UNIT 4 – MEASUREMENT – PART 2

Assignment	Title	Work to complete	Complete
1	***Volume***	Volume	
2	***Capacity***	Capacity	
3	***Mass/Weight in the Imperial System***	Mass/Weight in the Imperial System	
4	***More Mass/Weight in the Imperial System***	More Mass/Weight in the Imperial System	
5	***Mass/Weight in the Metric System***	Mass/Weight in the Metric System	
6	***Weight Conversions Between Measuring System***	Weight Conversions Between Measuring System	
7	***Working With Temperature***	Working With Temperature	
Mental Math	**Mental Math** Non-calculator practice		
Practice Test	**Practice Test** How are you doing?	Get this page from your teacher	
Self-Assessment	**Self-Assessment** ***"Traffic Lights"***	On the next page, complete the self-assessment assignment.	
Chapter Test	**Chapter Test** Show me your stuff!		

Traffic Lights

In the following chart, decide how confident you feel about each statement by sticking a red, yellow, or green dot in the box. Then discuss this with your teacher ***BEFORE*** you write the test.

Statement	Dot
After completing this chapter;	
• I can calculate the volume of a three-dimensional object in metric and imperial units	
• I can understand the difference between mass and weight, and understand why we often use the terms interchangeably	
• I can calculate mass and weight in both the SI and the Imperial systems	
• I can convert mass and weight within the SI system and the Imperial system	
• I can convert mass and weight between the SI and the Imperial system and vice versa	
• I can use conversion factors to convert between volume and mass	
• I understand the difference between the Celsius and the Fahrenheit temperature scales	
• I can convert from degrees Celsius to degrees Fahrenheit and vice versa	

Vocabulary: Unit 4

capacity
Celsius (^{0}C)
Fahrenheit (^{0}F)
gram (g)
kilogram (kg)
mass
ounce (oz)
pound (lb)
temperature
ton (tn)
tonne (t)
weight
volume

VOLUME

The volume of an object is the amount of space it occupies. There are specific formulas used to find the volume of different geometric solids. Just as area is expressed in square units, volume is ALWAYS expressed in cubic units; – cm^3, in^3, m^3, etc.
In equations, the symbol for volume is a capital v → **V**.

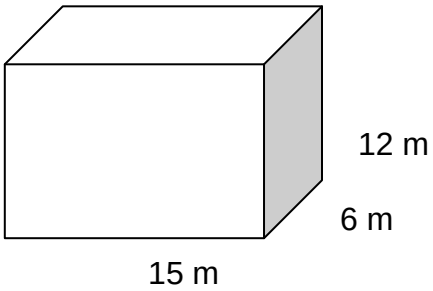
Example 1: Calculate the volume of the rectangular solid below.

Solution:

Rectangular Solid:
Volume is calculated by multiplying length times width times height.

$$\mathbf{V = \mathit{l} \times \mathit{w} \times \mathit{h}}$$

$$V = l \times w \times h$$
$$= 15 \times 6 \times 12$$
$$= 1080\ m^3$$



Example 2: Bob runs a landscaping business. He needs to cover a garden that is 10.8 m by 9.5 m with 10 cm of topsoil. What is the volume of topsoil he needs? If soil costs \$18.75/m^3, and Bob must buy whole m^3, how much will it cost Bob?

Solution: 1) Calculate the volume needed. To do this, convert the depth of the topsoil from centimetres to metres and then calculate the volume for the garden.

10 cm ÷ 100 = 0.1 m

Volume = 10.8 m × 9.5 m × 0.1 m
= 10.26 m^3

2) Calculate the cost of this volume of topsoil.

10.26 m^3 rounds to 11 m^3
11 m^3 × \$18.75 = \$206.25

As with square units, cubic units for volume can be converted within a measurement system – metric or imperial. To convert within a system, like m^3 to cm^3, or in^3 to ft^3, first change the original linear units to the desired unit and then calculate the volume in the new units.

Example 1: A bale of hay measures 15" by 24" by 36". What is the volume of a bale of hay in cubic inches and cubic feet?

Solution: 1) Calculate the volume in cubic inches.
Volume = 15 in × 24 in × 36 in = 12 960 in^3

2) Change the dimensions from inches to feet.
15 ÷ 12 = 1.25 ft 24 ÷ 12 = 2 ft 36 ÷ 12 = 3 ft

3) Calculate the volume in the new units.
Volume = 1.25 ft × 2 ft × 3 ft = 7.5 ft^3

Example 2: An aquarium is 17 cm wide and 35 cm long. If it is filled 23 cm deep, what is the volume of the water in the aquarium in cm^3 and m^3?

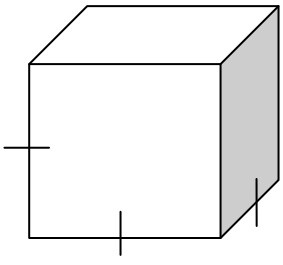
Solution: 1) Calculate the volume in cubic centimetres.
Volume = 17 cm × 35 cm × 23 cm = 13 685 cm^3

2) Change the dimensions from centimetres to metres.
17 ÷ 100 = 0.17 m 35 ÷ 100 = 0.35 m 23 ÷ 100 = 0.23 m

3) Calculate the volume in the new units.
Volume = 0.17 m × 0.35 m × 0.23 m t = 0.013685 m^3

If you are given the volume without the individual dimensions, use the following concept to convert between measurements.

Consider the cube to the right. It has side lengths of 10 mm or 1 cm. When finding the volume of this cube, we could use either measurement.



Volume = s × s × s

V = 10 mm × 10 mm × 10 mm = 1000 mm^3 **OR** V = 1 cm × 1 cm × 1 cm = 1 cm^3

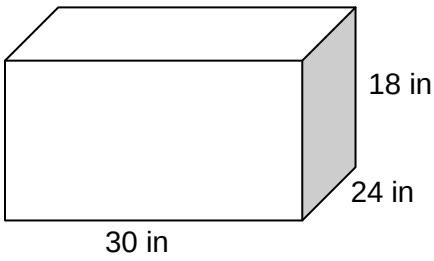
Therefore, 1 cm^3 = 1000 mm^3

The following are also true based on this example.

1 yd^3 = 27 ft^3 1 yd^3 = 46 656 in^3 1 ft^3 = 1728 in^3

ASSIGNMENT 1 – VOLUME

1) Calculate the volume as indicated.



a) in cubic inches – in^3

b) in cubic feet – ft^3

2) A box 3 in. × 4 in. × 6 in. is filled with paper clips. Will the contents of this box fit into a cube that has sides of 4 in. each? Hint: find the volume of each box.

3) The volume of Samantha's hockey bag is 8288 cubic inches (in^3). What is the volume in cubic feet (ft^3), to the nearest whole cubic foot?

4) Ryan is using a wheelbarrow that holds 3 cubic feet of soil.

a) How many cubic yards will his wheelbarrow hold?

b) If Ryan takes 32 loads with his wheelbarrow, how many cubic yards of soil will he move?

CAPACITY

Capacity is the maximum amount that a container can hold. It is related to volume in that the capacity of a container can be the volume of the container. But capacity is most often used with liquid measurements.

In the metric system of measurement, the base unit for capacity is the litre, L. We commonly use millilitres to measure capacity, too, and this is abbreviated mL. One litre equals 1000 mL. One mL also equals one cubic centimetre, but when using capacity, this is abbreviated as "cc" rather than "cm^3".

1 L = 1000 mL
1 L = 1000 cc
1 mL = 1 cc

In imperial units, capacity is measured in gallons, quarts, pints, cups, and fluid ounces. These relationships are detailed below.

1 gallon = 4 quarts (qt)
1 quart = 2 pints (pt)
1 pint = 2 cups (c)
1 bushel (bu) = 8 gal

Now it gets a bit confusing. There are two different sizes for a gallon: a British (UK) gallon and an American (US) gallon.
A British gallon (UK) is approximately 4.5 L and 1 UK pint = 20 fluid ounces (UK).
An American gallon is smaller. It is approximately 3.8 L and 1 pint = 16 fluid ounces.

1 cup (US) = 8 fl oz	1 gal (US) = 3.8 L
1 cup (UK) = 10 fl oz	1 gal (UK) = 4.5 L

Other liquid relationships used for recipes include:

1 teaspoon (tsp) = 5 mL

1 tablespoon (tbsp) = 15 mL

1 fl oz = 2 tablespoons (tbsp)

1 tablespoon (tbsp) = 3 teaspoons (tsp)

1 cup = 250 mL

Use these conversions and the ones in the Data Book when converting units.

Example 1: Convert the following measurements:

a) 500 mL into cups

b) 1.25 mL into teaspoons

c) 5 fl oz (US) into cups

d) 25 L into gal (US)

Solution: Use proportions and the proper conversions to make accurate calculations.

a) $\frac{\text{mL}}{\text{cups}} \quad \frac{250}{1} = \frac{500}{x}$ $\qquad x = 1 \times 500 \div 250 = 2$ cups

While this is a relatively easy conversion, if you get in the habit of setting these problems like this, you will not run into difficulty when they get more complicated.

b) $\frac{\text{mL}}{\text{tsp}} \quad \frac{5}{1} = \frac{1.25}{x}$ $\qquad x = 1 \times 1.25 \div 5 = 0.25$ tsp

c) $\frac{\text{fl oz}}{\text{cups}} \quad \frac{8}{1} = \frac{5}{x}$ $\qquad x = 1 \times 5 \div 8 = 0.625$ cups

d) $\frac{\text{L}}{\text{gal (US)}} \quad \frac{3.8}{1} = \frac{25}{x}$ $\qquad x = 1 \times 25 \div 3.8 = 6.58$ gal (US)

Example 2: Convert the following measurement:

a) 1000 mL into pints

Solution: Use proportions and the proper conversions to make accurate calculations.
Some conversions take 2 or more steps

a) $\frac{\text{mL}}{\text{cups}} \quad \frac{250}{1} = \frac{1000}{x}$ $\qquad x = 1 \times 1000 \div 250 = 4$ cups

$\frac{\text{cups}}{\text{pints}} \quad \frac{2}{1} = \frac{4}{x}$ $\qquad x = 1 \times 4 \div 2 = 2$ pints

ASSIGNMENT 2 – CAPACITY

1) Convert the following measurements.

a) 5 cups = _____ fl oz (US) b) 2 gal = _____ pt

c) 6.7 gal (US) = _____ L d) 3 L = _____ qt (US)

e) 15.5 L = _____ gal (UK)

f) 8 bu = _____ gal (1 bushel (bu) = 8 gal)

2) My gas tank holds 45 L. If I fill up in Washington State, how many American gallons will my tank hold?

3) If I were to fill up my tank in London, England, how many UK gallons would my 45 L tank hold?

4) Ann was making a cake at her aunt's house in California. Her recipe was in metric units but she only has imperial measuring devices. Convert the measurements for her.

30 mL to tablespoons 625 mL to cups

MASS/WEIGHT IN THE IMPERIAL SYSTEM

The words mass and weight are often used interchangeably, but they are technically not the same thing. **Mass** is the amount of matter in an object. Mass never changes, no matter where you go on the Earth. **Weight** is the measure of the force of gravity on the object and it can change depending where you are on the Earth. If you are at sea level, your weight will be more than if you are at the top of Mount Everest. However, for our purposes in this course, we will consider use the term weight and consider that it is a stable measure.

In the imperial system, the base units for weight are the ton (tn), pound (lb) and ounce (oz). They are relates in the following way:

1 ton (tn) = 2000 pounds

1 pound (lb) = 16 ounces (oz)

Example 1: Jennifer needs 1 pond 2 ounces of cheddar cheese, 12 ounces of Gouda cheese, and 11 ounces of Swiss cheese. How many pounds of cheese does she need all together?

Solution: Add the pounds to the pounds and the ounces to the ounces. Regroup the ounces as necessary.

1 pound + 2 ounces
+ 12 ounces
+ 11 ounces
1 pound 25 ounces

Now you must regroup the ounces as 1 pound = 16 ounces.

1 pound 25 ounces
- 16 ounces
2 pounds 9 ounces

Jennifer needs 2 pounds 9 ounces of cheese.

You could also change the amount of cheddar cheese all to ounces, add the total ounces from the three cheeses together, and then regroup the weight into pounds and ounces. The answer would be the same.

ASSIGNMENT 3 – MASS/WEIGHT IN THE IMPERIAL SYSTEM

1) Calculate the following conversions. SHOW YOUR WORK BELOW EACH QUESTION!

a) 54 oz = _____ lb _____ oz

b) 15 lb = _____ oz

c) 648 oz = _____ lb

2) Lucy gave birth to twins weighing 6 lb 5 oz and 5 lb 14 oz. What was their total weight?

3) The weight of water is approximately 2 pounds 3 ounces per litre. How much would 8 L of water weigh? Give your answer in pounds and ounces.

4) A basket of raspberries weighs 12 ounces. You need 4 lb to make jam. How many baskets do you need to pick?

MORE MASS/WEIGHT IN THE IMPERIAL SYSTEM

We have looked at the smaller units of weight, ounces and pounds. Now we will look at conversions with the larger base unit, the ton. Remember, the conversion

1 ton (tn) = 2000 pounds

Example: Alex drives a semi truck. The cab weighs 8.7 tons, and the trailer weighs 6.4 tons. When loaded, the gross weight of the whole truck and its cargo is 21.3 tons. What is the weight of the load in tons, and in pounds?

Solution: First find the weight of the load in tons by adding the weight of the cab and the trailer and subtracting from the total. Then convert this weight into pounds.

weight of truck = cab + trailer = 8.7 tn + 6.4 tn = 15.2 tn

weight of load = total weight – weight of truck = 21.3 tn – 15.2 tn = 6.2 tn

Now convert this weight into pounds using a proportion.

$$\frac{\text{lb}}{\text{tn}} \quad \frac{2000}{1} = \frac{x}{6.2} \qquad x = 2000 \times 6.2 \div 1 = 12\,400 \text{ lb}$$

The weight of the load is 6.2 tons or 12 400 pounds.

ASSIGNMENT 4 – MORE MASS/WEIGHT IN THE IMPERIAL SYSTEM

1) Calculate the following conversions. SHOW YOUR WORK BELOW EACH QUESTION!

a) 6790 lb = _____ tn

b) 5.45 tn = _____ lb

2) Kurt is planting wheat on his farm. He is using 28 800 pounds of wheat. How many tons is this?

3) An elevator can carry a maximum load of 1.5 tons. Two constructions workers weighing 195 lb and 210 lb need to load 65 boxes each weighing 42 lb in the elevator with them. Will the elevator safely hold all this weight?

4) A small truck weighs 1300 lb. It is loaded with cement pieces that weigh 150 lb each. The maximum combined weight of the truck and its load is 2.75 tn. How many pieces of cement can be loaded in the truck?

MASS/WEIGHT IN THE METRIC SYSTEM

In the SI or metric system of measurement, the base unit for mass is the **kilogram**, but it is commonly used for weight as well. These are the common conversions needed in the metric system:

1000 grams (g) = 1 kilogram (kg)

1000 milligrams (mg) = 1 gram (g)

1 tonne (t) = 1000 kilograms (kg)

The tonne (t) in the metric system is **NOT** the same as the ton (tn) in the imperial system. In the working world, a tonne is often referred to as a metric ton to avoid confusion.

Example 1: Convert the following weights.

a) 6.7 t = _____ kg b) 2975 kg = _____ t

Solution: Use a proportion and the correct conversions.

a) $\frac{t}{kg} \quad \frac{1}{1000} = \frac{6.7}{x}$ $x = 1000 \times 6.7 \div 1 = 6700$ kg

b) $\frac{t}{kg} \quad \frac{1}{1000} = \frac{x}{2975}$ $x = 1 \times 2975 \div 1000 = 2.975$ t

Example 2: A recipe requires 650 g of flour, 340 g of cornmeal, and 220 g of sugar. What is the total weight of these dry goods in kilograms?

Solution: Add the weights together, and then convert to kilograms

Total weight = 650 + 340 + 220 = 1210 g

To convert to kilograms, use a proportion.

$\frac{g}{kg} \quad \frac{1000}{1} = \frac{1210}{x}$ $x = 1 \times 1210 \div 1000 = 1.21$ kg

The total weight is 1210 g or 1.21 kg

ASSIGNMENT 5 – MASS/WEIGHT IN THE METRIC SYSTEM

1) Convert the following weights. SHOW YOUR WORK BELOW EACH QUESTION!

a) 2.8 kg = _____ g b) 125 g = _____ kg

a) 3.6 t = _____ kg b) 654 kg = _____ t

2) Irene needs 1.6 kg of tomatoes. She has baskets of tomatoes that weigh 256 g, 452 g, 158 g, and 320 g. How many more grams of tomatoes does she need?

3) A truck weighs 2.6 tonnes. It is loaded with 15 boxes that weigh 210 kg each. What is the total weight of the truck and its contents, in tonnes?

4) Karen is making a pot of potato soup. She needs 8 potatoes and each potato weighs about 375 g. How many kg of potatoes does she need?

WEIGHT CONVERSIONS BETWEEN MEASURING SYSTEMS

You have converted measures of weight from one unit to another within the SI (metric) and within the imperial system. In this section you will work with conversions between the SI units and the imperial units of weight.

The conversion to use between the systems for weight is:

1 kilogram = 2.2 lb

Example 1: Lorraine is using a recipe that required 6 pounds of apples. The bag of apples she bought at Safeway only shows the weight in kilograms. How many kilograms of apples does she need?

Solution: Convert the weight using a proportion.

$$\frac{\text{lb}}{\text{kg}} \quad \frac{2.2}{1} = \frac{6}{x} \qquad x = 1 \times 6 \div 2.2 = 2.7272 \text{ kg}$$

The total weight is 2.7 kg

Example 2: A recipe requires 150 g of sugar. How much is this in ounces?

Solution: Change the g to kg, then kg to lb, then lb to oz.

$$\frac{g}{kg} \quad \frac{1000}{1} = \frac{150}{x} \qquad x = 1 \times 150 \div 1000 = 0.150 \text{ kg}$$

$$\frac{lb}{kg} \quad \frac{2.2}{1} = \frac{x}{0.150} \qquad x = 2.2 \times 0.150 \div 1 = 0.33 \text{ lb}$$

$$\frac{lb}{oz} \quad \frac{1}{16} = \frac{0.33}{x} \qquad x = 16 \times 0.33 \div 1 = 5.28 \text{ oz}$$

The sugar has a weight of 5.3 oz.

Example 3: The cost of bananas at one store is $0.49/lb. At another store, bananas are on sale for $1.05/kg. Which is the better buy?

Solution: Convert the price of bananas at the first store into kilograms.

The cost of 1 lb is $0.49, but 1 kg is 2.2 times bigger than 1 lb.

So, 1 kg costs 2.2 times more than 1 lb.

$0.49 × 2.2 = $1.08

One kilogram of bananas at the first store costs $1.08 but only $1.05 at the second store, so the sale at the second store is the better buy.

ASSIGNMENT 6 – WEIGHT CONVERSIONS BETWEEN MEASURING SYSTEMS

1) Convert the following weights. SHOW YOUR WORK BELOW EACH QUESTION!

a) 67.5 kg = _____ lb

b) 125 lb = _____ kg

c) 3.6 t = _____ lb

d) 30 000 lb = _____ t

2) Chen weighs 68 kg. How much does he weigh in pounds?

3) A baby weighs 7 pounds 12 ounces at birth. How much did it weigh in grams?

4) The smallest bag at the store is 600 g. How much is this in ounces?

5) How much does 1 pound of hamburger cost if the store sells it for $9.74/kg?

6) Which is the better buy: 200 g of coffee beans at $3.85 or 1 pound for $9.60?

7) If a 10 lb bag of grass seed costs $75.45, how much does the seed cost per kilogram?

WORKING WITH TEMPERATURE

If you travel to the United States, you will notice that the temperature scale is different there. The U.S. uses the Fahrenheit scale (^{0}F) of the imperial system, while Canada uses the Celsius scale (^{0}C) of the SI or metric system.

In the SI system, water freezes at 0^0C and boils at 100^0C. In the imperial system, water freezes at 32^0F and boils at 212^0F. Since water freezes at 0^0C and 32^0F, the relationship between the two temperature systems can be calculated with the following formulas, where C represents degrees Celsius and F represents degrees Fahrenheit.

$$\mathbf{C = \frac{5}{9}(F - 32) \quad or \quad F = \frac{9}{5}C + 32}$$

Example 1: In Seattle, someone said it was 42^0F. What is this temperature in degrees Celsius?

Solution: Use the proper formula and convert, substituting 42 for F.

$C = \frac{5}{9}(F - 32)$ means $5 \div 9 \times (F - 32)$

***Remember to calculate the bracket before dividing or multiplying.

$C = 5 \div 9 \times (42 - 32)$

$= 5 \div 9 \times 10$

$= 5.6^0$C

Example 2: On a hot summer day, the temperature of tar heated to pave a road was 48^0C. What is this temperature in degrees Fahrenheit?

Solution: Use the proper formula and convert, substituting 48 for C.

$F = \frac{9}{5}C + 32$ means $9 \div 5 \times C + 32$

***Remember to calculate the dividing and multiplying before adding 32.

$F = 9 \div 5 \times 48 + 32$

$= 86.4 + 32$

$= 118.4^0$F

ASSIGNMENT 7 – WORKING WITH TEMPERATURE

1) Convert the following temperatures to degrees Fahrenheit. SHOW YOUR WORK!

a) 35^0C

b) -8^0C

c) 167^0C

d) 21^0C

e) -40^0C

f) 202^0C

2) Convert the following temperatures to degrees Celsius.

a) -20^0F

b) 80^0F

c) 375^0F

d) 2^0F

e) 0^0F

f) -2^0F

3) A cake recipe says to bake at 350^0F, but your oven only shows temperature in degrees Celsius. At what temperature should you set your oven?

4) The normal temperature for a dog is between 99^0F and 102^0F. Ashley's dog has a temperature of 40^0C. Convert this to Fahrenheit to see if the dog's temperature is normal.

5) Roger is painting the outside of his home. The instructions on the paint say he should not use the paint if the temperature is below 45^0F. The temperature is 9^0C. Is it safe to paint his home?

6) In 1992, the temperature in Pincher Creek, Alberta rose from -19^0C to 22^0C in just one hour due to a chinook wind. What are these temperatures in degrees Fahrenheit?

7) Which is hotter: a blowtorch at 1300^0C or a candle flame at 1830^0F? Calculate each on the other's scale.