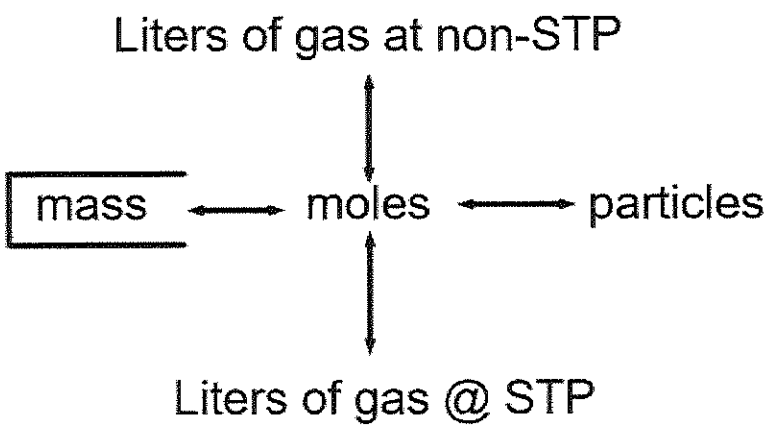
Top 10 Concept: #1 Stoichiometry

Stoichiometry is a fundamental concept in chemistry. Hard to avoid this concept in most chapters.



Video

- Honors Chemistry standards

(#7-1) What is the relationship between Mass, moles and number of particles.

1. What is the molar mass of the following items.
   a. $Ca(OH)_2$ $40.08 + 32 + 2 = 108\ g/mol$
   b. CO_2 $44\ g/mol$
   c. NO_3^{-1} $14 + 48 = 62\ g/mol$
2. You have 30 grams of $Ca(OH)_2$,
   a. Do you have more or less then 1 mole?

      less

   b. Do you have more or less then 0.5 moles?

      less

   c. Use a calculator solve exact answer for a and b? (show factor label work)

      $30\ g \cdot \frac{1\ mol}{108\ g} = 0.27\ mol$

3. You have 11 Liters of CO_2 at STP ,
   a. do you have more or less then one mole?

      less

   b. Calculate the actual value using factor label. $11.2\ L \cdot \frac{1}{22.4} = 0.49\ mol$
4. If you have 22g of CO_2 How many atoms of Oxygen are present?

$22\ g \cdot \frac{1\ mol}{44\ g} = \frac{1}{2}\ mol\ CO_2 \cdot \frac{2\ mol\ O}{1\ CO_2} = 1\ mol = 6.022E23\ Oxygen$

Use proportions to solve, not math

(#7-2) Chemicals combine in ratios of individuals as determined by the stoichiometric ratio?

$$2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$$

1. 20g or each reactant are placed in rigid container?
   a. Student hypothesis: H_2 is the limiting reactant due to the fact that the H_2 is being used up twice as fast. Justify/Nullify this statement.

   H_2 ↑ Quantity

   b. Determine the mass of water produced.

   $20_g O_2 \cdot \frac{1\,mol}{32g} \cdot \frac{2}{1} \cdot \frac{18}{1} = 22.5g$

   From "b" determine the mass of excess reactant.

   40 − 22.5 → 17.5g excess

What are the 2 factors that determine which reactant will be limiting?
1.
2.

2. You are given a sample of 5 Liters $H_{2(g)}$(STP) and 10 grams of $O_{2(g)}$ are placed in a previously evacuated 2.0L container and the reaction is run. The temperature increases due to energy released but after a time the temperature returns to the original temperature.
   a. Is the pressure in the container (bigger/smaller/ equal)? $2H_2 + O_2 \rightarrow 2H_2O$ (3 → 2) less particles
   b. Which reactant is the limiting reactant (use proportions to try and estimate)? H_2 less Quantity & greater Ratio used
   c. Create an ISE table to the right and complete.

$2H_2 + O_2 \rightarrow 2H_2O$			
I	5	10	
Δ	−5	−2.5	+5
E	0	7.5	

   d. How much mass of water will be produced.

   $5L \cdot \frac{1\,mol}{22.4L} \cdot \frac{18g}{1\,mol} = 6.25g\ H_2O$

$$CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$$

3. This reaction produces 11.20 L of CO_2 at equilibrium, what mass of $CaCO_3$ (100.0g/mol) was reacted? (no calculator) $11.2L\ CO_2 \rightarrow 0.5\,mol\ CO_2 \rightarrow .5\,mol\ CaCO_3 = 50g$

Percent Yield =

4. A 2500.0g sample of CuO is found.
   a. How much mass of Cu can be extracted from this sample.

   CuO, $\frac{63.5}{63.5 + 16} = \frac{63.5}{79.5} \times 100 = 79.8\%$

   $2500 \cdot .798 = 1996g$ Cu

   b. The chemist extracted 1950g of solid copper,
      i. What is the percent yield? $\frac{1950}{1996} \times 100 = 97.6\%$
      ii. What is the percent error? (google if you don't ~~know~~)

   $\frac{1950 - 1996}{1950} \times 100 = -2.3\%$ error

      iii. Give one reason that might cause this error in the experiment.

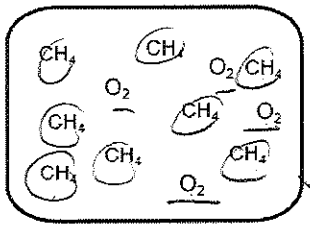
   - lost in filter? left behind.

(#7-3) Particulate drawing representations of stoichiometry.

$CH_4(g) + 2O_2(g) \Leftrightarrow CO_2(g) + 2H_2O(g)$

1. Draw the reaction afterwards.
2. Does pressure increase or decrease?
   Same → Same # of particles
3. Using the same equation draw the original reactants.
4. What was the limiting reactant?
   O2

2.2L container @ STP



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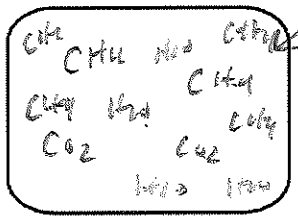
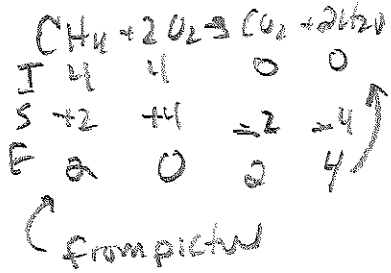
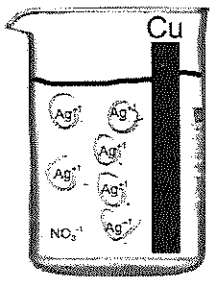


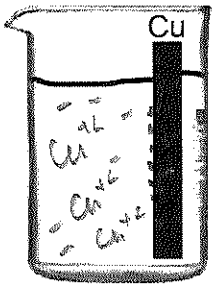
#3

$Cu(s) + 2AgNO_3(aq) \rightarrow 2Ag(s) + Cu(NO_3)_2(aq)$

5. Provided below you will see a beaker with the reactants for the reaction above.
   a. The reactant beaker only has 1 nitrate, how many should it have? 6
   b. Complete the beaker to the right showing the products.
   c. What substance could be considered the limiting reactant? Ag^+







6. In a separate experiment a 0.2M $AgNO_3$ solution is added to a excess copper solid. If the reaction goes to completion determine the concentration of each of the following after the reaction has completed.
   a. $[NO_3^{-1}]$ .2M
   b. $[Ag^+]$ 0
   c. $[Cu^{+2}]$ .1M

$Pb(NO_3)_2$

7. A 50.0mL 0.3M Na_2SO_4 solution is mixed with 50.0M of 0.15M of $Pb(NO_3)_2$ forming solid $PbSO_4$
   a. Write out the net ionic equation. $Pb^{2+} + SO_4^{-2} \rightarrow PbSO_4$
   b. Determine the concentration of each ion before the reaction takes starts

$[Na^+]$ =	$[SO_4^{-2}]$ =	$[Pb^{2+}]$ =	$[NO_3^{-1}]$ =
.6	.3	.15	.3

   c. Determine the concentration of each ion after the reaction takes place.

$[Na^+]$ =	$[SO_4^{-2}]$ =	$[Pb^{2+}]$ =	$[NO_3^{-1}]$ =
.3	.075	0	.15

Percent composition

Comparing various substances for the amount of mass is a common multiple-choice question. It is a valuable skill.

% by mass =
Percent composition: Ratio of mass
Formulas: ratio of number of individuals - empirical vs. molecular

8. Carbon dioxide (CO_2) and the oxalate ion ($C_2O_4^{-2}$) can both dissolve in water although oxalate to a much higher degree.
   a. Identify if either of these substances are empirical in nature?

   CO_2 Empirical

   C_2O_4 ← molecular → CO_2 ← Empirical

   b. Determine the percent mass of C in Carbon dioxide.

   Both Same

   $CO_2 = 32$ / 1L $= 44$ $\frac{12}{44} \times 100 = 27.2\%$ C

   c. If a person exhales 2.50E-5g of CO_2 how much actual mass of Carbon does a person lose? $2.5E-5 \cdot .272\% = 6.8E-6g$

9. Which of the following 5.00 samples of sodium Halides has the largest mass of sodium?

   NaF NaCl NaBr NaI

10. An unknown gas was identified as containing 38.1% Xe and 61.8% Cl.
    a. Determine the empirical formula for this substance.

    b. The unknown substance was also determined to have a molecular weight of 343amu/molecule. What is the actual formula of the substance?

$Xe = 38.1\% \xrightarrow{100g} 38.1g \cdot \frac{1\ mol}{131.3g} = 0.29mol / 0.29 = 1$

$Cl = 61.8\% \rightarrow 61.8g \cdot \frac{1\ mol}{35.4} = 1.74 / 0.29 = 6$

$XeCl_6$ ← Empirical

$131 + 35.4(6) = 343$ ← Empirical weight

$\frac{M\ weight}{E\ weight} = \frac{343}{343} = 1$

Molecular formula = 343