Sect 5.3 – Metric System of Measurement

Objective 1: Understanding the Metric System

The rest of the world uses the metric system of measurement. It is important to understand how it works. The system starts with three base units and then uses prefixes to derive the remaining units. The meter, m, (≈ 39.4 inches) is the base unit for length, the liter, L, (slightly bigger than a quart) is the base unit for volume, and the gram, g, (about the weight of one raisin) is the base unit for weight. There are six common prefixes that we will study. They are listed in the table below:

Prefix	Meaning	Length	Weight	Volume
kilo-, k	1000 times	1 km = 1000 m	1 kg = 1000 g	1 kl = 1000 L
hecto-, h	100 times	1 hm = 100 m	1 hg = 100 g	1 hl = 100 L
deca-, da	10 times	1 dam = 10 m	1 dag = 10 g	1 dal = 10 L
deci-, d	1/10 times	1 dm = 0.1 m	1 dg = 0.1 g	1 dl = 0.1 L
centi-, c	1/100 times	1 cm = 0.01 m	1 cg = 0.01 g	1 cl = 0.01 L
milli-, m	1/1000 times	1 mm = 0.001 m	1 mg = 0.001 g	1 ml = 0.001 L

Objective 2: Converting using Unit Conversion Factors

We can us the same approach as the last section to convert within the metric system. Listed below are some common conversions.

Metric System:

(ha – hectares, Pa – Pascals)

Length	**Weight/Mass**
1 cm = 10 mm 1 m = 100 cm = 1000 mm 1 km = 1000 m	1 g = 1000 mg 1 kg = 1000 g 1 metric ton = 1000 kg
Area and Pressure	**Volume**
1 ha = 10,000 m^2 1 kPa = 1000 Pa	1 cm^3 = 1 mL = 1 cc 1 L = 1000 cm^3 = 1000 mL

Convert each unit as indicated:

Ex. 1 Convert 0.35 ha to m^2.

Solution:

Since 1 ha = 10,000 m^2, then

$$\frac{0.35\text{ha}}{1} = \frac{0.35\text{ha}}{1} \bullet \frac{10000\text{m}^2}{\text{ha}} = 3500 \text{ m}^2.$$

Ex. 2 Convert 45,000 g to kg.

Solution:

Since 1 kg = 1000 g, then

$$\frac{45000\text{g}}{1} = \frac{45000\text{g}}{1} \bullet \frac{1\text{kg}}{1000\text{g}} = 45 \text{ kg}$$

Ex. 3 Convert $\frac{\$302}{\text{L}}$ to $\frac{\$}{\text{cc}}$.

Solution:

Since 1 cc = 1 mL and 1 L = 1000 mL, then

$$\frac{\$302}{\text{L}} \bullet \frac{1\text{L}}{1000\text{mL}} = \frac{\$0.302}{\text{mL}} = \frac{\$0.302}{\text{cc}} \approx \frac{\$0.30}{\text{cc}}$$

Ex. 4 Convert $\frac{48\text{cm}}{\text{sec}}$ to $\frac{\text{km}}{\text{hr}}$.

Solution:

First, convert sec to hr:

$$\frac{48\text{cm}}{\text{sec}} = \frac{48\text{cm}}{\text{sec}} \bullet \frac{3600\text{sec}}{1\text{hr}} = \frac{172800\text{cm}}{\text{hr}}$$

Now, convert cm to m:

$$\frac{172800\text{cm}}{\text{hr}} = \frac{172800\text{cm}}{\text{hr}} \bullet \frac{1\text{m}}{100\text{cm}} = \frac{1728\text{m}}{\text{hr}}$$

Finally, convert m to km:

$$\frac{1728\text{m}}{\text{hr}} = \frac{1728\text{m}}{\text{hr}} \bullet \frac{1\text{km}}{1000\text{m}} = \frac{1.728\text{km}}{\text{hr}} \approx 1.7 \text{ kph}.$$

Objective 3: Converting Using the Prefixes.

To convert within the metric system, we list our prefixes from largest to smallest, mark the prefix we are converting from and count how many times we have to move to get to the prefix we are converting to. The number of times and the direction tells us how to move the decimal point in the number to get our answer. Here is what our prefix chart looks like:

k	h	da	grams liters meters	d	c	m

Let's try some examples:

<u>Convert the following:</u>

Ex. 5 Convert 56 m to ___ cm.

<u>Solution:</u>

We start from the base unit and move over two places to the right:

k h da meters d c m

56 m = 56.00 = 5,600 cm.

Ex. 6 Convert 67.3 dg to ___ hg.

<u>Solution:</u>

We start from the d prefix and move three places to the left:

k h da grams d c m

67.3 dg = 067.3 = 0.0673 hg.

Ex. 7 Convert 0.0645 km to dm.

<u>Solution:</u>

We start from the k prefix and move four places to the right:

k h da meters d c m

0.0645 km = 00645 = 645 dm.

Ex. 8 Convert 565 cc to ___ L.

<u>Solution:</u>

The unit cc is the same as mL, so we start from the prefix m and move three places to the left:

k h da liters d c m

565 cc = 565 mL = 565 = 0.565 L.

Ex. 9 Convert $\frac{\$25}{\text{kg}}$ to $\frac{\$}{\text{dag}}$.

<u>Solution:</u>

We start from k and move two places to the right:

k h da grams d c m

So, 1 kg = 1.00 = 100 dag

Thus, $\frac{\$25}{\text{kg}} = \frac{\$25}{100\text{dag}} = \frac{\$0.25}{\text{dag}}$

Objective 4: Converting between the US and Metric Systems.

In this day and age, the metric system is virtually worldwide. Though there was a strong drive in the 1970's for the U.S. to adopt the metric system, the U.S. never made the transition. Thus, the U.S. is the only major country that does not use the metric system. Since the metric system is accepted in the rest of the world, it is important that we have the ability to convert between the two systems. Here are some useful conversions:

<u>Conversions between the Metric to US Systems:</u>

Length	**Weight/Mass**
1 in = 2.54 cm 1 ft = 30.48 cm = 0.3048 m 1 yd = 0.9144 m 1 mi = 1.609344 km	1 oz ≈ 28.35 g 1 lb ≈ 0.4536 kg = 453.6 g 1 T ≈ 907.2 kg = 0.9072 metric T
Area	**Volume**
1 in^2 ≈ 6.4516 cm^2 1 ft^2 ≈ 0.09290 m^2 1 yd^2 ≈ 0.8361 m^2	1 in^3 ≈ 16.3871 cm^3 1 ft^3 ≈ 0.0283168 m^3 1 ft^3 ≈ 28.3168 L 1 yd^3 ≈ 0.7646 m^3 1 fl oz ≈ 29.574 cm^3 1 qt ≈ 0.94635 L 1 gal ≈ 3.7854 L
Temperature	**Pressure**
$F = 1.8C + 32^\circ$ $C = \frac{5F-160^\circ}{9}$	1 psi ≈ 6895 Pa = 6.895 kPa 1 psf ≈ 47.88 Pa = 0.04788 kPa 1 atm ≈ 101.33 kPa

We will use the same techniques of constructing a unit conversion factor to convert between the two systems.

<u>Convert the following:</u>

Ex. 10 Convert 45 mi to ___ km.

<u>Solution:</u>

Since 1 mi = 1.609344 km, then

45 mi ≈ $\frac{45\text{mi}}{1} \bullet \frac{1.609344\text{km}}{1\text{mi}}$ = 72.42048 km ≈ 72 km.

Ex. 11 Convert 6501 g to ___ lb.

<u>Solution:</u>

Since 1 lb ≈ 453.6 g, then

6501 g ≈ $\frac{6501\text{g}}{1} \bullet \frac{1\text{lb}}{453.6\text{g}}$ = 14.33201... lb ≈ 14.33 lb.

Ex. 12 Convert 84 qt to ___ L

<u>Solution:</u>

Since 1 qt ≈ 0.94635 L, then

84 qt ≈ $\frac{84\text{qt}}{1} \bullet \frac{0.94635\text{L}}{1\text{qt}}$ = 79.4934 L ≈ 79 L.

Ex. 13 Convert 12,192 cm to ___ ft

<u>Solution:</u>

Since 1 ft = 30.48 cm, then

12192 cm = $\frac{12192\text{ cm}}{1} \bullet \frac{1\text{ft}}{30.48\text{cm}}$ = 400 ft.

Ex. 14 Convert 4760 ml to ___ c.

<u>Solution:</u>

There is no direct conversion between milliliters and cups so we will need to convert this in several steps. If we look at the chart, we see that 1 qt ≈ 0.946 L. In order to use this conversion, we will need to first convert the ml to L:

(ml → L) k h da liters d c m

So, 4760 ml = 4760 = 4.760 L or 4.760 L

(L → qt) Now, convert from liters to quarts:

Since 1 qt ≈ 0.94635 L, then

$4.760 \text{ L} \approx \frac{4.76\text{L}}{1} \bullet \frac{1\text{qt}}{0.94635\text{L}} = 5.02985\ldots\text{qt}$

To minimize the error, we will round off at the end of the problem.

(qt $\rightarrow$ c) Finally, convert from quarts to cups:

Since 1 qt = 4 c, then

$5.02985\ldots \text{ qt} = \frac{5.02985\ldots \text{ qt}}{1} \bullet \frac{4\text{c}}{1\text{qt}} = 20.1194 \ldots \text{ c} \approx 20.1 \text{ c}.$

Ex. 15 Convert $\frac{92.0 \text{ fl oz}}{\text{yd}^2}$ to $\frac{\text{mL}}{\text{m}^2}$.

Solution:

(fl oz $\rightarrow$ mL (cm^3)) First, convert from fl ounces to cu centimeters:

Since 1 fl oz ≈ 29.574 cm^3, then

$$\frac{92.0 \text{ fl oz}}{\text{yd}^2} \approx \frac{92.0 \text{ fl oz}}{\text{yd}^2} \bullet \frac{29.574 \text{ cm}^3}{1 \text{ fl oz}} = \frac{2720.808 \text{ cm}^3}{\text{yd}^2} = \frac{2720.808 \text{ mL}}{\text{yd}^2}$$

(yd^2 $\rightarrow$ m^2) Now, convert the square yards to square meters:

Since 1 yd^2 ≈ 0.836 1m^2, then

$$\frac{2720.808 \text{ mL}}{\text{yd}^2} \bullet \frac{1\text{yd}^2}{0.8361\text{m}^2} = \frac{3254.16577\ldots\text{mL}}{\text{m}^2} \approx \frac{3250 \text{ mL}}{\text{m}^2}.$$

Ex. 16 Convert $\frac{\$8.93}{\text{kg}}$ to $\frac{\$}{\text{oz}}$.

Solution:

(kg $\rightarrow$ lb) First, convert from kilograms to pounds:

Since 1 lb = 0.4536 kg, then

$$\frac{\$8.93}{\text{kg}} \approx \frac{\$8.93}{\text{kg}} \bullet \frac{0.4536\text{kg}}{1\text{lb}} = \frac{\$4.050648}{\text{lb}}.$$

(lb $\rightarrow$ oz) Now, convert the pounds to ounces:

Since 16 oz = 1 lb, then

$$\frac{\$4.050648}{\text{lb}} \bullet \frac{1\text{lb}}{16\text{oz}} = \frac{\$0.2531655}{\text{oz}} \approx \frac{\$0.25}{\text{oz}}.$$

Ex. 17 Convert 50˚F to ___ C .

Solution:

Plug 50˚ in for F in the formula

$C = \frac{5F - 160^\circ}{9}$ and solve:

$C = \frac{5(50^\circ) - 160^\circ}{9} = \frac{250^\circ - 160^\circ}{9}$

$= \frac{90^\circ}{9} = 10^\circ$ C.

Ex. 18 Convert 81.0˚C to ___ F.

Solution:

Plug 81˚ in for C in the formula F = 1.8C + 32˚ and solve: F = 1.8(81.0˚) + 32˚

= 145.8˚ + 32˚ ≈ 178˚ F.