OWL Homework and Quiz 1

- Sample problem set, Chapter 1 and Chapter 2 HW due today, 9/10/2018 at 11:55 PM……No extensions
- Chapter 3 HW assigned in OWL…….Due September 20 at 11:55 PM
- Quiz 1 – Due on September 12 at 11:59 PM
  - ✓ Available in canvas (Go to your class in Canvas and Click quizzes in Canvas navigation bar, Then you will direct to Quiz 1)
  - ✓ Duration 15 minutes, 6 MCQs, covers chapters 1 and 2, and two attempts
  - ✓ No extensions

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Example Problem 3.3

When aqueous solutions of acetic acid and potassium hydroxide are combined, a neutralization reaction will occur

Write the following equations:

- Molecular
- Total ionic
- Net ionic

Answer:

1. $\mathrm{CH_3COOH + KOH \rightarrow H_2O + KCH_3COO}$
2. $\mathrm{CH_3COOH(aq) + K^+(aq) + OH^-(aq) \rightarrow H_2O(\ell) + K^+(aq) + CH_3COO^-(aq)}$
3. $\mathrm{CH_3COOH(aq) + OH^-(aq) \rightarrow H_2O(\ell) + CH_3COO^-(aq)}$

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Precipitation Reactions

- A precipitation reaction is an aqueous reaction that produces a solid, called the precipitate

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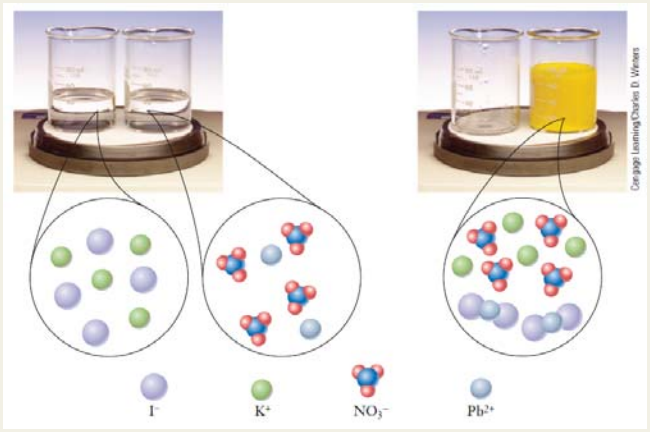

- Precipitation reaction between aqueous solutions of KI and $Pb(NO_3)_2$, which are both colorless
- The bright yellow solid, PbI_2, is produced

Net ionic reaction:

$$Pb^{2+}(aq) + 2I^{-}(aq) \longrightarrow PbI_2(s)$$

Interpreting Chemical Equations

- Balanced chemical reactions provide stoichiometric ratios between reactants and products
- Ratios relate relative numbers of particles

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

  - Two molecules of H_2 react with one molecule of O_2 to form two molecules of H_2O
  - 20 molecules of H_2 react with 10 molecules of O_2 to form 20 molecules of H_2O

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Avogadro's Number and the Mole

- Mole
  - ✓ One mole is the number of atoms in exactly 12 grams of ^{12}C or carbon-12
  - ✓ This number is also referred to as Avogadro's number, and its value is 6.022×10^{23} particles/mole
  - ✓ The mass of 6.022×10^{23} atoms of any element is the molar mass of that element

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- One mole samples of various elements are shown (Back row – left to right, Br, Al, Hg and Cu; front row (left to right) – S, Zn, Fe)
- All have the same number of particles

- Balanced chemical reactions also provide mole ratios between reactants and products

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

  - 2 moles of H_2 and 1 mole of O_2 react to form 2 moles of H_2O

Determining Molar Mass

- The molar mass of a compound is the sum of the molar masses of all the atoms in a compound

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Example problem:

- Determine the molar mass of each of the following compounds, all of which are used as fertilizers for the production of biomass:
  1) Calcium sulfate, $CaSO_4$
  2) Urea, $CO(NH_2)_2$
  3) Carnallite, $H_{12}Cl_3KMgO_6$

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Answer:

(1) $CaSO_4$:

1 mole Ca:	1×40.078 g/mol	=	40.078	g/mol
1 mole S:	1×32.06 g/mol	=	32.06	g/mol
4 moles O:	4×15.999 g/mol	=	63.996	g/mol
	Molar mass	=	136.13	g/mol

(2) $CO(NH_2)_2$:

1 mole C:	1×12.011 g/mol	=	12.011	g/mol
1 mole O:	1×15.999 g/mol	=	15.999	g/mol
4 moles H:	4×1.008 g/mol	=	4.032	g/mol
2 moles N:	2×14.007 g/mol	=	28.014	g/mol
	Molar mass	=	60.056	g/mol

(3) $H_{12}Cl_3KMgO_6$:

12 moles H:	12×1.008 g/mol	=	12.096	g/mol
3 moles Cl:	3×35.45 g/mol	=	106.35	g/mol
1 mole K:	1×39.0983 g/mol	=	39.0983	g/mol
1 mole Mg:	1×24.305 g/mol	=	24.305	g/mol
6 moles O:	6×15.999 g/mol	=	95.994	g/mol
	Molar mass	=	277.84	g/mol

(Q. 9)

Which compound has the largest molar mass?

- Sodium nitrate
- Potassium hydroxide
- Sodium carbonate

Answer: Sodium carbonate

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Calculations Using Moles and Molar Mass

- Molar mass allows conversion from mass to the number of moles, much like a unit conversion
  - 1 mol $C_7H_5N_3O_6$ = 227.133 g $C_7H_5N_3O_6$

Convert 300.0 g of ($C_7H_5N_3O_6$) TNT to moles of TNT,

$$300.0\ \text{g}\ C_7H_5N_3O_6 \times \frac{1\ \text{mol}\ C_7H_5N_3O_6}{227.133\ \text{g}\ C_7H_5N_3O_6}$$

$$= 1.321\ \text{mol}\ C_7H_5N_3O_6$$

$$\text{Number of moles} = \frac{\text{Mass}}{\text{Molar mass}}$$

- Avogadro's number functions much like a unit conversion between moles to the number of particles
  - 1 mol $C_7H_5N_3O_6$ = 6.022×10^{23} $C_7H_5N_3O_6$ molecules
  - How many molecules are in 1.320 moles of TNT?

$$1.321\ \text{mol}\ C_7H_5N_3O_6 \times \frac{6.022 \times 10^{23}\ \text{molecules}\ C_7H_5N_3O_6}{1\ \text{mol}\ C_7H_5N_3O_6}$$

$$= 7.955 \times 10^{23}\ \text{molecules}\ C_7H_5N_3O_6$$

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Example Problem

- A 245.3-g sample of glutamic acid, $C_5H_9NO_4$, is recovered from an experiment using fermentation to convert biomass
  - How many moles of $C_5H_9NO_4$ are in this sample?
  - How many molecules are in this sample?

Solution: (1) First, we will calculate the molar mass of glutamic acid

$C_5H_9NO_4$:	5 moles C:	5×12.011	g/mol	=	60.055	g/mol
	9 moles H:	9×1.008	g/mol	=	9.072	g/mol
	1 mole N:	1×14.007	g/mol	=	14.007	g/mol
	4 moles O:	4×15.999	g/mol	=	63.996	g/mol
			Molar mass	=	147.130	g/mol

Use molar mass as a conversion factor to convert from mass to moles

$$245.3\ \text{g}\ C_5H_9NO_4 \times \frac{1\ \text{mol}\ C_5H_9NO_4}{147.130\ \text{g}\ C_5H_9NO_4} = 1.667\ \text{mol}\ C_5H_9NO_4$$

- 2) convert from moles to molecules using Avogadro's number as a conversion factor

$$1.667\ \text{mol}\ C_5H_9NO_4 \times \frac{6.022 \times 10^{23}\ \text{molecules}\ C_5H_9NO_4}{1\ \text{mol}\ C_5H_9NO_4}$$

$$= 1.004 \times 10^{24}\ \text{molecules}\ C_5H_9NO_4$$