**Chemistry I**
**Stoichiometry Review**

**Topics:**

- Definition of a mole
- Molar Mass
- Mole conversions (be able to covert from one unit to another):
  - Mass to moles
  - particles to moles
  - particles to mass
  - mass to mass
- Limiting Reactant and percent yield

**Practice Questions**

1. What is a mole?

$6.022 \times 10^{23}$ particles of any substance

2. What is stoichiometry? Why is it important to a chemist?

A branch of chemistry that focuses on the relative quantities of reactants and products in a chemical reaction. It can be used to predict how much product can be formed from a particular amount of reactant OR how much reactant is needed to make a certain amount of product.

3. Calculate the mass of one mole of

a) water $H_2O$

$2.02g + 16.00g \rightarrow$ **18.02g**

b) acetic acid

60.05 g

c) oxygen gas

32.00 g

d) zinc phosphate

386.11 g

4. What is Avogadro's number? How is it related to a mole?

$6.022 \times 10^{23}$

It is the number of particles (atoms, molecules, etc) in 1 mole of any substance

5. Calculate the number of grams in each of the following.

a. 1.5 moles of potassium oxide

$1.5 \text{ mol } K_2O \times \frac{94.20 \text{ g}}{1 \text{ mol } K_2O} = 141.3 \text{ g} \xrightarrow{S.F.} \boxed{140 \text{ g } K_2O}$

b. 5.9 moles of sodium

$5.9 \text{ mol Na} \times \frac{22.99 \text{ g Na}}{1 \text{ mol Na}} = 135.6 \text{ g Na} \xrightarrow{S.F.} 140 \text{ g Na}$

c. 7.24 x $10^{22}$ atoms of copper

$7.24 \times 10^{22} \text{ atom Cu} \times \frac{1 \text{ mol Cu}}{6.02 \times 10^{23} \text{ atoms Cu}} \times \frac{63.55 \text{ g Cu}}{1 \text{ mol Cu}} = \boxed{7.64 \text{ g Cu}}$

d. 4.85 x $10^{-3}$ moles of silver nitrate

$4.85 \times 10^{-3} \text{ mol } AgNO_3 \times \frac{169.87 \text{ g } AgNO_3}{1 \text{ mol } AgNO_3} = \boxed{0.824 \text{ g } AgNO_3}$

6. Calculate the number of particles (atoms, formula units or molecules) of each of the following:

a. 0.018 mol of Au

$0.018 \text{ mol Au} \times \frac{6.02 \times 10^{23} \text{ atoms Au}}{1 \text{ mol Au}} = \boxed{1.1 \times 10^{22} \text{ atoms Au}}$

b. 3.5 mol of $C_3H_8$

$3.5 \text{ mol } C_3H_8 \times \frac{6.02 \times 10^{23} \text{ molecules } C_3H_8}{1 \text{ mol } C_3H_8} = \boxed{2.1 \times 10^{24} \text{ molecules } C_3H_8}$

c. 150.0 g of sulfur

$150.0 \text{ g S} \times \frac{1 \text{ mol S}}{32.06 \text{ g S}} \times \frac{6.02 \times 10^{23} \text{ atoms S}}{1 \text{ mol S}} = \boxed{2.82 \times 10^{24} \text{ atoms S}}$

d. 5.0 g of $Na_2CO_3$

$5.0 \text{ g } Na_2CO_3 \times \frac{1 \text{ mol } Na_2CO_3}{105.99 \text{ g } Na_2CO_3} \times \frac{6.02 \times 10^{23} \text{ form. units}}{1 \text{ mol } Na_2CO_3} = \boxed{2.8 \times 10^{22} \text{ form units } Na_2CO_3}$

7. Complete the questions for the following reaction. Use dimensional analysis.

$$C_3H_8 + 5O_2 \longrightarrow 3CO_2 + 4H_2O$$

a. How many moles of oxygen will be needed to react with 0.38 mol of propane, $C_3H_8$ ?

$0.38 \text{ mol } C_3H_8 \times \frac{5 \text{ mol } O_2}{1 \text{ mol } C_3H_8} = \boxed{1.9 \text{ mol } O_2}$

b. How many moles of water will be produced from the combustion of 50.0 grams of propane?

$50.0 g\ C_3H_8 \times \frac{1 \text{ mol } C_3H_8}{44.10 g\ C_3H_8} \times \frac{4 \text{ mol } H_2O}{1 \text{ mol } C_3H_8} = \boxed{4.54 \text{ mol } H_2O}$

c. How many grams of carbon dioxide is produced from the combustion of 25.5 grams of propane?

$25.5 g\ C_3H_8 \times \frac{1 \text{ mol } C_3H_8}{44.10 g\ C_3H_8} \times \frac{3 \text{ mol } CO_2}{1 \text{ mol } C_3H_8} \times \frac{44.01 g\ CO_2}{1 \text{ mol } CO_2} = \boxed{76.3 g\ CO_2}$

d. How many molecules of carbon dioxide will be produced from the consumption of 5.6 grams of oxygen?

$5.6 g\ O_2 \times \frac{1 \text{ mol } O_2}{32.00 g\ O_2} \times \frac{3 \text{ mol } CO_2}{5 \text{ mol } O_2} \times \frac{6.02 \times 10^{23} \text{ molecules } CO_2}{1 \text{ mol } CO_2} =$ [redacted] molecules $CO_2$

$\boxed{6.3 \times 10^{22}}$

e. How many molecules of propane is burned if 250.0 g of propane is burned?

$250.0 g\ C_3H_8 \times \frac{1 \text{ mole } C_3H_8}{44.10 g\ C_3H_8} \times \frac{6.02 \times 10^{23} \text{ molecules}}{1 \text{ mole } C_3H_8} = \boxed{3.41 \times 10^{24} \text{ molecules } C_3H_8}$

8. In a reaction of 0.26 mol of NaCl with 0.18 mol of $Pb(NO_3)_2$, how many grams of lead(II) chloride will be produced? What is the limiting reagent?

$$2\,NaCl + Pb(NO_3)_2 \longrightarrow PbCl_2 + 2\,NaNO_3$$

$0.26 \text{ mol } NaCl \times \frac{1 \text{ mol } PbCl_2}{2 \text{ moles } NaCl} \times \frac{278.10 g\ PbCl_2}{1 \text{ mol } PbCl_2} = \boxed{36 g\ PbCl_2}$

$0.18 \text{ mol } Pb(NO_3)_2 \times \frac{1 \text{ mol } PbCl_2}{1 \text{ mol } Pb(NO_3)_2} \times \frac{278.10 g\ PbCl_2}{1 \text{ mol } PbCl_2} = \boxed{50 g\ PbCl_2}$

★ 36 grams of $PbCl_2$ will be produced. NaCl is the limiting reagent

Excess reactant:

$0.26 \text{ mol } NaCl \times \frac{1 \text{ mol } Pb(NO_3)_2}{2 \text{ mol } NaCl} \times \frac{331.2 g\ Pb(NO_3)_2}{1 \text{ mole}} = 43 g\ Pb(NO_3)_2$ reacted (or 0.13 moles) → $0.18 \text{ mol } Pb(NO_3)_2 - 0.13 \text{ moles} = \boxed{0.05 \text{ moles left}}$ (16.6 grams)

9. Identify the limiting reactant when 0.091 mol of magnesium reacts with 6.4 g of oxygen to produce magnesium oxide. Which is the limiting reagent?

$$2\,Mg + O_2 \longrightarrow 2\,MgO$$

$$0.091 \text{ mol } Mg \times \frac{1 \text{ mol } MgO}{1 \text{ mol } Mg} \times \frac{40.30 \text{ g } MgO}{1 \text{ mol } MgO} = \boxed{3.7 \text{ g } MgO}$$

$$6.4 \text{ g } O_2 \times \frac{1 \text{ mol } O_2}{16.00 \text{ g } O_2} \times \frac{2 \text{ mol } MgO}{1 \text{ mol } O_2} \times \frac{40.30 \text{ g } MgO}{1 \text{ mol } MgO} = \boxed{32 \text{ g } MgO}$$

**Mg is the limiting reactant**

(10)

To find excess reactant:

$$0.091 \text{ mol } Mg \times \frac{1 \text{ mol } O_2}{2 \text{ mol } Mg} \times \frac{32.00 \text{ g } O_2}{1 \text{ mol } O_2} = 1.46 \text{ g } O_2 \text{ reacted}$$

$$6.4 \text{ g } O_2 - 1.46 \text{ g} = \boxed{4.9 \text{ g } O_2 \text{ remain}}$$

10. If 3.40 g of magnesium oxide is actually produced from the reaction in #12, what is the percent yield?

$$\% \text{ yield} = \frac{\text{actual}}{\text{theoretical}} \times 100$$

$$" = \frac{3.40 \text{ g}}{3.7 \text{ g}} \times 100$$

$$\boxed{" = 92\%}$$

11. In a reaction between lead (II) nitrate and copper (II) bromide, do the following:
   a) write the formulas for the reactants and the products and balance the equation
   b) If 0.67 moles of copper (II) bromide react with 0.52 grams of lead (II) nitrate, how many grams of lead(II) bromide will be produced?
   c) Which reactant is the limiting reagent?

a) $Pb(NO_3)_2 + CuBr_2 \longrightarrow PbBr_2 + Cu(NO_3)_2$

b) $$0.67 \text{ mol } CuBr_2 \times \frac{1 \text{ mol } PbBr_2}{1 \text{ mol } CuBr_2} \times \frac{367.01 \text{ g } PbBr_2}{1 \text{ mol } PbBr_2} = 245.9 \text{ g } PbBr_2$$

$\boxed{250 \text{ g}}$ ← SF

$$0.52 \text{ g } Pb(NO_3)_2 \times \frac{1 \text{ mol } Pb(NO_3)_2}{331.2 \text{ g } Pb(NO_3)_2} \times \frac{1 \text{ mol } PbBr_2}{1 \text{ mol } Pb(NO_3)_2} \times \frac{367.01 \text{ g } PbBr_2}{1 \text{ mol } PbBr_2} = \boxed{0.58 \text{ g } PbBr_2}$$

c) $Pb(NO_3)_2$