Eventually, there was a problem. Not everyone measured things exactly the same way using a referent.

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So, standards were developed based on the referents the Egyptians had used, and a system of measurement evolved.



On the following page is a list of some of the common units of measure and the referents that they started from. **Cubit**: the distance from the end of the middle finger to the elbow



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Span: the distance from the tip of your pinky to the tip of your thumb when your hand is stretched out (**This is ½ cubit**.)

Test it out. Put your pinky of your right hand on the tip of your middle finger of your left hand and stretch your thumb down your arm towards the elbow.

Did your thumb reach your wrist? Is your thumb at a spot on your wrist that is about halfway to your elbow? Did your thumb reach the **midpoint** between your middle finger tip and your elbow?

Palm: the distance across your fingers while they are close together (**This is 1/6 of a cubit.**)

Test it out. Place your fingers across your forearm at your elbow joint. Can you move your fingers 6 times to get to the tip of your middle finger?



The cool thing is that every person can divide the distance from middle fingertip to their elbow in half with a span, and their "palm" or width of their fingers does fit across their forearm from the tip of the middle finger to elbow joint 6 times.

The problem, of course, is that one person's cubit is different from another person's cubit. Therefore, the standard units or the set lengths were developed to make a cubit the same for everyone.



The Imperial system of measurement developed from the Egyptian system of cubits, spans, and palms.

It took centuries to develop as various cultures used the system and adapted it. The Romans, the British, and the Americans all had a 'hand' in developing the system.



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Recall that **linear** measurements are lengths or distances.

Other ways to write inches using abbreviations or symbols are

6 inches = 6 in = 6"

Other ways to write a measurement in feet using abbreviations or symbols are

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2 feet = 2 ft = 2'



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Example 1

List 3 commonly used length units from the Imperial system. Name an object for each that could be a referent for that unit of measure. Explain what the Imperial unit could measure.



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Solution

- 1. **Foot** A foot is about the same size as a person's forearm, perhaps as long as a big foot. It could be used to measure things such as the length of a wall or a desk.
- 2. **Inches** An inch is about the same size as the width of an adult thumb. It could be used to measure short distances such as the length of a picture frame or the perimeter of a floor tile.
- 3. **Yards** A yard is 3 feet or about the same as the distance from an adult's finger tips to the nose when the arm is lifted straight out to the side. It is good for measuring longer distances, such as the length of a football field.

Area is the surface space covered by a shape.

Here are some common Imperial units of linear measure and area measure and their abbreviations.

Name of Linear unit (Imperial)	Related Area unit
inch (in)	inches squared = in ²
foot (ft)	feet squared = ft ²
yard (yd)	yard squared = yd ²
mile (mi)	acres

Example 2

Danielle is going to fix her kitchen floor by putting down new ceramic tiles. Her floor is 10 ft long and 9 ft wide. Each floor tile is the shape of a square and measures 1 ft². How many floor tiles does she need to cover the floor?



1 ft



A man weighs 180 lbs on Earth. His weight on the moon is 1/6 of his Earth weight. How much will he weigh on the moon? a. 1080 lbs b. 30 lbs c. 100 lbs

Call your instructor to give your treasure chest answer and earn coins towards bonus marks.

There are other things to measure than distances and areas. We also measure how much objects weigh. In science, you have learned that **weight** is how heavy an object is. Weight is different on earth than it is on the moon because the pull of gravity is different.



Mass is the proper term to describe how much 'stuff' is in an object. Sometimes people get mass and weight mixed up because they do refer to similar things. Here are some common Imperial units for the weight of objects.

> A **pound** (**lb**) is the weight unit that would be good to measure how heavy medium sized objects are. A person or

an animal such as a dog could have their

Weight (Imperial)

An **ounce** (**oz**) is a measure for something that is very light. The mass of a pencil would be measured in ounces.



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The **ton** (**T**) is the unit of measure for very heavy objects such as a car or an elephant.



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Name of Mass Unit (Imperial)	Abbreviation
ounce	oz
pound	lb
ton	Т

weight measured in pounds.

Example 3

- a. What would be an appropriate unit in the Imperial system to measure the weight of a block of cheese?
- b. Name some objects that might be similar in weight to a block of cheese.

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Solution a

Think of how large an average-sized block of cheese at the store is. It is not too heavy to lift with one hand; in fact, it is quite light.

Now think of people. The average full-grown male is about 180 pounds. Way to heavy to lift with one hand! So, 1 or 2 pounds might be similar to the size of a block of cheese.

Solution b

A small block of cheese might be similar in weight to a "pound of butter". A larger block of cheese might be similar in weight to a laptop or textbook.



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Why is the Imperial mass unit called the 'pound' abbreviated as 'lb'?

- a. "Pd" was already used to mean "paid".
- b. The English all ready used "pound" for money.
- c. The Roman word 'libra' means pound.

Call your instructor to give your treasure chest answer and earn coins towards bonus marks. Have you ever seen a new born baby? It is common for people to express how much a new born baby weighs in **pounds** and **ounces**.



A nurse at a hospital weighed the Jones' baby and he was 7 pounds 6 ounces. So, ounces must be smaller units than pounds.

This is similar to saying that a very tall man is 7 feet 6 inches. Inches are the smaller units used to make a full foot, and **ounces** are the smaller unit of weight that are used to make a full pound.



Volume (Imperial)

The volume of an object involves three dimensions in its calculation and means the amount of threedimensional space that is occupied by an object.

Here are some common units of volume in the Imperial system.

Name of Volume Unit (Imperial)	Abbreviation
cubic inch	in³
cubic foot	ft ³
cubic yard	yd ³



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Capacity (Imperial)

Capacity is related to volume. The volume of the box was 105 inches³, which is a three-dimensional measure of the box.

The three dimensions that were needed to calculate volume are the length, the width, and the height of the box. The **volume** is the amount of space that is taken up by the object. It might be an 'empty' box, but it is filled with air and takes up that much 3-D space.

The **capacity** of the box is how much stuff it may hold. The box could hold 105 cubes of ham. It has a capacity of 105 cubes of ham. In the Imperial system, the units for capacity are not cubes of ham!

The chart below shows some common Imperial capacity units.

ľ	Name of Capacity Unit (Imperial)	Abbreviation
	fluid ounce	fl oz
	cup	С
	pint	pt
	quart	qt
	gallon	gal
	bushel	bsh





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A fluid ounce is different than an ounce of weight. Fluid means to flow. Liquid flows and a fluid ounce refers to a measure of something that flows. Milk or liquid medicine might be measured in fluid ounces.

A cup is equal to 8 fluid ounces. You have likely used a measuring cup when baking. A cup might measure milk or oil for a recipe, but it can also measure flour or sugar. Flour or sugar are not liquid, but they can flow or can be poured out.



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A pint is equal to 2 cups and a quart is equal to 2 pints. A gallon is 4 quarts. A gallon is an Imperial unit of capacity that is commonly used to measure gasoline, for example.

Keep in mind that stuff that "flows" is not always liquid. A bushel is a measure of dry capacity. Farmers often use bushels to refer to how much grain they harvested from their crops. Again, grain



is not liquid, it is dry, but it can flow or be poured.

A bushel is 4 pecks. A peck is 2 gallons. If a bushel is 4 pecks, you could say a bushel is 8 gallons.

$$4 \times 2 = 8$$

Canada changed from using the Imperial system of measurement to using the Systeme Internationale during the 1970s. Changing an entire country from one measurement system to another takes some time. The process occurred from about 1970 to 1977.



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Changing a country's measurement system is difficult, but there were some good reasons for changing. At the time of the change, some Canadians wondered why Canada made the change. It meant that people who were used to one method of measurement had to learn a new one. It also meant that trades people needed to change all their equipment to metric sizes. Also, people who worked with companies in the US would need to know both systems.







Canada officially uses the metric system, but we have never stopped using the **Imperial system** completely. Why do you think that is??

- a. No one knew how to spell Systeme Internationale.
- **b.** McDonalds has a "quarter pounder", and they did not want to change the name to point 55 kilogrammer.
- c. Many set measurements cannot be changed easily. For example, in Western Canada, a section of land is measured in miles and roads divide the land.

Call your instructor to give your treasure chest answer and earn coins towards bonus marks.

One thing about the Imperial system that makes it rather tricky to work with is that the names of the units are all very different from each other.

An **inch** is the smallest whole unit of linear measurement. The smallest whole unit of mass is the **ounce**.



It is also difficult to tell how many smaller units make up the next larger unit in the system. Twelve inches make one foot. Then, three feet make one yard, which is the next largest linear unit.

No real pattern exists between the number of small units that it takes to make a larger unit. Also the names do not help to explain the relation between the units.

The unit called the **foot** is about the size of a person's foot, but the name 'inch' doesn't help much in describing how big it is.



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The word **yard** doesn't really help to describe how many feet will make up 1 yard nor how big a yard is.

The Canadian government chose to change to the metric system partly because the metric system is easier to work with. You will soon see why.

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Linear Units (Metric)

Here are some common metric units to measure distance or length.

Linear Unit (Metric)	Abbreviation
millimetre	mm
centimetre	cm
metre	m
kilometre	km

Millimetre is the smallest unit in this chart. It takes 10 millimetres to make a centimetre and 100 centimetres make 1 metre and so on.





Notice that each unit for **linear** measure ends in the word **metre**. That ending in the name indicates that the unit is for measuring length or distance.



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Example 5

Match the object in the first column with the metric unit of measure that would be best suited to measure it.

- __ diameter of a dime __ length of a football field
- ____ distance across a desert
- ___ cloth for a dress
- __ length of a bookmark

- 1. metre
- 2. centimetre
- 3. kilometre
- 4. millimetre

Solution

Notice in the chart that millimetres are smaller than centimetres and so on. Use the chart to help make the decisions.

- 4 diameter of a dime
- **1** length of a football field
- **3** distance across a desert
- **1** cloth for a dress
- 2 length of a bookmark
- 1. metre
- 2. centimetre
- 3. kilometre
- 4. millimetre



Area units in the metric system are also easy to recognize. They are the linear units squared, except for the largest one. The hectare is a large area of land, similar to the acre in the Imperial system.



Husain is from Europe and is coming to Canada to look at buying a small farm. He is familiar with hectares, but when he called a real estate office in Alberta, the farms were listed in acres (Imperial) and hectares (metric). This was fortunate for Husain because he would not have understood the amount of land the farms had if the real estate office had quoted the land area only in acres.

This table shows a list of common area units in the metric system and their abbreviations.

Area Unit (Metric)	Abbreviation
square millimetre	mm ²
square centimetre	cm ²
square metre	m²
square kilometre	km ²
hectare	ha

Mass (Metric)

Notice that most mass units in the metric system use the word 'gram'. The metric tonne is the only one that does not. Gram is the mass 'base unit'. Remember that linear metric units ended with 'metre'. Well, mass units end with 'gram'.

Also, notice that all the beginning parts of the names were used in the linear unit names.

The beginning part of a word is called the *prefix*. Milli always means very small. Kilo means quite large. Milli always means $\frac{1}{1000 \text{ th}}$ of the base unit.

Kilo means 1000 times the base unit.

Name of Mass Unit (Metric)	Abbreviation
milligram	mg
gram	g
kilogram	kg
metric tonne	t



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Volume (Metric)

Recall that volume is the threedimensional measure of an object. The dimensions are measured in linear units.



Name of Volume Unit (Metric)	Abbreviation
millimetre cubed	mm³
centimetre cubed	cm ³
metre cubed	m ³

Capacity (Metric)

Recall that capacity is the measure of how much 'stuff' can fit in an object.

Notice again that each capacity unit has the word **litre** in it and that the prefixes were used for other metric measurement categories.

Name of Capacity Unit (Metric)	Abbreviation	
millilitre	mL	
centilitre	cL	20°C
litre	L	100
kilolitre	kL	30

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Putting it Together: Imperial units and metric units can be compared in size. A pencil could be measured in **inches** (Imperial) or **centimetres** (metric).

The units in the charts below are listed from **largest** to **smallest**.

Units o	f Length
Metric	Imperial
kilometre (km)	mile (mi)
metre (m)	yard (yd)
centimetre	foot (ft)
millimetre	inch (in)
36	
Mass	Weight
Metric	Imperial
kilogram (km)	ton (T)
gram (m)	pound (lb)
centigram	ounce (oz)
milligram	ounce(oz)
Units of	Capacity
Metric	Imperial
kilolitre (kL)	gallon (gal)
litre (L)	quart (qt)
centilitre (cL)	pint (pt)
millilitre (mL)	cup (c)
millilitre (mL)	ounce (oz)
	All to All
	Stilling Stilling



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How Does It Work? Practice Questions

1. When did Canada change its measurement system to the metric system?

2. What kind of object would square feet be used to measure? Why?

- 3. Millimetres cubed or mm^3 would be a good unit of measure for (Choose the best response.)
 - a. the length of a butterfly's wing
 - b. the 3-dimensional size of a diamond
 - c. the amount of water in an ice cube
 - d. the 3-dimensional size of a suitcase

4. Match each metric unit in the list on the right to the Imperial unit of measure that is similar in size.

feet	1. litre
ton	2. cubic metre
quart	3. centilitre
inch	4. mililitre
cubic yard	5. tonne
fluid ounce	6. kg
pound	7. metre
cup	8. centimetre

5. Name 3 linear units of measure from the metric system. Match each with a similar unit of measure from the Imperial system.



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Practice Solutions

1. When did Canada change its measurement system to the metric system?

Canada passed legislation in 1970 to change from Imperial to metric measurements. The process went from 1970 to 1977. Official declaration in 1972.

2. What kind of object would square feet be used to measure? Why?

1 foot is about the length of a person's forearm. 1 square foot or 1 ft² might be the area covered by a floor tile or a ceiling tile. Square feet might be used in the floor plan of a house. Your answer may have been different, but check to be sure that the object(s) you selected were not really big, like a farm or really small, like an ace of spades card.

- 3. Millimetres cubed or mm³ would be a good unit of measure for (Choose the best response.)
 - a. The length of a butterfly's wing
 - b. The 3 dimensional size of a diamond
 - c. The amount of water in an ice cube
 - d. The 3 dimensional size of a suitcase.

mm³ is a volume measurement. Any unit to the power 3 means volume. It measures the amount of 3-dimensional space an object takes up. mm (millimetres) are small so mm³ measures the volume of a small object. The best response is b. 4. Match each metric unit in the list on the right to the Imperial unit of measure that is similar in size.

7 feet	1. litre
<u>5</u> ton	2. cubic metre
<u>1</u> quart	3. centilitre
8_ inch	4. mililitre
2 cubic yard	5. tonne
<u>3</u> fluid ounce	6. kg
pound	7. metre
cup	8. centimetre

5. Name 3 linear units of measure from the metric system. Match each with a similar unit of measure from the Imperial system.

Linear measurements measure distances or lengths.

Three metric linear measures are

- centimetre
- metre
- kilometre (but you may choose others)

In the Imperial system, the linear measures that match those chosen from the metric system are as follows, but you must match your list.

- centimetre inch
- metre foot
- kilometre -mile

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Total 37

(5)

How Does It Work? Assignment

Now it's time to show your stuff! Put lots of details into your work.

1. A list of Imperial and metric units is given below. Complete the chart with metric units on the right and Imperial units on the left.

kilometre	centimetre
pound	cup
millilitre	cubic metre
acre	mile
gallon	litre

Metric

2. Complete the chart below with appropriate units of measure from the metric system and the Imperial system.

Items to be Measured	Metric Unit	Imperial Unit	
length of classroom			
height of car			
length of your foot			
your height			
distance travelled in your car			
area of your room			
spice in a recipe			
weight of a tomato			
your weight			
weight of a car			
water in a swimming pool			
volume of a small box			

Unit 4: Measurement Systems

6

ADLC Math 10-3

(1)

(1)

(5)

(5)

3. Husain is planning to buy land and start a tree farm and greenhouse business. He needs to buy a fairly large piece of land for his business. He went



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to the real estate office and asked if any pieces of land that are 2 million inches squared in size were for sale.

a. Are square inches a good way to measure the land needed to have a tree farm? Explain.

b. What would have been a better unit of measure to describe the size of lot that Husain needs? Explain your choice.

- 4. Name the five area units from
 - a. the Imperial system

b. the metric system

5. One school has 100 students in Grade 10. The mathematics textbook *Introduction to Math 10* is 1.2 cm thick. All 100 books must be stored in a stack. What is the height of the stack of books?



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	6.	Ex	plain volume and capacity.
2		a.	How are the two things similar?
2		b.	How are they different?
2		c.	List two Imperial capacity units.
2		d.	List two metric capacity units.

2

7. A milligram measures the mass of an object. List two objects that might be measured in milligrams and explain your choices.

a. _____ (1)_____ (1)b. 2 Describe the size of a bushel of apples. 8.



You are ready to start Digging Deeper!



Digging Deeper

Recall that the Egyptians started out with a cubit. At first, it was a referent because it was the distance along a person's forearm, before it developed into a standard unit of measure.



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Six palms made 1 cubit and 2 spans also made 1 cubit. There is a relationship between the units of measure that the Egyptians had. Smaller units built into bigger units.

In the Imperial and Metric systems, smaller units also build to make the bigger units.

• 12 inches make 1 foot



100 centimetres make 1 metre

In the Imperial system, for example, when we say that 12 inches = 1 foot, we are really saying that feet and inches are related. They both measure the same type of thing—distance or length. We also imply that a measurement can be converted from inches to feet or from feet to inches.

The Imperial system has a mishmash of relationships among the measurements. In other words, no distinct pattern determines how many smaller units make a larger unit. Also, no relationship exists between the names of the units and what they measure.



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Example 6

The word 'pint' refers to a capacity unit of measure. Can you tell by the name if it is bigger or smaller than a cup?

Solution

From our understanding of Imperial units, it can be said that the pint and the cup are related because they are both capacity units. It cannot be determined from the name 'pint' if it is bigger or smaller than a cup.

A chart listing the smaller units that add up to bigger units would help to show which Imperial units are the smaller ones and which are the bigger ones. Or a person could memorize which are bigger or smaller.

Here are the related Imperial units you have learned about in this lesson.

Imperial Units of Conversion		
Length	Capacity	Weight
1 mile (mi) = 1 760 yards (yd)	1 gallon (gal) = 4 quarts	1 ton (T) = 2 000 pounds (lb)
1 mile = 5 280 feet (ft)	1 gallon = 128 fluid ounces (fl oz)	1 pound = 16 ounces
1 yard (yd) = 3 feet	1 quart (qt) = 2 pints (pt)	* 1 bushel
1 yard (yd) = 36 inches	1 pint = 2 cups (c)	
1 foot (ft) = 12 inches	1 cup = 8 ounces (oz)	
	1 bushel = 8 gallons	

* Bushel as a 'weight' in pounds depends on what is being weighed. Google bushel to explore how it is used as a weight measurement.

Example 7

Use the Imperial units of conversion chart to answer the following questions.

- a. How many feet are in 1 mile?
- b. How many quarts are in 1 gallon?
- c. How many feet are in 6 yards?
- d. How many cups are in 1 gallon?

Solution

a. In the chart, we read that

1 mile = 5 280 feet (ft)

There are 5280 feet in 1 mile.

b. In the chart, we read that

1 gallon (gal) = 4 quarts

There are 4 quarts in 1 gallon.

c. In the chart, we read that

1 yard (yd) = 3 feet

6 yards = ? feet

Multiply both sides by 6.

 $\times 6 \left(\begin{array}{c} 1 \text{ yard} = 3 \text{ feet} \\ 6 \text{ yards} = ? \end{array} \right) \times 6$

 $3 \times 6 = 18$

There are 18 feet in 6 yards.



Imperial conversion charts are very useful so that you do not have to memorize how many small units make a larger one. They are also useful for determining how many small units are in more than one large unit as example 7c demonstrated.

Charts can also be used to calculate how many large units are in a smaller unit.

Wait a second! How can there be **large** units in a **small** unit? It's like asking "How may pizzas are there in a piece of pizza?" Obviously, there is not a whole pizza in a piece of pizza. We talk about the piece as a fraction of the larger whole pizza.



In the same way, we can determine how many large units are in a smaller one. Fractions or decimals are used to express how many large units are in a smaller one.

Example 8

Use the Imperial units of conversion chart to answer the following questions.

- a. How many feet are in 1 inch?
- b. How many cups are in 4 ounces?

Solution a

To find out how many feet are in 1 inch, start with 1 foot = 12 inches.

Write the relationship as a rate or fraction. There is 1 foot per 12 inches.

1 foot

12 inches

Now, change the rate to a unit rate.

 $\frac{1 \text{ foot}}{12 \text{ inches}} = \frac{1}{12}$ foot per inch or 1 foot ÷12 inches $=\frac{0.8\overline{3} \text{ ft}}{1 \text{ inch}} \text{ or } 0.08\overline{3} \text{ ft / inch}$

There are $0.08\overline{3}$ feet in 1 inch.





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Charts are very useful for Imperial unit conversions. A chart cannot possibly have every conversion listed, so if you can 'read between the lines' of the chart, you can expand the information in it.

The metric system also has smaller units combining to make larger units in the same measurement category.

For example, **10 millimetres = 1 centimetre**

100 centimetres = 1 metre

A relationship also exists between the names of the units in the measurement category.

Linear units always use the ending (or *suffix*) *metre*.

suffix: occurring at the end of a word

For mass units, the base unit is the gram. All units of mass end in the word 'gram'.

Example 9

What is the suffix for the metric capacity units of measure?

Solution

Capacity units in the metric system are millimetres, litres, and kilolitres.

All capacity units end with 'litre'.

Another relationship exists within the metric system. The first part of the name of the unit indicates how many smaller parts make up the unit.

The metric system uses **base units**. The base units are like starting points.

The linear base unit is a metre. For mass, the base unit is the gram and for capacity, it is the litre.

Hey! Those are the suffixes used in each of those categories.

Suffix	Meaning
metre	distance
litre	capacity
gram	mass

The prefix indicates if a unit is larger or smaller than the base unit.



Remember, a kilogram is 1000 times larger than a gram. A milligram is smaller than a gram. It is $\frac{1}{1000^{\text{th}}}$ of a gram.

Likewise, a kilometre is larger than a metre. *• Thinkstock* A milligram is smaller than a metre!

WOW! In the metric system the names used for the units are really big clues about what the units will measure and how large the unit is.

Now that you are ready, try answering some of the practice questions related to the two measurement systems.





Digging Deeper Practice Questions

Use the Imperial conversion chart to answer questions 1 to 3.

Imperial Units of Conversion		
Length	Capacity	Weight
1 mile (mi) = 1 760 yards (yd)	1 gallon (gal) = 4 quarts	1 ton (T) = 2 000 pounds (lb)
1 mile = 5 280 feet (ft)	1 gallon = 128 fluid ounces (fl oz)	1 pound = 16 ounces
1 yard (yd) = 3 feet	1 quart (qt) = 2 pints (pt)	
1 yard (yd) = 36 inches	1 pint = 2 cups (c)	
1 foot (ft) = 12 inches	1 cup = 8 ounces (oz)	

- 1. Determine each of the following:
 - a. How many ounces in 2 pounds?
 - b. How many cups in 12 ounces?
- 2. Which is larger 1 yard or 1 foot? Explain your reasons for your answer.

3.	Which has a greater capacity, a 1 gallon jug or a 2 quart
	jar? Why?

4. In the metric system, is 5 kilograms larger or smaller than 5 grams? Explain your reasons for your answer.

- 5. Name the base units for the metric system in the following categories:
 - a. mass
 - b. distance
 - c. capacity _____
- 6. Name units from the Imperial system in the following categories:
 - a. weight
 - b. capacity
 - c. linear units

7. Millilitres are a capacity unit and cm³ are a related metric unit. How are these units related?

- 8. Remember that capacity and volume are related! Construct a chart to show metric units of capacity that match or are related to metric volume units because they measure similar amounts.



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Practice Solutions

Use the Imperial conversion chart to answer questions 1 to 3.

- 1. Determine each of the following:
 - a. How many ounces in 1.5 pounds? **1.5 pounds = 1 pound 0.5 pounds**

1 pound = 16 ounces 0.5 pound = 8 ounces 16 ounces + 8 ounces = 24 ounces

b. How many cups in 12 ounces?

1 cup = 8 ounces ? cups = 12 ounces

Set up as a ratio equation.

 $\frac{? \text{ cups}}{12 \text{ ounces}} = \frac{1 \text{ cup}}{8 \text{ ounces}}$

Cross multiply.

 $\frac{? \text{ cups}}{12 \text{ ounces}} = \frac{1 \text{ cup}}{8 \text{ ounces}}$

? cups =
$$\frac{1 \text{ cup} \times 12 \text{ ounces}}{8 \text{ ounces}}$$

$$=1 \times 12 \div 8$$

=1.5

There are 1.5 cups in 12 ounces.

2. Which is larger - 1 yard or 1 foot? Explain your reasons for your answer.

A yard is larger than a foot. It takes 3 feet to make 1 yard.

3. Which has a greater capacity, a 1– gallon jug or a 2 –quart jar? Why?

1 gallon = 4 quarts from the chart. Because 2 quarts is less than 4 quarts, 2 quarts must be smaller than 1 gallon.

4. In the metric system is 5 kilograms larger or smaller than 5 grams? Explain your reasons for your answer.

5 kilograms is larger than 5 grams. There is not a chart to compare the number of units, but 'kilo' is a prefix that means bigger than the base unit and 'gram' is the base unit for mass.

5. Name the base units for the metric system in the following categories:

a.	mass	gram
b.	distance	metre
C.	capacity	litre

6. Name units from the Imperial system in the following categories:

a.	weight	pound
b.	capacity	cup
c.	linear units	foot

 Millilitres are a capacity unit and cm³ are a related metric unit. Why are these units related?

Millilitres are capacity units. They measure how much stuff will fill the space.

Picture a cube 1 cm ×1 cm × 1 cm.



1 millilitre of water will fill the space of 1 cm³.

Centimetres cubed or cubic centimetres are volume units. They represent how much space is already used up or occupied by the 3-D object.

Centimetres cubed are related to millimetres because both refer to the same amount of 3-dimensional space. 1 millimetre of water will fill 1 cm³ of space. 8. Remember that capacity and volume are related! Construct a chart to show metric units of capacity that match or are related to metric volume units because they measure similar amounts.

Metric capacity units	Metric volume units
ml	cm ³
L	m ³







4. Construct a chart to show common metric units of volume and the Imperial capacity units that are related.



(4)

- 5. Name the base units for the metric system in the following categories:
 - a. Linear units
 - b. Capacity units
 - c. Mass units

Unit 4: Measurement Systems

2	6. a	. Is a kilolitre larger or smaller than a millilitre. Why?
2	b	Are 3 cups larger or smaller than 24 ounces. Why?
1	7. a	In which decade Canada start using the metric system as the national measurement system?
2	b	Name some advantages that the metric system has over the Imperial system.
2	C.	Although Canada uses the metric system, name some situations when the Imperial system is used instead. Why is the Imperial system still used in those situations?
Use the Imperial unit conversion chart to answer question 8.

Imperial Units of Conversion		
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1 mile (mi) = 1 760 yards (yd)	1 gallon (gal) = 4 quarts	1 ton (T) = 2 000 pounds (lb)
1 mile = 5 280 feet (ft)	1 gallon = 128 fluid ounces (fl oz)	1 pound = 16 ounces
1 yard (yd) = 3 feet	1 quart (qt) = 2 pints (pt)	
1 yard (yd) = 36 inches	1 pint = 2 cups (c)	
1 foot (ft) = 12 inches	1 cup = 8 ounces (oz)	

- 8. Determine how many
 - a. fluid ounces in 1 gallon
 - b. pounds in 4.5 tons

(2) c. feet in 18 inches

2 d. quarts in 1 pint

e. yards in 1 foot

2

(1)

2



9. Are ounces for measuring weight or capacity. Explain.

Lesson Summary

In this lesson, you learned about the history of the Imperial and metric systems.

You 'got messy' and made up your own measurement system so you could understand better how measurement systems work.

You chose appropriate units of measure from both systems.

You used charts in the Imperial system to compare unit size, and you used the naming system to compare unit size for metric measurements.

Please attach your return address label to the back of this booklet and send Unit 4 Lesson A to be marked.

You are now ready to proceed Unit 4 Lesson B.



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Math 10-3

Unit 4: Measurements Systems Lesson A: Imperial and Metric Systems Introduction



Teacher's Signature