Introduction to Chemistry

A. Unit Conversions

1. In Chemistry 11 and 12, a mathematical method called ____________________________

will be used extensively. This method uses _____________________________________

____

a **CONVERSION FACTOR** ____

____

e.g. If **1 min = 60 s** then expressed as a fraction two conversion factors are given:

Since the top part **EQUALS** the bottom part, **this fraction has a value equal to "1"**. Multiplying any expression by this conversion is the same as multiplying by "1" and therefore **WILL NOT CHANGE** the value of the expression.

EXAMPLE II.1	**USING CONVERSION FACTORS**
Problem:	How many minutes are there in 3480 seconds?
Solution:	

2. The method of unit conversions uses conversion factors ___________________________

____

Every unit conversion problem has three major pieces of information which must be identified:

i. the ____________________ amount and its **UNITS**,

ii. the ____________________ amount and its **UNITS**, and

iii. a ___________________________________ which relates or connects the initial **UNITS** to the **UNITS** of the unknown.

ALL calculations must ____

e.g. What is the cost of 2 dozen eggs if eggs are $1.44/doz?

What is the cost	of 2 doz eggs	if eggs are $1.44/doz?
______________ **AMOUNT**	______________ **AMOUNT**	____________________

Putting everything together completes the unit conversion.

cost ($) =

Notice that the unit "doz" cancels.

e.g. If a car can go 80 km in 1 h, how far can the car go in 8.5 h?

If a car can go 80 km in 1 h	how far can the car go	in 8.5 h?
CONVERSION	**UKNOWN AMOUNT**	**INITIAL AMOUNT**

how far (km) =

Note that the unit "h" cancels.

3. The general form of a unit conversion calculation is as follows:

(__________ amount) = (__________ amount) × (____________________)

EXAMPLE II.2	UNIT CONVERSION CALCULATIONS
Problem:	If 0.200 mL of gold has a mass of 3.86 g, what is the mass of 5.00 mL of gold?
Solution:	Unknown amount and unit = ____________ Initial amount and unit = ____________ Conversion factors 0.200 mL = 3.86 g, so Putting everything together mass (g) =

EXAMPLE II.3	UNIT CONVERSION CALCULATIONS
Problem:	If 0.200 mL of gold has a mass of 3.86 g, what volume is occupied by 100.0 g of gold?
Solution:	Unknown amount and unit = ____________ Initial amount and unit = ____________ Conversion factors 0.200 mL = 3.86 g, so Putting everything together volume (mL) =

4. All of the previous problems have involve a single conversion factor; ________________

____

____

e.g. If eggs are $1.44/doz, and if there are 12 eggs/doz, how many individual eggs can be bought for $4.32?

UNKNOWN AMOUNT = ____________________

INITIAL AMOUNT = __________

CONVERSION FACTORS:

Ideally, we would like

$$(\$) \rightarrow (\text{eggs})$$

but since we don't have this conversion factor we must first convert

$$(\$) \rightarrow (\text{doz})$$

and then

$$(\text{doz}) \rightarrow (\text{eggs})$$

Putting it all together,

how many eggs (eggs) =

EXAMPLE II.4	**MULTIPLE UNIT CONVERSION CALCULATIONS**
Problem:	The automobile gas tank of a Canadian tourist holds 39.5 L of gas. If 1 L of gas is equal to 0.264 gal in the United States and gas is $1.26/gal in Dallas, Texas, how much will it cost the tourist to fill his tank in Dallas?
Solution:	Unknown amount and unit = __________ Initial amount and unit = __________ Conversion factors _________________________ Putting everything together cost ($) =

B. SI Units

1. The International System (SI) of metric units has numerous "base units". A "base unit" is

____

____

____

Base Units

QUANTITY	WRITTEN UNIT	UNIT SYMBOL
length		
mass		
time		
amount of substance		
volume		
mass		

2. Multiples of base units are produced by ______________________________

____

Multiples Of Base Units

WRITTEN PREFIX	PREFIX SYMBOL	EQUIVALENT EXPONENTIAL
		10^6
		10^3
		10^2
		10^1
		10^{-1}
		10^{-2}
		10^{-3}
		10^{-6}

OTHER IMPORTANT EQUIVALENCES

$$1\ \text{mL} = 1\ \text{cm}^3$$

$$1\ \text{m}^3 = 10^3\ \text{L}$$

$$1\ \text{t} = 10^3\ \text{kg}$$

EXAMPLE II.5	PREFIXES, UNIT SYMBOLS, AND EXPONENTS
Problem:	Re–write the expression “5 kilograms” using (a) Prefix and Unit symbol and (b) Exponential Equivalent.
Solution:	(a) 5 kilogram = (b) Since the exponential equivalent of “kilo” and “k” is “10^3” 5 kilogram =

EXAMPLE II.6	PREFIXES, UNIT SYMBOLS, AND EXPONENTS
Problem:	Re–write the expression “2 ms” using (a) Written Prefix and Unit and (b) Exponential Equivalent.
Solution:	(a) 2 ms = (b) Since the exponential equivalent of “milli” and “m” is “10^{-3}” 2 ms =

EXAMPLE II.7	PREFIXES, UNIT SYMBOLS, AND EXPONENTS
Problem:	Re–write the expression “2.7×10^{-2} m” using (a) Written Prefix and Unit and (b) Prefix and Unit symbol.
Solution:	(a) Since “10^{-2}” is equivalent to “centi” and “m” = metre 2.7×10^{-2} m = (b) 2.7×10^{-2} m =

3. The following multiples are used far less frequently.

WRITTEN PREFIX	PREFIX SYMBOL	EQUIVALENT EXPONENTIAL
yotta	Y	10^{24}
zetta	Z	10^{21}
exa	E	10^{18}
peta	P	10^{15}
tera	T	10^{12}
giga	G	10^{9}
nano	n	10^{-9}
pico	p	10^{-12}
femto	f	10^{-12}
atto	a	10^{-18}
zepto	z	10^{-21}
yocto	y	10^{-24}

C. Metric Conversions

1. Metric conversions involve using ____

____

e.g. (a) Write a conversion statement between **cm** and **m**.

since "c" stands for "10^{-2}" then 1 cm = __________

(b) Write a conversion statement between **ms** and **s**.

since "m" stands for "10^{-3}" then 1 ms = __________

EXAMPLE II.8	**METRIC CONVERSIONS**
Problem:	How many micrometres are there in 5 cm?
Solution:	**UNKNOWN AMOUNT** = how many micrometres (µm) **INITIAL AMOUNT** = 5 cm **CONVERSION:** (cm) → (m) → (µm) 1 cm = __________ 1 µm = __________ Putting it all together (µm) = Notice that all the given prefix symbols are directly related to the "base unit". In order to connect two metric prefixes, connect them to the base unit first.

EXAMPLE II.9	**METRIC CONVERSIONS**
Problem:	How many milligrams is 8 kg?
Solution:	**UNKNOWN AMOUNT** = how many milligrams (mg) **INITIAL AMOUNT** = 8 kg **CONVERSION:** (kg) $\rightarrow$ (g) $\rightarrow$ (mg) 1 kg = ___________ 1 mg = ___________ Putting it all together (mg) =

EXAMPLE II.10	**METRIC CONVERSIONS**
Problem:	Express 5 Mg/mL in kilograms/litre
Solution:	**UNKNOWN AMOUNT** = ______________________ **INITIAL AMOUNT** = ________________ **CONVERSION:** (Mg) $\rightarrow$ (g) $\rightarrow$ (kg) 1 Mg = ___________ 1 kg = ___________ (mL) $\rightarrow$ (L) 1 mL = ___________ Putting it all together, $\frac{kg}{L}$ =

D. Derived Quantities

1. A **DERIVED QUANTITY** is ____

____

A **DERIVED UNIT** is ____

____

e.g. The heat change occurring when the temperature of a water sample increases is given by

$$\Delta H = c \bullet m \bullet \Delta T$$

where: $\Delta H =$ the change in heat; "Δ" is the Greek letter "delta" and is used to indicate "the change in" (ΔH is measured in joules, **J**).

$m =$ the mass of water being heated (**g**).

$\Delta T =$ the change in temperature of the water (**°C**)

and $c =$ a derived quantity called the specific heat capacity, which can be calculated by rearranging the above equation.

$$c = \frac{\Delta H}{m \text{ x } \Delta T}$$

The units of **c** are derived by substituting the units of each symbol into the equation. For example, using the values: $\Delta H = 4.02 \times 10^4$ J, m = 175 g, and ΔT = 55.0 °C gives

$c =$

Therefore, ***c*** is a ___________________________, having **derived units**, found by combining three other quantities (ΔH, m, and ΔT) and their units.

E. Density

1. Density is derived quantity that describes the mass contained in a given volume. Mass is the quantity of matter in an object.

$$d = \frac{m}{V}$$

where: d = ________________

m = ___________

V = ________________

If mass is measured in grams (g) and volume in litres (L), the units of density are:

$$d = \frac{mass\ (g)}{Volume\ (L)} = \frac{g}{L}$$

2. Density calculations involve substituting information into the density equation after rearranging the equation to solve for the unknown.

EXAMPLE II.11	DENSITY CALCULATIONS
Problem:	(a) An iron bar has a mass of 19 600 g and volume of 2.50 L. What is the iron's density? (b) If mercury has a density of 13 600 g/L, what volume of (in mL) is occupied by 425 g of mercury?
Solution:	(a) Substitute into the density equation. d = (b) Rearrange density equation to solve for V V =

IMPORTANT FACT

for water at 4 °C, the density = 1000.0 g/l or 1.0000 g/ml

note that measuring the volume of a sample of water allows you to immediately know its mass, and vice versa. so for water at 4 °C,

1 g = 1 ml

LESS DENSE LIQUIDS AND OBJECTS WILL FLOAT ON LIQUIDS HAVING A GREATER DENSITY

Objects will sink in a liquid if $\mathbf{d_{OBJECT}} > \mathbf{d_{Liquid}}$

Objects will float in a liquid if $\mathbf{d_{OBJECT}} < \mathbf{d_{Liquid}}$

F. Significant Figures

1. When **COUNTING** a small number of objects it is not difficult to find the **EXACT** number of objects; however, when a property such as mass, volume, time, or length is **MEASURED** it is **impossible** to find the exact value because _______________________

____

____

Measurements will have a certain number of _____________________________________

____

A **SIGNIFICANT FIGURE** is a ____

All of the digits in a measurement are considered **certain** with the **final digit considered uncertain** or a "best guess". Collectively, _______________________________________

____

e.g. If a stopwatch is used to time an event and the elapsed time is **35.2** s, then the measurement has _____ significant figures (3, 5, and 2).

e.g. A balance gives a reading of 97.53 g when a beaker is placed on it. This reading has 4 significant figures since it contains _____ digits.

2. When a measurement is reported it is usual to assume that numbers such as

10, 1100, 120, 1000, 12 500

____

____

That is, we assume the last digits are zeroes because they are rounded off to the nearest 10, 100, 1000, etc.

10 (_____ sf), 1100 (_____ sf), 120 (_____ sf), 1000 (_____ sf), 12 500 (_____ sf)

Furthermore, SI usage dictates that ____

____

For example,

10.0 and 100.0

are proper examples of SI usage with _____ and _____ significant figures, but

100. and 1000.

are "improper" ways of showing numbers. If you need to show that a number has been measured to 3 significant figures and has a value of 100 or that the number 1000 has 4 significant figures, then it must be written in ________________________________

$1.00 \times 10^2 = 100$ (to _____ significant figures)

$1.000 \times 10^3 = 1000$ (to _____ significant figures)

EXAMPLE II.12	**SIGNIFICANT FIGURES**
Problem:	How many significant figures do each of the following measurements have? 52.3 g, 1800 mL, 0.09835 m, 12.574 cm, 2.480×10^5 ms
Solution:	

3. Measurements are often described as _______________or _______________. These two terms are often used interchangeably; however, they do not mean the same thing.

An **ACCURATE** measurement is one that is ____
(The closer to the correct/accepted value, the more accurate the measurement.)

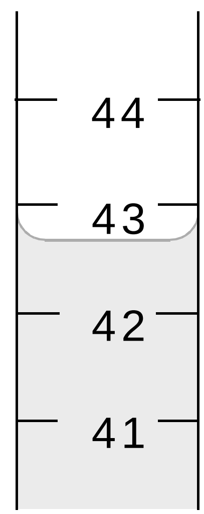
A **PRECISE** measurement is ____
In general, the more precise a measurement, the more significant digits it has.

4. Recall,

The **number** of significant figures is equal to ____

____

In the figure at right, the liquid level is somewhere between 42 mL and 43 mL. We know it is at least 42 mL, so we are certain about the first 2 digits. We might estimate that the volume is 42.6 mL; it could be between 42.5 mL or 42.7 mL. The final digit is a guess and is therefore uncertain. Collectively, the 2 certain and 1 uncertain digit are significant. The measurement 42.6 mL has 3 significant figures.



Whenever you are given a measurement without being told something about the device used to obtain the measurement, assume that the **LAST DIGIT GIVEN IS SOMEWHAT UNCERTAIN.**

5. **"DEFINED"** numbers and **"COUNTING"** numbers are assumed to be ______________

so that they are ____

____

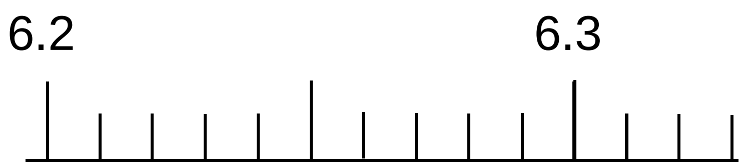
(i.e., they have no uncertainty).

e.g. When “1 book” or “4 students” is written, it means exactly “1 book” or “4 students”, not 1.06 books or 4.22 students.

The conversion factor 1 kg = 1000 g defines an exact relationship, so the numbers are assume to be perfect.

6. When reading a measurement from a scale, each unnumbered division are **CALIBRATED** or **“marked off”** at regular intervals. The value of each unnumbered is equal to the difference between the numbered divisions divided by the number of subdivisions.

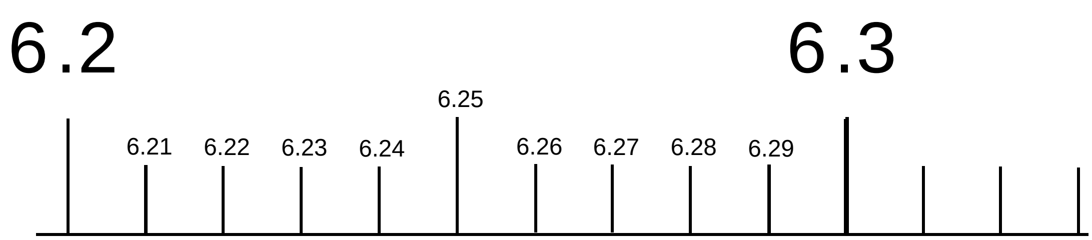
Consider the following scale:



There are 10 subdivisions between 6.2 and 6.3, so each subdivision has a value of

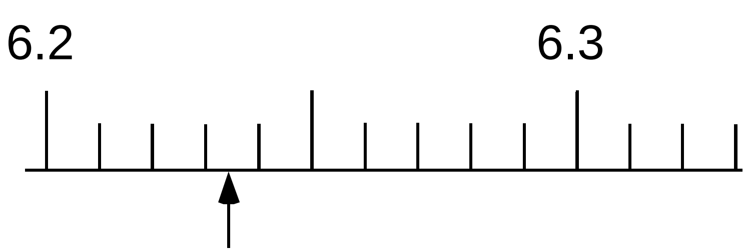
subdivision = __________ = __________

Therefore, we can imagine the subdivisions to be as follows:



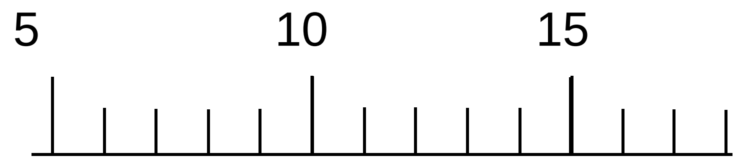
When reading a measurement from a scale, the final digit should be __________________

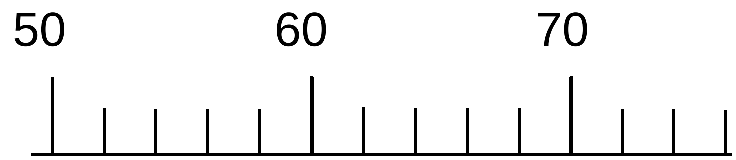
____

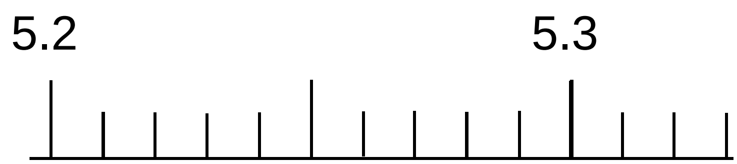


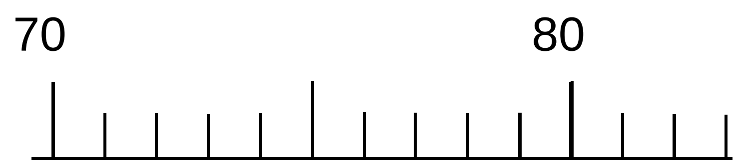
This should be read as 6.23**4** cm

e.g. Read the following measurements









7. When determining the number of significant figures a measurement has ______________

____

____

0.0**253** kg has _____ significant figures

67.90 cm has _____ significant figures

0.0**870** mm has _____ significant figures

To avoid confusion express numbers in scientific notation in which case **all digits in the number portion are significant.**

2.53 $\times 10^{-2}$ kg has _____ significant figures
6.790 $\times 10^{1}$ cm has _____ significant figures
8.70 $\times 10^{-2}$ mm has _____ significant figures

8. After **MULTIPLYING** or **DIVIDING** numbers, ________________________________

____

____

$$2.53 \times 3.1675 = \mathbf{8.01}3775$$

When multiplying two numbers like

$$5.0 \times 20.0 = \mathbf{10}0 \text{ is wrong (1 significant figures)}$$
$$5.0 \times 20.0 = \mathbf{1.0} \times 10^2 \text{ is correct (2 significant figures)}$$

When there are more than 2 numbers in a calculation, ____________________________

____

____

$$\frac{15.55 \times 0.0\mathbf{12}}{24.6} = 0.0075853659 = \_\_\_\_\_\_\_\_\_\_$$

$$\frac{2.56 \times 10^5}{\mathbf{8.1} \times 10^8} = 3.1604938 \times 10^{-4} = \_\_\_\_\_\_\_\_\_\_$$

Always perform calculations to the **maximum number of significant figures** allowed by your calculator and ____

____

Rounding off immediate answers will often lead to rounding errors and incorrect answers.

9. When **ADDING** or **SUBTRACTING** numbers, ______________________________

____

____

12.5	6 cm
+ 125.8	cm
138.3	6 cm

This answer should be rounded to **1** decimal place, so the answer is __________

41.037 6	g
- 41.037 5	84 g
0.000 0	16 g

This answer should be rounded to **4** decimal places, so the answer to the correct sig figs is __________

$$1.234 \times 10^{6} \times 4.568 \times 10^{7} = ?$$

Since the exponents are different, ____

____

$$0.1234 \text{ x } \mathbf{10^{7}} + 4.\mathbf{568} \times 10^{7} = 4.\mathbf{691}4 \times 10^{7}$$

= _______________

When **multiplying** or **dividing** two numbers, the result is **rounded off to the least number of**

_________________________ used in the calculation.

When **adding** or **subtracting** two numbers, the result is **rounded off to the least number of**

_________________________ used in the calculation.