Chem 121 Rybolt  Exam 2  Fall 2007 Name  

**KEY**  

Numerical constants may be listed below. Other needed information is given in the problem or written on the board or found in the periodic tables you will use during exam. For numerical problems, be sure to show your work, include units and circle your final answer. If several choices are given, circle the correct answer. Your written answers should be brief and to the point. You can use your own calculator on the exam, but no notes, books, external information, or other electronic devices are to be used. No cell phone is to be used in Exam room. \( N_A = 6.02 \times 10^{23} \text{ mol}^{-1} \)

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1) For reaction \( 2\text{KClO}_3 \rightarrow \text{2KCl} + 3\text{O}_2 \), how many grams of \( \text{KClO}_3 \) are required to produce 128g of \( \text{O}_2 \)

\[
\begin{align*}
\text{mol} \text{KClO}_3 &= \frac{128 \text{ g} \text{O}_2}{32 \text{ g} \text{O}_2} \left( \frac{\text{mol} \text{KClO}_3}{2 \text{ mol} \text{KClO}_3} \right) \left( \frac{122.6 \text{ g} \text{KClO}_3}{1 \text{ mol} \text{KClO}_3} \right) \\
&= \frac{3.269 \text{ g} \text{KClO}_3}{3.27 \text{ g} \text{KClO}_3} \\
\text{or} & \quad 3.27 \text{ g} \text{KClO}_3 
\end{align*}
\]

2) The active ingredient in a new toothpaste is \( \text{NaF} \); how many moles of \( \text{Na}^+ \) ions are found in 128g of sodium fluoride.

\[
\begin{align*}
\text{mol} \text{Na}^+ &= \frac{128 \text{ g} \text{NaF}}{42 \text{ g} \text{NaF}} \left( \frac{1 \text{ mol} \text{Na}^+}{1 \text{ mol} \text{NaF}} \right) \\
&= 3.0 \text{ mol} \text{Na}^+ 
\end{align*}
\]

3) Given the molecular formula of \( \text{C}_3\text{H}_9\text{O}_6 \), the empirical formula is \( \text{C}_3 \text{H}_3 \text{O}_2 \).

4) One of the active ingredients in Selsun Blue Shampoo is selenium sulfide, \( \text{SeS} \). The mass (g) of sulfur in 128g of \( \text{SeS} \) is

\[
\begin{align*}
\text{mass} \text{S} &= \frac{128 \text{ g} \text{SeS}}{79.0 \text{ g} \text{Se} + 32.1 \text{ g} \text{S}} \left( \frac{32.1 \text{ g} \text{S}}{79.0 \text{ g} \text{Se} + 32.1 \text{ g} \text{S}} \right) \\
&= 28.9 \text{ g} \text{S} 
\end{align*}
\]

5) Balance the equation below and after the equation is balanced with no fractions the number in front of \( \text{CO} \) must be 1 2 4 8 10

\[
\begin{align*}
2\text{B}_2\text{O}_3 + \text{7C} & \rightarrow \text{3B}_4\text{C} + \text{6CO} 
\end{align*}
\]

6) An industrial process to produce sulfuric acid actually yields 1.28x10^6 pounds, whereas, the theoretical yield is 6.00x10^7 kilograms. Recall that there are 2.20 pounds in exactly one kilogram. The percent yield of this process is

\[
\begin{align*}
\% \text{ yield} &= \frac{1.28 \times 10^6 \text{ lb}}{6.00 \times 10^7 \text{ kg}} \left( \frac{1 \text{ lb}}{2.20 \text{ kg}} \right) \times(100\%) \\
&= \frac{5.82 \times 10^5 \text{ kg}}{6.00 \times 10^7 \text{ kg}} \left( 100\% \right) = 97.0\% 
\end{align*}
\]
7) You are preparing fluid for intravenous feeding and add 128g of glucose, C₆H₁₂O₆ to enough water to make a 2.00 liter solution. The molarity of this solution is

\[ M = \frac{128 \text{ g}}{180.16 \text{ g/mol}} \times \frac{1 \text{ mol}}{2.00 \text{ L}} = 0.356 \text{ mol/L} \]

8) An unknown compound is found to have the following composition: Carbon (C)-24.0%  Hydrogen (H)-12.0%  Sulfur (S)-64.0% Find the empirical formula \( \text{C}_x\text{H}_y\text{S}_z \) where \( x,y,z \) is

\[
\begin{align*}
1,1,1 & \quad & 1,2,1 & \quad & 3,2,1 & \quad & 1,6,1 & \quad & 2,1,5 \\
24\% & \quad & (< \frac{\text{mol}}{12.01}) & \quad & = 2.00 \text{ mol C} & \quad & < \\
12\% & \quad & (< \frac{\text{mol}}{1.008}) & \quad & = 12.0 \text{ mol H} & \quad & > 6 \text{ H} \\
64\% & \quad & (< \frac{\text{mol}}{32.106}) & \quad & = 1.99 \text{ mol S} & \quad & < 1 \text{ S}
\end{align*}
\]

9) and if the molar mass of the prior compound is 200g/mol then the molecular formula must be

\[ \text{EM} = 1\text{C} + 6\text{H} + 1\text{S} \quad \text{n}(\text{EM}) = (\text{MM}) \]

\[ \text{EM} = 12 + 6 + 32 \quad (n)(580) = (200) \]

\[ 4(\text{C}_1\text{H}_6\text{S}_1) \rightarrow \text{C}_4\text{H}_{24}\text{S}_4 \]

10) Determine the volume(mL) of 0.400 M HCl acid required to neutralize 128.0 mL of 0.800 M NaOH base solution. This acid and base combine in a one to one ratio.

\[ (0.400 \text{ mol/L})(V_A) = (0.800 \text{ mol/L})(128 \text{ mL}) \]

\[ V_A = 256 \text{ mL} \]

11) How many milliliters of 10.0M hydrochloric acid are needed to carry out a dilution to form 128.0 mL of 3.50M acid.

\[ M_1V_1 = M_2V_2 \]

\[ (10.0 \text{ M})(V_1) = (3.50 \text{ M})(128 \text{ mL}) \]

\[ V_1 = 44.8 \text{ mL} \]
12) To prepare a solution of 250 mL of 1.28 M \( \text{H}_2\text{SO}_4 \) (sulfuric acid) will require \( \boxed{0.320 \text{ mol}} \) of \( \text{H}_2\text{SO}_4 \)

\[
(250 \text{ mL}) (1.28 \text{ mol/L}) = 0.320 \text{ mol}
\]

13) Coca-cola contains phosphoric acid – write its formula

\( \text{H}_3\text{PO}_4 \)

14) Name each of the following oxo acids

\( \text{H}_2\text{SO}_3(\text{aq}) \) sulfurous acid

\( \text{HNO}_3(\text{aq}) \) nitric acid

15) Name the following binary acids

\( \text{HF}(\text{aq}) \) hydrofluoric acid

\( \text{HCl}(\text{aq}) \) hydrochloric acid

16) Consider the balanced chemical equation \( \text{CH}_4 + 2 \text{ O}_2 \rightarrow \text{CO}_2 + 2 \text{ H}_2\text{O} \). 20.0 g of methane and 128 g of oxygen are combined to produce water. Show by calculation which is the limiting reactant.

\[
\text{CH}_4 \quad 20.0 \text{ g} \left( \frac{\text{mol}}{16.0 \text{ g}} \right) = 1.25 \text{ mol CH}_4
\]

\[
\text{O}_2 \quad 128 \text{ g} \left( \frac{\text{mol}}{32 \text{ g}} \right) = 4.00 \text{ mol O}_2
\]

\[
\frac{\text{actual needed}}{\frac{1.25}{1}} = \frac{4.00}{2} = 2
\]

Smallest ratio is limiting \( \text{CH}_4 \)

17) Given the reaction below write the products using a complete (or molar) form. Consider that you are combining two solutions to form insoluble silver(I) iodide while the remaining ions are soluble.

\[
2 \text{ Ag(NO}_3)_2(\text{aq}) + \text{ MgI}_2(\text{aq}) \rightarrow 2 \text{ AgI(s)} + \text{ Mg(NO}_3)_2(\text{aq})
\]

\[
2 \text{ Ag}^+ + 2\text{I}^- \rightarrow \text{Mg}^{2+} + \text{Zn}^{2+}
\]

18) Write \( \text{Pb(NO}_3)_2(\text{aq}) + 2 \text{ KI(\text{aq})} \rightarrow \text{PbI}_2(\text{s}) + 2 \text{ KNO}_3(\text{aq}) \) as a net ionic reaction leaving out all spectator ions.

\[
\text{Pb}^{2+} + 2\text{I}^- \rightarrow \text{PbI}_2(\text{s})
\]

19) In the class Demo when we mixed colorless solutions of silver nitrate and sodium chloride what did you observe? —don’t write any chemical equations, but tell me what you saw - be specific and mention color if any observed.

White precipitate formed

or white cloudiness in solution
20) In a class demo when we mixed vinegar and baking soda what gas was formed?

\[ \text{CO}_2(\text{g}) \text{ carbon dioxide} \]

21) a) In acetic acid solution would you have more of: \( \text{HC}_2\text{H}_3\text{O}_2^- \) or \( \text{H}^+ \text{ and C}_2\text{H}_3\text{O}_2^- \) weak

(b) in hydrochloric acid solution would you have more of \( \text{HCl} \) or \( \text{H}^+ \text{ and Cl}^- \) strong

22) For the Bronsted-Lowry acid-base reaction equilibrium shown below, write acid or base below each of the four chemical species

\[ \text{H}_3\text{PO}_4 + \text{H}_2\text{O} \rightleftharpoons \text{H}_3\text{O}^+ + \text{H}_2\text{PO}_4^- \]

23) Complete the following reaction showing how ammonia can function as an Arrhenius base when dissolved in water

\[ \text{NH}_3 + \text{H}_2\text{O} \rightarrow \text{NH}_4^+ + \text{OH}^- \]

24) Write the name of the following:

SO\(_3\) sulfur trioxide \quad \text{NH}_3 \quad \text{ammonia}

25) Write the formula of the compound that might be mispronounced as moly-b-den-um (I) bie-ar-bon-ate.

\( \text{Mo}_4 \text{H}_2\text{CO}_3 \)

26) Write the formula of the following:

nitrate ion \( \text{NO}_3^- \) \quad \text{aluminum sulfate} \quad \text{Al}_2(\text{SO}_4)_3 \quad \text{these ions combine in} \, \text{2:1 ratio to give} \quad \text{in 2:1 ratio to give}