PAL Worksheet – Chem 6A

Measurement

A. Metric system

The metric system has seven base units for measured quantities. Chem 6A uses five of these:

Unit	Unit abbreviation	Property
liters	L	volume
meters	m	length or distance
kilograms	kg	mass
mole	mol	amount
kelvin	K	temperature

Metric prefixes

Metric prefixes are multipliers that allow us to express large or small quantities as an exponent. They are defined according to the table below. The prefixes are applied to the base units, except in the case of mass, where it applies to grams and not kilograms.

giga	G	10^{9}		1 000 000 000
mega	M	10^{6}		1 000 000
kilo	k	10^{3}		1 000
hecto	h	10^{2}		100
deka	da	10^{1}		10
base unit		10^{0}		1
deci	d	10^{-1}	1/10	0.1
centi	c	10^{-2}	1/100	0.01
milli	m	10^{-3}	1/1 000	0.001
micro	μ	10^{-6}	1/1 000 000	0.000 001
nano	n	10^{-9}	1/1 000 000 000	0.000 000 001

Where base unit = meters, grams, liters, moles

There are two methods to use a metric prefix.

Method 1: Apply it to the base unit, e.g. 1 cm = 0.01 meter. Meter is the base unit.

Method 2: Apply it to the smaller unit, e.g. 100 cm = 1 meter. A cm is smaller than a meter so we need more cm to make up a meter.

You can use either method as long as you don't mix them together.

Using metric prefixes with units as ratios

To say that 1 cm = 0.01 meter is to say that these are equivalent quantities. We can express this as a ratio (using **method 1** to apply metric prefixes):

$$\frac{1\text{ cm}}{0.01\text{ m}} \quad \text{OR} \quad \frac{0.01\text{ m}}{1\text{ cm}}$$

Note that if we want to use **method 2** of applying metric prefixes in this example, our ratios become:

$$\frac{100\text{ cm}}{1\text{ m}} \quad \text{OR} \quad \frac{1\text{ m}}{100\text{ cm}}$$

Which unit goes in the numerator depends on the question being asked and what information you are trying to find. For example,

Convert 0.055 cm to 1 meter. We can use a metric ratio (also called a **conversion factor**) above to make this conversion. Since we are starting with cm, we need to have cm in the denominator to cancel that unit; m will then be in the numerator. We can use either of the following conversion factors:

$$\frac{0.01\text{ m}}{1\text{ cm}} \quad \text{OR} \quad \frac{1\text{ m}}{100\text{ cm}}$$

$$0.055\text{ cm} \times \frac{0.01\text{ m}}{1\text{ cm}} = 0.00055\text{ m}$$

$$0.055\text{ cm} \times \frac{1\text{ m}}{100\text{ cm}} = 0.00055\text{ m}$$

No matter which version of the cm to m ratio we use, we get the same answer, **as long as we use the ratio in the correct orientation and only one method of applying prefixes**.

Start Practicing!

1. Express the equivalent quantities of nm to m as a ratio in both orientations (nm in the numerator and then in the denominator) using **method 1**. Then repeat using **method 2**.

2. Express L to μL as a ratio in both orientations using both methods of applying prefixes.

B. English system

Use the conversions between the English and metric systems from the table below to complete the problems in this section.

Metric	English
2.54 cm	1 in
5 mL	1 tsp
30 mL	1 oz
1 L	1.06 qt
454 g	1 lb
1 kg	2.2 lb

1. Express cm to in as a ratio, in both orientations.

2. Express lb to g as a ratio, in both orientations.

3. Express oz to mL as a ratio in both orientations.

4. Complete the following conversions. In each case start with the quantity given and then multiply it by the correct English-metric conversion factor.

   a. 63 tsp to mL

   b. 3.1 g to lb

   c. 124 mL to oz

   d. 0.087 cm to inches