Review Prior to Equilibrium

Significant Figures

- Significant figures (sig figs) are the number of digits in a number or measurement that are meaningful. Sig figs are important in order to calculate answers to problems using measurements. Sig figs are used so that when you are performing calculations using measured values the answer is only as accurate as the measurements used.

Sig figs rules:
1. All non-zero digits are significant. Ex. 384 has _______ sig figs
2. All zeros between non-zero digits are significant. Ex. 1,002 has ______ sig figs
3. Zeros before the first non-zero digit are not significant Ex. 0.0020901 has ______ sig figs
4. Zeros after the last non-zero digit **may** be significant (they are significant if the number has a decimal). Ex. 0.00200 has _______ sig figs Ex. 200 has ______ sig figs

Note: *If you want the zeros after the last non-zero digit to be significant, you should write the number in scientific notation. For example if 200 should have 3 sig figs instead of 1, it should be written as* 2.00×10^2

- Examples

1. 315=
2. 300=
3. 300.=
4. 0.135=
5. 0.0305=
6. 0.01350=

Calculations with sig figs:

Adding and Subtracting with Sig Figs

- When adding and subtracting, the answer will have the same number of decimals or places as the digit with the **least** number of decimals/places.
- Examples:
  - 0.135 + 0.01 =
  - 350 + 315 =

Multiplying and Dividing with Sig Figs

- When multiplying and dividing with sig figs, the answer will have the same number of sig figs as the number in the question with the **least** number of sig figs.
- Example:
    - 0.43986 x 0.10 =
    - 3050 x 0.028090=

When combining multiplying/dividing with adding/subtracting

- Use BEDMAS and do not round until the end (just keep track of the number of sig figs each number has using underlining of subscripts)
- Example:
    - 0.31 + 4.00 x 3.6498=

Scientific Notation

- Do you know what has a mass of 5,973,600,000,000,000,000,000,000 kg?

  It's the Earth!

- Do you know what has a mass of 0.000000000000000000000000000000091093826 kg. ?

  This is the mass of an electron!

- Scientists have developed a shorter method to express very large or very small numbers. This method is called scientific notation.
- Scientific Notation is based on powers of the base number 10.
- Scientific Notation: an easier way to write a long number... instead of writing 602200000000000000000000 we write 6.022 x 10^{23}
- This means that we multiply 6.022 by 10^{23}.
    - Remember: 10^{23} means 10x10x10x10x10x10x10x10x10x10x10x10x10x10x 10x10x10x10x10x10x10x10x10.
- The mass of the earth would be written as _______________ kg.
- The mass of an electron would be written as _________________ kg.

If the number is big (greater than 1) the exponent will be positive.

If the number is small (less than 1) the exponent will be negative.

Chemical Equations

- The *Law of Conservation of Mass* states that in a chemical reaction the total mass of reactants is equal to the total mass of the products.
- Matter cannot be created or destroyed. Also, elements cannot change to become other elements (exception: unstable elements). This means the number of atoms of each element in the reactants must be the same as the products.
    - **Ex.** If there are 3 oxygen atoms in the reactants, there must be exactly 3 oxygen atoms in the products.

A *balanced chemical equation* represents the identities and relative amounts of reactants and products in a chemical reaction. The total number of each type of atom remains the same.

How to balance chemical equations:

You cannot change the number of atoms/each element in the compound (subscripts), but you can multiply the entire compound by a number (add a coefficient).

Remember: # of atoms in reactants must = # atoms in products

Can only add coefficients, **you cannot change subscripts**

Tips:

- If there is ever an element that is alone, we usually balance this one last.
- If there is an element in more than one compound in either the reactants or the products, save it for the end.
- If you ever get stuck, try doubling everything.

Examples:

____ H_2 + ____O_2 → ____H_2O

____$KMnO_4$ + ____HCl → ____KCl + ____$MnCl_2$ + ____H_2O + ____Cl_2

____ Fe + ____ Cl_2 → ____ $FeCl_3$

Balancing Word Equations:

- A *word equation* identifies the reactants and products in a chemical reaction using only the names of the elements and compounds.

- In a word equation, if it states a lone element (not in a compound), this means it is just that element on its own… not with a *charge* (only ions have charges). HOWEVER: watch out for diatomic elements.

Sodium and water produces sodium hydroxide and hydrogen gas.

Moles

Avogadro's Number:

- Since atoms and molecules are so tiny we cannot work with them individually; instead we work with moles of atoms and molecules.
- A mole = Avogadro's number = 6.022×10^{23} (similarly to how 1 dozen=12)
- Named after Amedeo Avogadro
- Avogadro's number is often represented by the symbol n in formulas, but the units are moles (mol).

Unit Conversions:

- Remember we are actually multiplying by 1, so we are not changing the number.
- Unit Conversions: # & units given x $\frac{\text{units we want}}{\text{units we were given}}$ =

Conversion:

Ex. If you have 1.20 mols of carbon dioxide how many molecules of carbon dioxide do you have?

Molar Mass:

- Molar mass of an element is the mass that one mole of that element has.
- The molar mass of an element is found on the periodic table and has units grams/mole.

Ex. The molar mass of hydrogen:

Molar Mass of Compounds:

- Molar mass of a compound is the mass that one mole of that compound has. This can be found by adding up the molar mass of each atom in the compound.

Ex. Aluminum Borate:

Conversion:

Ex. How many moles of water are in a 250.0 g sample of water?

Concentration

- Solubility is the physical property referring to the ability of a substance (solute) to dissolve in a solvent.
- **Molarity =** Number of moles of solute dissolved in one liter of solution
    - has units "mole/L", represented by "M" (molar)
    - To calculate molarity you must first find the number of moles of solute and divide by the volume of solution (in liters).
    - $\text{Molarity} = \dfrac{\text{moles of solute}}{\text{volume of solution (L)}}$
    - Concentration questions can be difficult to complete using the conversion factor method, so it may just be easier to use the formula.

Example:

Determine what volume of water you would need to add to 3.5 moles of sodium hydroxide to make a 1.0 M solution.

Stoichiometry

- Stoichiometry uses the quantitative relationship between reactants and products in a chemical reaction to determine the quantities of reactants and products in a certain chemical reaction.

Mole-mole problems:

- In a balanced equation we can determine how many moles of one reactant or product is needed to react with or produce another reactant or product. We can use a conversion factor and use the coefficients for the conversion factor.

Ex. $NaCl + F_2 \rightarrow NaF + Cl_2$

How many moles of fluorine molecules are needed to completely react with 3 moles of sodium chloride?

Multi-step conversions:

These are completed the same way as a normal conversion, but we will need more than one conversion factor.

Hints:

- If you are not given moles, you need to go to moles first.

- If you are trying to find information for any chemicals other than what you are given, your second conversion factor will need to go to moles or the other chemical.
- You will usually need one more conversion factor, to find the volume, mass or # of items.

Ex. For the reaction between zinc and hydrochloric acid:

If we start with 0.500g of zinc, what volume of hydrogen gas (@ STP) would be produced??

Manipulating Formulas

Since mathematics is a language of physical science, it is important that you be able to rearrange formulas so they are in a workable format.

To solve for a variable means to use math to get the variable by itself.

Example 1 - Solve for d

- $v = \frac{d}{t}$

Example 2 - Solve for x

- $\frac{ay}{x} = \frac{cb}{s}$

Example 3 - Solve for x

- $y = mx + b$

Name:_______________

Sig Figs & Scientific Notation Practice

1. Determine the number of significant figures each of the following numbers has:
   a. 102:____________
   b. 1.00×10^2:_________
   c. 100:____________
   d. 0.100:__________
   e. 0.0030400:________
   f. 0.0300:___________

2. Write the answers to the following calculations with the correct number of sig figs.
   a. 9.285 + 3.2 =
   b. 12.8 – 3.29 =
   c. 1100 + 3210 =
   d. 12 x 9.86
   e. 11.1/3.7
   f. $\frac{5.89 + 6.1}{4.1000}$

3. Write the following numbers in scientific notation:
   a. 1803000
   b. 0.00093280
   c. 0.900
   d. 10900

4. Write the following numbers in standard notation:
   a. 1.301×10^7
   b. 9.39×10^{-3}
   c. 2.50×10^{-5}
   d. 3.387×10^2

Balancing Equations

1. ____Al + ____Fe_3O_4 → ____Al_2O_3 + ____Fe
2. ____CH_3OH + ____O_2 → ____CO_2 + ____H_2O
3. ____P_4O_{10} + ____H_2O → ____H_3PO_4
4. ____PCl_5 + ____H_2O → ____H_3PO_4 + ____HCl
5. ____$SbCl_5$ + ____H_2O → ____$SbOCl_3$ + ____HCl
6. ____MgO + ____Si → ____Mg + ____SiO_2
7. ____$CaCl_2$ + ____Na_2CO_3 → ____$CaCo_3$ + ____NaCl

8. ____C_6H_6 + ____O_2 → ____CO_2 + ____H_2O

9. ____Al_2S_3 + ____H_2O → ____$Al(OH)_3$ + ____H_2S

10. ____C_2H_6 + ____O_2 → ____CO_2 + ____H_2O

11. ____$KClO_3$ → ____KCl + ____$KClO_4$

12. ____KBr + ____Cl_2 → ____KCl + ____Br_2

Name:______________________________

Balancing Word Equations

Write out the balanced chemical reaction for the following reactions.

1. Aluminum bromide and chlorine produces aluminum chloride and bromine

2. Sodium phosphate and calcium chloride yield calcium phosphate and sodium chloride

3. Hydrogen and nitrogen monoxide yield water and nitrogen

of Items – Mole Conversion Assignment

1. How many molecules are in the quantities below?
   a. 2.0 moles
   b. 0.35 mole

2. How many moles are in the number of molecules below?
   a. 1.5×10^{20}
   b. 3.4×10^{26}

3. How many Magnesium Bicarbonate molecules are in 7.82 moles?

4. How many moles of Barium Iodide would 3.28×10^{22} molecules be?

Name:________________________

Molar Mass Assignment

1. Determine the molar mass of the following elements:
   a. Nitrogen:
   b. Tin:
2. Which element has a molar mass of:
   a. 9.0122g/mol?
   b. 50.9415g/mol?
3. Determine the molar mass of the following compounds:
   a. $LiNH_4$
   b. $K_2C_2O_4$
   c. KCl
   d. $Ca(NO_3)_2$
   e. Lead (II) Iodate
   f. Benzoic acid
   g. Zinc Sulfite

Molarity Calculations

1. What is the molarity of a solution in which 3.0 mol of NaCl are dissolved in 1.0L of solution?

2. What is the molarity of a solution in which 0.589 mol of $AgNO_3$ is dissolved in 500.0 mL of solution?

3. How many moles of KNO_3 should be used to prepare 2.00 L of a 0.500 M solution? What would be the mass of that KNO_3?

4. To what volume should 5.0 g of KCl be diluted in order to prepare a 0.25 M solution?

Name:__________________________

of Item – Mass Conversion Assignment

1. Determine the number of **moles** in each of the quantities below:
   a. 25g of NaCl
   b. 125g of H_2SO_4
   c. 100. g of $KMnO_4$
2. Determine the number of **grams** in each of the quantities below:
   a. 2.5 moles of NaCl
   b. 0.50 moles of H_2SO_4
   c. 1.70 moles of $KMnO_4$

Stoichiometry: Mole- Mole Problems

1. ____N_2 + ____H_2 → ____NH_3

How many moles of hydrogen are needed to completely react with two moles of nitrogen?

2. ____ $KClO_3$ → ____ KCl + ____ O_2

How many moles of oxygen are produced by the decomposition of six moles of potassium chlorate?

3. ____ Zn + ____ HCl → ____ $ZnCl_2$ + ____ H_2

How many moles of hydrogen are produced from the reaction of three moles of zinc with an excess of hydrochloric acid?

Name:______________________

Mass-Mass Stoichiometry

1. ____ $KClO_3$ → ____ KCl + ____O_2

How many grams of potassium chloride are produced if 25 g of potassium chlorate decompose?

2. ____ N_2 + ____H_2 → ____ NH_3

How many grams of hydrogen are necessary to react completely with 50.0g of nitrogen in the above reaction?

3. How many grams of ammonia are produced in the reaction in Problem 2?

4. ____ $AgNO_3$ + ____ $BaCl_2$ → ____ $AgCl$ + ____ $Ba(NO_3)_2$

How many grams of silver chloride are produced from 5.0 g of silver nitrate reacting with an excess of barium chloride?

5. How much barium chloride is necessary to react with the silver nitrate in Problem

Name:____________________________

Isolating a variable

1. $A = \pi r^2$ (solve for π)

2. $A = \pi r^2$ (solve for r)

3. $\frac{hi}{ho} = \frac{di}{do}$ (solve for ho)

4. $\frac{hi}{ho} = \frac{di}{do}$ (solve for do)

5. $V_f = V_i + at$ (solve for a)

6. $a = \frac{v^2}{r}$ (solve for v)

7. $T^2 = \frac{m4\pi^2R}{F}$ (solve for F)

8. K.E. = $\frac{1}{2} mv^2$ (solve for v)

9. $v = \sqrt{2as}$ (solve for a)

10. $v^2 = \sqrt{2ask}$ (solve for s)

Solving for the variable:

1. $0.00018 = \frac{(0.0020)^2}{[H1]^2}$

2. $Keq = \frac{(0.60)^2 (0.30)}{(0.09)^2}$

3. $0.75 = \frac{(1.5 - X)^2}{(1.0 + X)^2}$

4. $0.317 = \frac{[NO_2]^2}{0.268}$