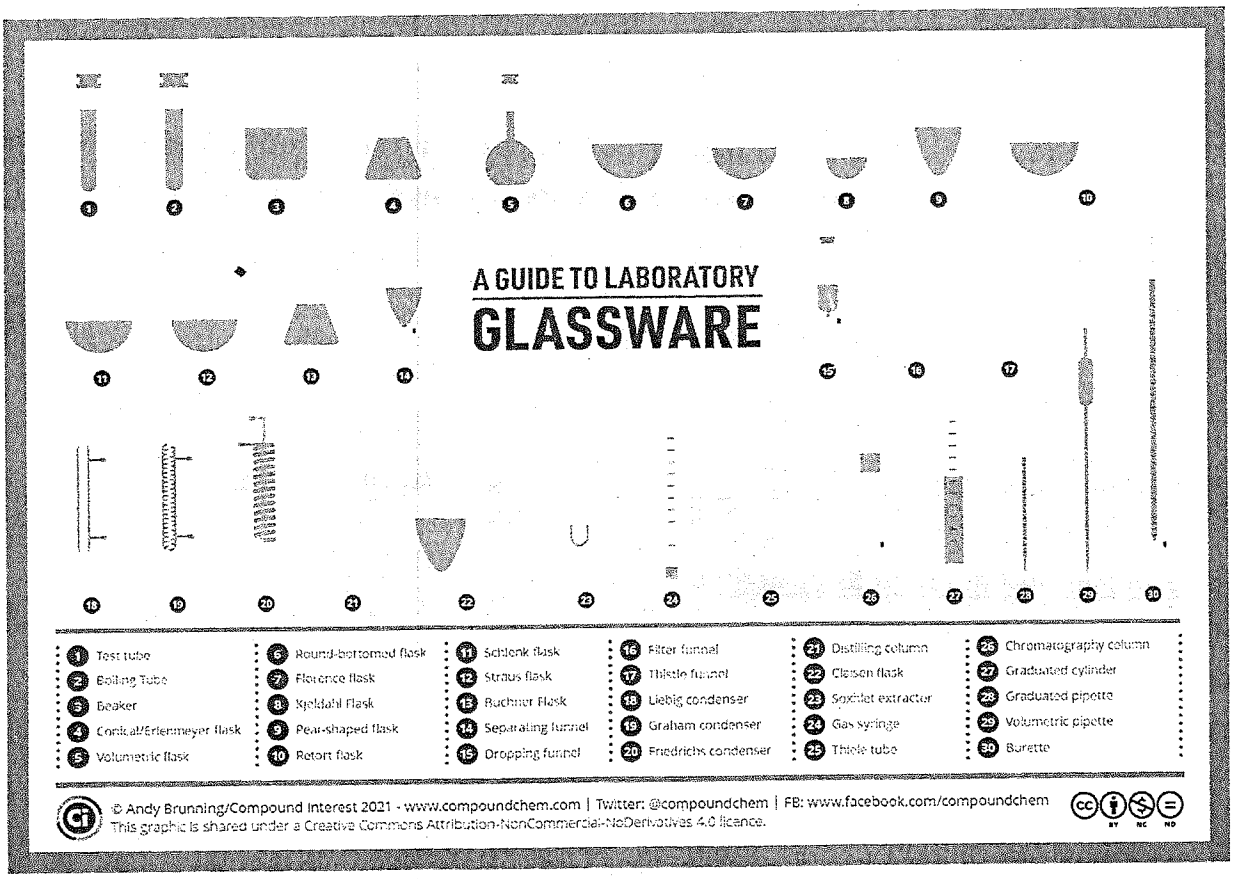
Grade 12 University Level Chemistry

INTRODUCTION UNIT

Lesson	Learning Goals
Math Skills	☑ Convert numbers from standard form to scientific notation and vice versa ☑ Identify the correct significant digits when performing math equations ☑ Demonstrate units using dimensional analysis
Stoichiometry	☐ Identify a mole ratio between reactants and products ☐ Use dimensional analysis to convert from known mass to an unknown ☐ Use dimensional analysis to convert from known concentration and volume to an unknown
Limiting & Excess Reagents	☐ Identify limiting and excess reagents ☐ Use limiting reagents to determine values for unknown chemical species ☐ Calculate moles remaining
Titrations	☐ Define acids, bases and titrations ☐ Calculate the pH and pOH of strong acids and bases ☐ Use mole ratios to determine concentrations and pH



SCH4U Math Skills

Significant Digits: Precision is very important in chemistry. Each digit obtained as a result of a measurement is called a significant figure. For example the measurement 6.77 cm has three significant figures, while 45 m has only two. Every number that you have seen has a certain number of significant digits. There are 5 rules to identifying sig digs:

Identifying Significant Digits

Rule #1: "Non-zero numbers are significant"

How many sig figs are there in the numbers below?

3.1428 5 3.14 3 469 3

Rule #2: "Sandwiched zeros are significant!" All zeros between non-zero numbers are significant .

How many sig figs are there in the numbers below?

7.053×10^3 4 70501 5 302 3

Rule #3: "Zeros on the left are NOT significant" Zeros to the left of the first significant figure are NOT significant

How many sig figs are there in the numbers below?

0.0056 2 0.07089 4 0.000001 1

Rule #4: "Zeros on the right… sometimes significant" Zeros on the far right ARE significant if the number contains a decimal. Zeros on the far right are NOT significant if the number has no decimal point.

How many sig figs are there in the numbers below?

4.300×10^{-4} 4 200 1 0.010050 5

Rule #5: "Exact numbers" have an precise number of significant digits

Significant Digits when Adding or Subtracting

When you add or subtract numbers with different precision (decimal places), you must round your final answer to the least precise number place.

Example 1: A chemist adds 150.0 g sample to a beaker containing 0.507g. What is the total mass? 150.5g

Significant Digits when Multiplying/Dividing

When you multiply or divide numbers with different precision, you must round your final answer to the least number of significant digits.

Example 2: What is the density of a 87.45 g metal sample with a volume of 2.0 cm^3?

$d = \frac{m}{V}$ $= 4.3725 kg/m^3$ 0.08745 kg 0.020 m^3

$d = \frac{0.08745 kg}{0.020 m^3}$ $\boxed{d = 4.4 kg/m^3}$

Dimensional Analysis:

Molar mass (m / n M)	$m = n \cdot M$ $\quad mol \cdot g/mol = g$
Avogadro's number	$n \cdot 6.02 \times 10^{23} =$ # of atoms
Concentration (molarity) (n / c V)	$\frac{mol}{L} = mol/L = M$

Example 1: What is the mass in grams of an 8.4 mole sample of iron? **[470 g]**

G: 8.4 mol = n
R: m = ?
A: m = n · M
S: m = 8.4 mol · 55.85 g/mol
> m = 470 g

Example 2: A solution contains 0.42 moles of solute in 0.75 L. Calculate the molarity of the solution. **[0.56M]**

G: n = 0.42 mol, V = 0.75 L
R: C = ?
A: $C = \frac{m}{V}$
S: $C = \frac{0.42 mol}{0.75 L}$
> C = 0.56 M

Example 3: A teaspoon of salt, NaCl has a mass of about 5.0 g. How many formula units are in a teaspoon of salt? **[5.2×10^{22} formula units]**

M = 22.99 g/mol + 35.45 g/mol
= 58.44 g/mol

G: m = 5.0 g
R: n = ?
A: $n = \frac{m}{M}$
S: $n = \frac{5.0 g}{58.44 g/mol}$
> n = 0.08555 mol · 6.02×10^{23}
n = 5.2×10^{22} formula units

CHECK YOUR UNDERSTANDING

1. What is the mass of 5.00×10^{14} molecules of water? **[1.50×10^{-8} g]** $[5 \times 10^{14} \div 6.02 \times 10^{23}] \cdot 18.02$
2. Convert 0.45 g of sodium hydroxide, NaOH to moles. **[0.011 mol]** $= 1.50 \times 10^{-8} g$ (1)
3. How many moles of hydrochloric acid, HCl, are present in 0.085 L of a 3.0 M solution? **[0.26 mol]**

$\frac{0.45 g}{40 g/mol} = 1.1 \times 10^{-2} mol$ (2) | (3) 0.085 L · 3.0 M
= 0.3 mol

SCH4U Review: Stoichiometry

Example 1: What mass of hydrogen gas is needed to react completely with nitrogen gas to produce 50.0 g of ammonia gas? **[8.90 g]**

G: $50.0\text{g} = m_{NH_3}$

R: $m_{H_2} = ?$

S: $m_{H_2} = 8.89\text{g}$

$\_\_N_2 + \underline{3}\ H_2 \rightarrow \underline{2}\ NH_3$

24.02g/mol 2.02 17.04g/mol

4.401mol 2.93429mol $\times \frac{3\text{mol } H_2}{2\text{mol } NH_3}$

$\times 2.02$

Example 2: Aluminum reacts with chloride gas to form aluminum chloride. What mass of aluminum chloride can be produced from the reaction of 60.0g of aluminum metal? **[297 g]**

G: $m_{Al} = 60.0\text{g}$

R: $m_{AlCl_3} = ?$

S: 297g

$\underline{2}\ Al_{(s)} + \underline{3}\ Cl_{2(g)} \rightarrow 2AlCl_3$

26.98g/mol 70.9g/mol 133.33g/mol

2.22358mol Al 2.22386mol

296.5

Example 3: What is the minimum volume of 0.25 mol/L magnesium chloride, $MgCl_2$, needed to precipitate all the silver ions in 60 mL of 0.30 mol/L silver nitrate, $AgNO_3$? Assume that silver chloride is completely insoluble in water. **[0.04L]**

95.21g/mol 169.88g/mol

G: $C_{MgCl_2} = 0.25\text{mol/L}$ ____ $MgCl_2 + \underline{2}\ AgNO_3 \rightarrow Mg(NO_3)_2 + 2AgCl$

$V_{AgNO_3} = 0.06\text{L}$ $C_{AgNO_3} = 0.30\text{mol/L}$

R: $V_{MgCl_2} = ?$

A: $n = c \cdot v$

S: $n_{AgNO_3} = 0.3\text{mol/L} \cdot 0.06\text{L}$

$= 0.018\text{mol } AgNO_3 \times \frac{1\text{mol } MgCl_2}{2\text{mol } AgNO_3}$

$= \frac{0.009\text{mol } MgCl_2}{0.25\text{mol/L}}$

$= 4 \times 10^{-2}\text{L}$

CHECK YOUR UNDERSTANDING

1. How many molecules of sulfur trioxide will form when 2.50g of S_8 will react with excess oxygen:

   $\_\_S_8 + \underline{12}\ O_2 \rightarrow \underline{8}\ SO_3$ **[4.69×10^{22} molecules SO_3]**

2. If 325 mL of lead (II) nitrate solution reacts with an excess solution of sodium chloride, 6.34 g of solid was filtered out of the solution, Find the molar concentration of the lead (II) nitrate solution.

   $\_\_Pb(NO_3)_2 + \underline{2}\ NaCl \rightarrow PbCl_2 + 2NaNO_3$ **[0.0701M]**

☆check notes for answers

reactant?

Limiting & Excess Reagents

Example 1: What is the limiting reagent when 10.0g of $Fe_2(SO_4)_3$ reacts with an equal mass of NaOH? What mass of $Fe(OH)_3$ is produced? **[$Fe(SO_4)_3$ is LR, 5.34g]**

$Fe_2(SO_4)_3 + 6NaOH \rightarrow 2Fe(OH)_3 + 3Na_2SO_4$

~~**Example 2:** In the following reaction, 4.87 g of lithium nitride reacts with 5.80 g of water. What is the~~ limiting reactant? What mass of lithium hydroxide will be produced? What mass of excess reactant remains at the end of the reaction? **[H_2O, 7.71g, 1.13g]**

$$\_\_\_ Li_3N + \_\_\_ H_2O \rightarrow \_\_\_ LiOH + \_\_\_ NH_3$$

<- Strawberry

CHECK YOUR UNDERSTANDING

1. 30.0 g of NH_4NO_3 and 50.0 g of Na_3PO_4, determine the limiting reagent and the mass of ammonium phosphate that is produced? **[NH_4NO_3 is LR, 18.6 g]**
2. In a synthesis reaction, 62.0 g of P_4 and 4.00 g of H_2 react to produce PH_3. What is the limiting reactant? **[H_2]** What mass of PH_3 will be produced? **[44.9g]**