Northern Arizona University **Quiz #3**
CHM 151, General Chemistry I Dr. Brandon Cruickshank
Section 6, Fall 2008 September 18, 2008

Name _____

1. Calculate the **molar mass** of TNT, trinitrotoluene ($C_7H_5N_3O_6$). [2 pts]

(7)(12.01 g) + (5)(1.008 g) + (3)(14.01 g) + (6)(16.00 g) = **227.14 g**

2. **True or False?** [2 pts]

a) Ionic compounds are composed of ions that are held together by electrostatic attraction.

TRUE

b) Consider the combustion of hydrogen gas: $2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$. If 10.0 moles of H_2 are reacted with excess O_2, 10.0 moles of H_2O will be produced assuming complete reaction.

TRUE

3. How many **O atoms** are in 3.0 moles of P_2O_5? Circle the correct answer. [3 pts]

a) 2.5×10^{-23} b) 1.8×10^{23} c) 3.0×10^{24} **d) 9.0×10^{24}** e) none of these

$$3.0 \text{ mol } P_2O_5 \times \frac{5 \text{ mol O}}{1 \text{ mol } P_2O_5} \times \frac{6.022 \times 10^{23} \text{ O atoms}}{1 \text{ mol O}} = \mathbf{9.0 \times 10^{24} \text{ O atoms}}$$

4. During physical activity, lactic acid forms in muscle tissue and is responsible for muscle soreness. Elemental analysis shows that it contains by mass 40.0% C, 6.71% H, and 53.3% O.

a) Determine the **empirical formula** of lactic acid. [4 pts]

$$40.0 \text{ g C} \times \frac{1 \text{ mol C}}{12.01 \text{ g C}} = 3.33 \text{ mol C}$$

$$6.71 \text{ g H} \times \frac{1 \text{ mol H}}{1.008 \text{ g H}} = 6.66 \text{ mol H}$$

$$53.3 \text{ g O} \times \frac{1 \text{ mol O}}{16.00 \text{ g O}} = 3.33 \text{ mol O}$$

A correct formula for the compound is $C_{3.33}H_{6.66}O_{3.33}$; however, this is not the empirical formula, which will have the simplest ***whole*** number ratio. Dividing each subscript by the smallest number of moles (3.33) gives the empirical formula, $\mathbf{CH_2O}$.

b) If the molar mass of lactic acid is 90.08 g/mol, what is its **molecular formula**? [2 pts]

$$\frac{\text{molar mass}}{\text{empirical mass}} = \frac{90.08 \text{ g}}{30.03 \text{ g}} \approx 3$$

This means that the molecular formula is $(CH_2O)_3$ or $\mathbf{C_3H_6O_3}$.

5. Balance the following equation with the *smallest* set of whole numbers. The sum of **all** the coefficients is? Don't forget to count coefficients of one. Circle the correct answer. [3 pts]

$$Ca_3(PO_4)_2(s) + H_2SO_4(aq) \rightarrow CaSO_4(s) + H_3PO_4(aq)$$

a) 4 b) 6 c) 7 **d) 9** e) 18

$Ca_3(PO_4)_2$ (*s*) + 3 H_2SO_4 (*aq*) → 3 $CaSO_4$ (*s*) + 2 H_3PO_4 (*aq*)

6. Nitroglycerin ($C_3H_5N_3O_9$) is a powerful explosive. Its decomposition may be represented by

$$\underset{\text{nitroglycerin}}{4C_3H_5N_3O_9} \rightarrow 6N_2 + 12CO_2 + 10H_2O + O_2$$

This reaction generates a large amount of heat and many gaseous products. It is the sudden formation of these gases, together with their rapid expansion, that produces the explosion.

a) What is the maximum amount of O_2 in **grams** that can be obtained from 300.0 g of nitroglycerin (molar mass = 227.1 g/mol)? The molar mass of O_2 is 32.00 g/mol. [4 pts]

$$300.0 \text{ g NG} \times \frac{1 \text{ mol NG}}{227.1 \text{ g NG}} \times \frac{1 \text{ mol } O_2}{4 \text{ mol NG}} \times \frac{32.00 \text{ g } O_2}{1 \text{ mol } O_2} = \mathbf{10.57\ g\ O_2}$$

b) Calculate the **percent yield** in this reaction if the amount of O_2 generated is found to be 8.55 g. [2 pts]

$$\%\text{ yield} = \frac{\text{actual yield}}{\text{theoretical yield}} \times 100\% = \frac{8.55 \text{ g}}{10.57 \text{ g}} \times 100 = \mathbf{80.9\%}$$

7. Phosphorus trichloride, PCl_3, is a commercially important compound used in the manufacture of pesticides, gasoline additives, and a number of other products. It is made by the direct combination of phosphorus and chlorine.

$$P_4(s) + 6Cl_2(g) \rightarrow 4PCl_3(l)$$

Given that **1.50 moles of P_4** are reacted with **7.50 moles of Cl_2**, answer the following questions.

Assuming complete reaction, how many **moles of PCl_3** are produced? [3 pts]

$$1.50 \text{ mol } P_4 \times \frac{4 \text{ mol } PCl_3}{1 \text{ mol } P_4} = 6.00 \text{ mol } PCl_3$$

$$7.50 \text{ mol } Cl_2 \times \frac{4 \text{ mol } PCl_3}{6 \text{ mol } Cl_2} = 5.00 \text{ mol } PCl_3$$

Cl_2 is the limiting reagent; it limits how much product can be produced. Therefore, **5.00 moles** of PCl_3 are produced.

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1 mole = 6.022×10^{23} particles Molar masses: H (1.008 g/mol), C (12.01 g/mol), N (14.01 g/mol), O (16.00 g/mol), P (30.97 g/mol), Cl (35.45 g/mol)