ES105 Chemistry

I. Chemical Equations

A. $C + O_2 \rightarrow CO_2$

1. Carbon reacts with oxygen to become carbon dioxide
2. Reactants and products
3. Each is shown as MOLECULES
4. Balanced, because same number of reactant atoms as product atoms
5. Sometimes physical state indicated in subscript parenthesis
   a. $C_{(s)} + O_{2\ (g)} \rightarrow CO_{2\ (g)}$
   b. $_{(l)}$ liquid, $_{(aq)}$ dissolved in water

B. Learn to balance equations

1. Reactants and products shown as MOLECULES
   a. Cannot change the proportions of atoms within the molecules
   b. Cannot add or delete reactants or products from equation--must use only those indicated in the equation
2. numbers within the equation
   a. Subscripts apply only to element (or group in parentheses) it is ‘touching’
   b. Coefficient, the number out front, full size, applies to entire molecule it is in front of—and this number CAN be changed in balancing the reaction
      1) can change the number of each molecule--coefficients,
      2) cannot change subscripts of elements—the molecule
3. The same number of atoms of reactants and products will exist
4. Examples:
   a. hydrogen gas and oxygen gas react to become water

   $H_2 + O_2 \rightarrow H_2O$ not balanced

   Cannot simply go to $H_2 + O_2 \rightarrow H_2O + O$

   Because that is adding a product not originally present in equation

   So…let’s double the water

   $H_2 + O_2 \rightarrow 2\ H_2O$ still not balanced, too much hydrogen on product side, so lets double H_2 on reactant side

   $2\ H_2 + O_2 \rightarrow 2\ H_2O$ four hydrogen, two oxygen, done!

b. Iron reacting with oxygen to become rust

$Fe + O_2 \rightarrow Fe_2O_3$

$4 Fe + 3 O_2 \rightarrow 2 Fe_2O_3$ looks good!

c. In-class activity--You do this one: $N_2 + H_2 \rightarrow NH_3$

d. Combustion of methane

$CH_4 + O_2 \rightarrow CO_2 + H_2O$ not balanced,

$CH_4 + 2 O_2 \rightarrow CO_2 + 2 H_2O$ How's this?

e. In-class activity--Now you do propane

$C_3H_8 + O_2 \rightarrow CO_2 + H_2O$

II. Volume relationships in chemical equations

A. Equal volumes of gases, at the same temperature and pressure, have the same number of molecules

1. Determined by reacting gases, and found that combine in small whole number ratios
2. 2 volume hydrogen + 1 volume oxygen → 2 volume steam
3. 3 hydrogen H_2 + 1 nitrogen N_2 → 2 ammonia NH_3
4. Can use to calculate volume changes in reactions

B. Avogadro's hypothesis accepted 6 years after his death

C. Example

$C_3H_8 + 5 O_2 \rightarrow 3 CO_2 + 4 H_2O$ combustion of propane

Start with 0.556 L of propane. How much oxygen will be needed to burn the propane?

Oxygen/Propane in ratio of 5:1

0.556 L C_3H_8 X <u>5 L O_2</u> = 2.87 L O_2

D. You calculate how much CO_2 is produced when 2 L of C_3H_8 is burned on your worksheet

E. Avogadro's number 6.02×10^{23} is one mole of molecules

III. Molecular mass, Formula mass, Molar mass

A. Calculate the molecular weight from molecular formula

1. Oxygen example--atomic weight 16 u

   O_2 molecular weight is 32 u, 32 grams/ mole of molecular oxygen

2. carbon dioxide example

   CO_2 molecular weight: C=12, O_2=32, → 44 g/mole

3. You calculate the molecular weight of propane: Use C=12, H=1

B. Can determine number of moles of a substance from molar mass and gram quantity, and vice versa

C. Examples

1. 0.250 moles of Na is how many grams?

   First determine molar mass of sodium 23 g/mole

   Multiply 0.250 moles x $\frac{23\ g}{Mole}$ = 5.75 g Na

2. Number of moles in 176 g of CO_2

   First find molar mass of CO_2 C=12, O_2=32, → 44 g/mole

   Now divide quantity by molar mass

   $\frac{176\ g}{44\ g/mole}$ = 4 moles

Keep units with numbers so you can use dimensional analysis to be sure you multiply or divide. Units, just like numbers, cancel when paired above and below division bar (fraction bar)