

**EVALUATING
ACADEMIC READINESS
FOR APPRENTICESHIP TRAINING**
Revised for
ACCESS TO APPRENTICESHIP

**MATHEMATICS SKILLS
IMPERIAL/METRIC CONVERSION**

**AN ACADEMIC SKILLS MANUAL
for
The Food Preparation Trades**

This trade group includes the following trades:
Baker & Cook and Retail Meat Cutter

*Workplace Support Services Branch
Ontario Ministry of Education and Training*

Revised 2011

In preparing these Academic Skills Manuals we have used passages, diagrams
and questions
similar to those an apprentice might find in a text, guide or
trade manual.

**This trade related material is not intended to instruct
you in your trade. It is used only to
demonstrate how understanding an academic skill will help
you find and use the information you need.**

MATHEMATICS SKILLS

IMPERIAL/METRIC CONVERSION

*An academic skill required for the study of the
Food Preparation Trades*

INTRODUCTION

The metric system is Canada's official system of measurement, still, many recipe books give measurements and the cooking temperatures in imperial units. To be comfortable working in Canadian kitchens, you need to be familiar with both the metric system and the imperial system. You also need to know how to work between them. This skills manual briefly reviews the two systems of measurement and how to convert from one to the other under the following topics..

- ◆ Basic units of measurement
- ◆ Converting within the imperial and metric systems
- ◆ Converting between metric and imperial units

BASIC UNITS OF MEASUREMENT

Length

In the metric system, the basic unit of length is the *meter*.

- Other linear units (units of length) include the *kilometer*, the *centimeter* and the *millimeter*.

In the imperial system the common linear units are the *inch*, *foot*, *yard* and *mile*. The unit *mil* is used to measure paint thickness. One mil is equal to one-thousandth of an inch.

Weight

The basic unit of weight in the metric system is the *gram*.

- Other units of weight include the *kilogram* and the *milligram*.

The common units of weight in the imperial system are the *ounce*, *pound* and *ton*.

Volume or Capacity

The basic unit of capacity of liquids in the metric system is the *liter*.

- The other common unit of capacity is the *milliliter*.
- The volume of both solids and liquids is indicated by cubic units of length such as a cubic centimeter, written as cc, cu cm or cm^3 .
- Volume and capacity are related in the metric system. One milliliter equals 1 cc.

The imperial system has many units of liquid capacity. They include the *cup*, *quart* and *gallon*.

Dry measurements include the *quart* and *bushel*.

- Volume is also measured by cubic measurements like cubic inches, written as cu in or in^3 .

Pressure

The imperial unit of pressure is **pounds per square inch (psi)**.
In the metric system, you use the unit **kilopascals (kPa)**.

CONVERTING WITHIN THE IMPERIAL AND METRIC SYSTEMS

Working with both systems

Sometimes you will need to be able convert, or change, from one system to the other. Some equivalents become so familiar, you learn them without thinking about it.

Example: Our old pound of butter is now sold as 454 grams, making the equivalent 1 pound equal 454 grams easy to remember.

Many cookbooks either provide measurements in both systems or have an equivalency chart. But you will need to be able to calculate conversions yourself. To do this, you need a chart that lists *equivalent measurements*.

Example: One inch is equal to, or equivalent to, 2.54 centimeters. Similarly, 1 centimeter is equivalent to .39 inches.

If you need to convert units between systems when working on a job, you are usually provided with the equivalents, but you will save yourself time if you know the most common equivalents.

Before we start converting between the two systems, we will briefly review how to convert within each of the systems.

Converting Within the Imperial System

Table 1 is a chart of equivalents that is used when converting within the imperial system:

IMPERIAL EQUIVALENTS
12 inches (in) = 1 foot (ft)
3 ft = 1 yard (yd)
1760 yd = 1 mile (mi)
16 ounces (oz.) = 1 pound (lb)
3 teaspoons (tsp) = 1 tablespoon (tbsp)
16 tbsp = 1 cup (C) = 8 fluid oz (fl oz)
2 C = 1 pint (pt)
2 pt = 1 quart (qt)
4 qt = 1 gallon (gal)

In this chart, the larger units are on the left. Charts might be set up with the larger units on the right, so the first line would read 12 in = 1 ft. However, one unit, usually the larger unit, has a 1 in front of it. The other unit has a number different than 1 in front of it. This number is the **conversion factor**. To convert an imperial amount in one unit to another unit, follow these two rules.

Rule 1. If you are converting from a larger unit to a smaller unit, you multiply the amount of the larger unit by the conversion factor.

Example: Convert 3 pints (a larger unit) to cups (a smaller unit).

The chart tells you that 1 pint = 2 cups. The conversion factor is 2. Since you are going from a larger unit to a smaller unit, multiply pints by the conversion factor 2.

$$3 \text{ pt} \times 2 = 6 \text{ C}$$

Example: Convert 16 cups to quarts.

Since there is no line that directly relates quarts to cups, you must first change the cups to pints.

$$16 \text{ C} \div 2 = 8 \text{ pt}$$

Now you can convert from pints to quarts.

$$8 \text{ pt} \div 2 = 4 \text{ qt}$$

Rule 2: To convert a quantity from a smaller unit to a larger unit, divide the amount of the smaller unit by the conversion factor.

Example: Convert 48 ounces (a smaller unit) to pounds (a larger unit), divide 48 by the conversion factor.

From the chart 1 pound = 16 ounces. The conversion factor is 16. Since you are going from a smaller unit to a larger one, divide by 16

$$48 \text{ oz} \div 16 = 3 \text{ lb}$$

Converting Within the Metric System

To convert within the metric system, you multiply or divide by 10, or a power of 10 such as 100 or 1000. To do this, you move the decimal point to the left or right the required number of places, using zeros as place holders when necessary. (You are actually multiplying or dividing by a power of ten when you move a decimal point.)

Table 2 lists the most commonly used prefixes with the basic units for weight (gram), length (meter), and volume (litre).

Table 2: METRIC EQUIVALENTS		
Prefix	Value	Basic Unit
kilo	1000	gram metre litre
centi	$1/100 = .01$	gram metre litre
milli	$1/1000 = .001$	gram metre litre

To convert to or from the basic units of meter, gram or liter, look at the prefix in front of the non-basic unit to tell how many places to move the decimal point.

1. The prefix **kilo** means **1000** times the basic unit.
 - To change from a unit with *kilo* as its prefix to a basic unit, or to convert from a basic unit to a unit with *kilo* as its prefix, move the decimal point 3 places.
2. The prefix **milli** means **.001** times the basic unit.
 - To change from a unit with *milli* as its prefix to a basic unit, or to convert from a basic unit to a unit with *milli* as its prefix, move the decimal point 3 places.
3. The prefix **centi** means **.01** times the basic unit.
 - To change from *centi* to a basic unit, or to convert from a basic unit to a unit with *centi* as its prefix, move the decimal point 2 places.

What direction do you move the decimal point to complete the conversion? Use the following rules:

1. To convert from a **smaller** unit to a **larger** one, move the decimal in the original amount to the **left**.
2. To convert from a **larger** unit to a **smaller** one, move the decimal to the **right**.
3. The number of places to move the decimal point in the original amount when converting to or from a basic unit depends on the prefix of the other unit.
 - With the prefix **kilo**, move the decimal **three** places.
 - With the prefix **milli**, move the decimal **three** places.
 - With the prefix **centi**, move the decimal **two** places.

Example: Convert 650 milliliters to liters.

You are going from a smaller unit to a larger one. The decimal point moves to the left. The prefix milli requires you to move the decimal point three places when going to or from a basic unit. Therefore, you move the decimal point three places to the left.

$$650 \text{ ml} = .650 \text{ L}$$

CONVERTING BETWEEN METRIC AND IMPERIAL UNITS

To convert, or change, from one system to the other, you can use a chart, like Table 3 below, that lists *equivalent measurements*.

To use the chart to convert an amount in one system to the other system, you need to determine the *conversion factor*.

Example: To convert an amount in centimeters to an equivalent amount in inches, look at *the Metric to Imperial side of the chart*. Find the cm to inch equivalent: 1 cm = .39 inches.

The number .39 is the conversion factor. Multiply the original amount in centimeters by the conversion factor .39 and write the new unit, inches, with the answer.

MEASUREMENT EQUIVALENCIES

IMPERIAL TO METRIC EQUIVALENTS	METRIC TO IMPERIAL EQUIVALENTS
1 inch (in) = 2.54 centimeters (cm)	1 cm = .39 in
1 foot (ft) = .305 metres (m)	1 m = 39.4 in = 3.3 ft = 1.09 yd
1 yard (yd) = .914 m	
1 mile (mi) = 1.6 kilometer (km)	1 km = .62 mi
1 pound (lb) = 454 grams (g) or .454 kg	1 kg = 2.2 lb
1 ounce (oz) = 28.38 g	1 g = .035 oz = .0022 lb
1 fluid ounce (fl oz) = 28.4 milliliters (ml)	
1 teaspoon = 5 ml	
1 cup (C) = 8 fl oz = 227 ml = .227 L	1 L = 4.4 C
1 pint (pt) = 454 ml	
1 quart (qt) = .908 liters (L)	1 L = 1.1 qt
1 gal (gal) = 3.6 L	1 L = .275 gal
degrees Fahrenheit (F) = 9/5 degrees C +32	degrees Celsius (C) = 5/9(degrees F - 32)

Converting from Imperial to Metric

Suppose you have 8 cups of flour and you need to convert the amount to a metric unit.

Since you have an imperial measurement and you want to find a metric equivalent, you use the **imperial to metric side of the chart**. The unit with 1 in front is the unit you are converting from. The unit with the conversion factor in front is the unit you are converting to.

Example: Change 8 cups of flour to a metric unit.

Look at the *Imperial to Metric chart* to find the line that equates cups to milliliters. The chart states that 1 c = 227 ml, so .227 is the conversion factor

$$8 \times 227 = 1816$$

$$8 \text{ c} = 1816 \text{ ml}$$

or

$$8 \text{ c} = 1.816 \text{ L}$$

Multiply the imperial amount by the conversion factor 227

Place the metric unit, meters, after the answer.

You could change ml to liters if you wanted.

To convert from an amount in an imperial unit to a metric unit, here are the steps:

1. Use the Metric to Imperial side of the chart
2. The conversion factor is in front of the metric unit.
3. Multiply the original imperial amount by the conversion factor.
4. Put the correct metric units after the multiplication answer.
5. The amount is now converted to metric.

Example: Find the metric equivalent of 12 C.

Multiply 12 times .227 and change the unit to liters.

$$1 \text{ C} = .227 \text{ L}$$

$$12 \text{ C} = .227 \times 12 = 2.72 \text{ L}$$

Example: Convert 4 tbsp to milliliters:

$$4 \text{ tbsp} =$$

$$1 \text{ tsp} = 5 \text{ ml}$$

$$12 \times 5 = 60 \text{ ml}$$

$$4 \times 3 = 12 \text{ tsp}$$

(5 is the conversion factor)

If the chart doesn't show a direct equivalent, you must convert within the original system until you have a unit with a metric conversion factor. For example, if you want to convert feet to centimeters using the chart on the previous page, you must first convert the feet to inches. Then you can use the conversion factor on the chart for inches to centimeters. First convert the feet to inches, then convert inches to centimeters.

Example: Convert 5 feet to centimeters.

The table does not show feet to centimeters, so first convert feet to inches.

Use Table 1, Imperial Equivalents.

$$\begin{aligned}1 \text{ ft} &= 12 \text{ inches} && \text{conversion factor is 12} \\5 \text{ ft} &= 5 \times 12 \\&= 60 \text{ in}\end{aligned}$$

Now convert 60 inches to centimeters. Use Table 3, Imperial to Metric Equivalents.

$$\begin{aligned}1 \text{ in} &= 2.54 \text{ cm} && \text{conversion factor is 2.54} \\60 \text{ in} &= 2.54 \times 60 \\&= 152.4 \text{ cm}\end{aligned}$$

Example: Let's do the same question of converting 5 feet to centimeters, but this time convert the feet directly to meters and then convert the meters to centimeters.

$$\begin{aligned}1 \text{ ft} &= .305 \text{ m} \\5 \text{ ft} &= 5 \times .305 \\&= 1.525 \text{ m} \\1.525 \text{ m} &= 152.5 \text{ cm}\end{aligned}$$

Notice the answers to the same question vary slightly in the examples. This is because the conversion factors have been rounded off.

Example: How many grams does 9 ounces of chocolate weigh?

$$\begin{aligned}1 \text{ oz} &= 28.4 \text{ g} \\9 \text{ oz} &= 28.4 \times 9 = 255.6 \text{ g}\end{aligned}$$

Example: Find the distance traveled in km if a car has been driven 45 mi.

From the imperial to metric chart:

$$\begin{aligned}1 \text{ mi} &= 1.6 \text{ km} && 1.6 \text{ is the conversion factor)} \\45 \text{ mi} &= 1.6 \times 45 \\&= 72 \text{ km}\end{aligned}$$

Converting from Metric to Imperial

You might also want to convert from metric to imperial units. Use the Metric to Imperial Equivalents side of the chart. The procedure for using the chart is the same. The unit with the 1 in front is the metric unit. The number in front of the imperial unit is the conversion factor.

Because there are fewer units in the metric system, there are sometimes several conversion factors after a metric unit. For example, 1 meter can equal 39.4 inches or 3.3 feet or 1.09 yards. To convert from meters to feet, choose the conversion factor that changes meters to feet, which is 3.3. To convert from meters to inches, choose the conversion factor 39.4.

To convert from a metric unit to an imperial unit, here are the steps:

1. The conversion factor is in front of the imperial unit in the Metric to Imperial side of the chart.
2. Multiply the original metric amount by the conversion factor.
3. Put the correct imperial unit after the multiplication answer.
4. The amount is now converted to imperial units.

Example: You are traveling to a city 450 km away. How many miles do you travel?

Since you are converting an amount a metric unit to an imperial unit, use the Metric to Imperial chart.

$$1 \text{ km} = .62 \text{ mi} \quad \text{conversion factor is } .62$$

$$\begin{aligned} 450 \text{ km} &= .62 \times 450 \\ &= 279 \text{ mi} \end{aligned}$$

In Brief:

1. When you convert, the first step is to check which system the amount is now in and which system you are converting to.
2. Next choose the correct chart for that conversion.
3. Find the line with the required conversion factor on it.
4. Multiply the original amount by the conversion factor.
5. The multiplication answer is the amount in the new unit.
6. The last step is to write the new unit after the converted amount.

Example: You have a 10 kilogram bag of flour. How many pounds are in the bag.

$$\begin{aligned} 1 \text{ kg} &= 2.2 \text{ lb} && \text{From the metric to imperial chart:} \\ 10 \text{ kg} &= 2.2 \times 10 = 22 \text{ lb} \end{aligned}$$

Example: One liter of water weighs 1 kg. How many pounds does 4 L weigh?

There are two steps to this problem. First we need to find how much 4 L weighs in kilograms and then we need to convert the kilograms to pounds.

$$\begin{aligned} 1 \text{ L} &\text{ weighs } 1 \text{ kg} \\ 4 \text{ L} &\text{ weigh } 4 \text{ kg} \end{aligned}$$

$$\begin{aligned} 1 \text{ kg} &= 2.2 \text{ lb} && \text{conversion factor is } 2.2 \\ 4 \text{ kg} &= 2.2 \times 4 \\ &= 8.8 \text{ lb} \\ 4 \text{ L of water} &\text{ weigh } 8.8 \text{ lb.} \end{aligned}$$

Example: Convert 4.5 liters to gallons.

From the Metric to Imperial chart:

$$\begin{aligned} 1 \text{ L} &= .22 \text{ gal} && \text{conversion factor is } .22 \\ 4.5 \text{ L} &= 4.5 \times .22 \\ &= .99 \text{ gal} \end{aligned}$$

Converting temperature

The imperial and metric systems use different units to measure temperature. The metric system uses the Celsius (C) scale. In this scale, the freezing point of water is 0°C and the boiling point is 100°C. In the Fahrenheit scale, the freezing point of water is 32°F and the boiling point is 212°F.

Two important temperature equivalents are:

$$0^{\circ}\text{C} = 32^{\circ}\text{F}$$

$$100^{\circ}\text{C} = 212^{\circ}\text{F}$$

1. **To change from Fahrenheit to Celsius**, subtract 32 from the degrees F and multiply the answer by 5/9. Use the Celsius unit (°C) in the final answer. The formula is $^{\circ}\text{C} = \frac{5}{9} (^{\circ}\text{F} - 32)$

Example: Change 45°F to Celsius.

$$\begin{aligned}^{\circ}\text{C} &= \frac{5}{9} (^{\circ}\text{F} - 32) \\ &= 5/9(45^{\circ} - 32) \\ &= 5/9(13^{\circ}) \\ &= 7.2^{\circ}\text{C}\end{aligned}$$

2. **To change from Celsius to Fahrenheit**, multiply the degrees C by 9/5 and add 32. Use the Fahrenheit unit (°F) in the answer. The formula is: $^{\circ}\text{F} = \frac{9}{5} (^{\circ}\text{C}) + 32$

Example: Change 33°C to Fahrenheit.

$$\begin{aligned}^{\circ}\text{F} &= \frac{9}{5} (^{\circ}\text{C}) + 32 \\ &= 9/5(33^{\circ}) + 32 \\ &= 59.4^{\circ} + 32 \\ &= 91.4^{\circ}\text{F}\end{aligned}$$

Example: Change 200°C to Fahrenheit.

$$\begin{aligned}^{\circ}\text{F} &= \frac{9}{5} (^{\circ}\text{C}) + 32 \\ &= 9/5 (200^{\circ}\text{C}) + 32 \\ &= 360 + 32 \\ &= 392^{\circ}\text{F}\end{aligned}$$

TO CONVERT FROM IMPERIAL TO METRIC

1. Find the equivalent units on the imperial to metric chart.
2. Multiply the given number of imperial units by the conversion factor (the number in front of the metric unit).
3. Write the multiplication answer with metric units to get the metric equivalent.
4. If there is no direct equivalency, for example from inches to meters, convert the inches to a unit for which there is an equivalency, which in this case is feet. Now the feet can be converted to meters.

TO CONVERT FROM METRIC TO IMPERIAL

1. Find the metric to imperial equivalent.
2. Multiply the given number of metric units by the conversion factor (the number in front of the imperial unit).
3. Write the multiplication answer with imperial units to get the imperial equivalent.
4. If there is no direct equivalency, as with millimeters to inches, convert the millimeters to a unit for which there is an equivalency, which in this case is centimeters. Now the centimeters can be converted to inches.

Answer the following questions. Use the conversion charts in the skills manual. Your answers might be rounded off to a different number of decimal places. Answers are on the last page.

1. What are the equivalent temperatures in Fahrenheit degrees to:

- a) 100°C b) 229°C c) 0°C d) 160°C

2. What are the equivalent temperatures in Celsius degrees to:

- a) 32°F b) 350°F c) 500°F d) 425°F

3. Make the following conversions from metric to imperial.

- a) $1\text{ cm} = \underline{\hspace{1cm}}\text{ in}$ b) $25\text{ cm} = \underline{\hspace{1cm}}\text{ in}$ c) $1\text{ m} = \underline{\hspace{1cm}}\text{ in} = \underline{\hspace{1cm}}\text{ ft} = \underline{\hspace{1cm}}\text{ yd}$
- d) $12\text{ m} = \underline{\hspace{1cm}}\text{ yd}$ e) $.5\text{ m} = \underline{\hspace{1cm}}\text{ in}$ f) $1\text{ km} = \underline{\hspace{1cm}}\text{ mi}$
- g) $30\text{ km} = \underline{\hspace{1cm}}\text{ mi}$ h) $1\text{ L} = \underline{\hspace{1cm}}\text{ qt}$ i) $6.8\text{ L} = \underline{\hspace{1cm}}\text{ qt}$
- j) $1\text{ kg} = \underline{\hspace{1cm}}\text{ lb}$ k) $5\text{ kg} = \underline{\hspace{1cm}}\text{ lb}$ l) $1\text{ g} = \underline{\hspace{1cm}}\text{ oz} = \underline{\hspace{1cm}}\text{ lb}$

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- m) 500 g = _____ lb n) 200 g = _____ oz o) 1 L = _____ C
- p) 3.2 L = _____ C q) 1 L = _____ gal r) 45 L = _____ gal

4. Make the following conversions from imperial to metric:

- a) 1 in = _____ cm b) 15 in = _____ cm c) 1 yd = _____ m
- d) 35 yd = _____ m e) 1 mi = _____ km f) 60 mi = _____ km
- g) 1 qt = _____ L h) 6 qt = _____ L i) 1 lb = _____ g = _____ kg
- j) 3 lb = _____ kg k) .8 lb = _____ g l) 1 fl oz = _____ ml
- m) 32 fl oz = _____ ml n) 1 C = _____ fl oz = _____ ml = _____ L
- o) 1 tsp = _____ ml p) 7 tsp = _____ ml q) 5 C = _____ L
- r) 1.1 C = _____ ml s) 1 pt = _____ ml t) 3 pt = _____ ml
- u) 1 gal = _____ L v) 1.2 gal = _____ L

5. If a bread recipe requires the bread to be baked at 150°C and your oven is only calibrated in degrees Fahrenheit, at what setting should you put your oven?

6. a) If you have 20 L of stock made, how many quarts do you have?
- b) If the recipe you are using calls for 3 qt of stock, how many times can you make the recipe with that amount of stock?

7. If you traveled 450 miles on a trip, how many kilometers did you travel?
8. a) If a recipe for a cake called for 2 tbsp of vanilla, how many ml would you put in the bowl?
- b) If you needed 4 and a half cups of flour, how many liters would that be? (Change the 4 1/2 cups to a decimal before converting.)
9. If a bag of flour weighs 25 pounds, how many kilograms does it contain?

ANSWERS

1. a) 212°F b) 444°F c) 32°F d) 320°F
2. a) 0°C b) 177°C c) 260°C d) 218°C
3. a) .39 in b) 9.75 in c) 39.4 in, 3.3 ft, 1.09 yd d) 13.08 yd e) 19.7 in
f) .62 mi g) 18.6 mi h) .88 qt i) 5.98 qt j) 2.2 lb k) 11 lb
l) .035 oz, or .0022 lb m) 1.1 lb n) 7 oz o) 4.4 C p) 14 C
q) .275 gal r) 12.375 gal
4. a) 2.54 cm b) 38.1 cm c) .914 m d) 31.99 m e) 1.6 km f) 96 km
g) 1.14 L h) 6.84 L i) 454 g, 454 kg j) 1.362 kg k) 363.2 g
l) 28.4 ml m) 908.8 ml n) 8 fl oz, 227 ml, or .227 L o) 5 ml p) 35 ml
q) 1.135 L r) 249.7 ml s) 454 ml t) 1362 ml u) 3.63 L v) 4.36 L
5. 302°F
6. a) 22 qt
b) $22 \div 3 = 7$ You can make 7 portions of the recipe.
7. 720 km
8. a) $2 \text{ tsp} = 6 \text{ tbsp}$
 $6 \times 5 = 30 \text{ ml}$
b) $4.5 \times .227 = 1 \text{ L}$
9. $25 \times .454 = 11.35 \text{ kg}$