

**FORM A**

**Chem 130**  
**Exam 1, Ch 5-6**  
**100 Points**

**Name** \_\_\_\_\_  
**October 21, 2011**

Please follow the instructions for each section of the exam. Show your work on all mathematical problems. Provide answers with the correct units and significant figures. Be concise in your answers to discussion questions. Point values are in parentheses by each problem.

**Part 0: Warmup. 4 points each**

1. Choose the INCORRECT statement:
  - a. Most molecular compounds are either non-electrolytes or weak electrolytes.
  - b. Most ionic compounds are strong electrolytes. Answer \_\_\_\_\_
  - c. Net ionic equations include only the actual participants in the reaction.
  - d. An acid produces hydride ions in solution.
2. If someone were to light a cigar at one end of a closed room, persons on the other end of the room might soon perceive an odor due to gaseous emissions from the cigar. Such a phenomenon is an example of:
  - a. ideality
  - b. diffusion
  - c. dissolution
  - d. effusion Answer \_\_\_\_\_

**Part I: Complete all of problems 3-8**

3. Compare the following using a maximum of three sentences for each pair of terms.
  - a. **strong electrolyte** versus **weak electrolyte**. (5)
  - b. **ideal gas** versus **non-ideal (or real) gas**: (5)
4. It is possible to use precipitation reactions to separate ions in solution by removing target ions as insoluble salts. Propose an approach to separate  $\text{Fe}^{2+}$  from  $\text{Ba}^{2+}$  using precipitation reactions. Include balanced reactions (indicating states of products and reactants). (10)

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5. Answer the following based on the reaction:  $\text{SO}_3^{2-} + \text{MnO}_4^- \rightarrow \text{SO}_4^{2-} + \text{Mn}^{2+}$

- a. What is the oxidation state of manganese in the permanganate ion? \_\_\_\_\_ (2)
- b. What is the oxidation state of sulfur in the sulfite ion? \_\_\_\_\_ (2)
- c. Balance the reaction in acidic aqueous solution. (8)

6. A 1.27 g sample of an oxide of nitrogen, believed to be either NO or  $\text{N}_2\text{O}$ , occupies a volume of 1.07 L at  $25^\circ\text{C}$  and 737 mm Hg. Which oxide is it? (10)

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8. How does the kinetic-molecular theory of gases help explain why a helium-filled balloon shrinks if it is taken outside on a cold winter day? (10)

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**Part II. Answer two (2) of problems 9-12. Clearly mark the problems you do not want graded. 15 points each.**

9. Write balanced overall reactions and net ionic equations for each of the following: Indicate the state (*s*, *l*, *g*, *aq*) of each of the reactants and products.

a. Aqueous sulfuric acid is mixed with aqueous sodium bicarbonate

Balanced Reaction: (5)

Net Ionic Equation: (2)

b. Aqueous lead (II) nitrate is mixed with aqueous lithium hydroxide

Balanced Reaction: (5)

Net Ionic Equation: (2)

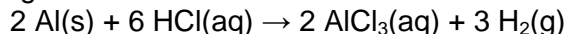
10. Sodium dithionite,  $\text{Na}_2\text{S}_2\text{O}_4$ , is an important reducing agent. One interesting use is in the purification of wastewater by the reduction of chromate ion with  $\text{S}_2\text{O}_4^{2-}$  in basic solution to form insoluble chromium (III) hydroxide, with sulfite ion produced as another product.

a. Write the balanced reaction for the process occurring in basic solution. (10)

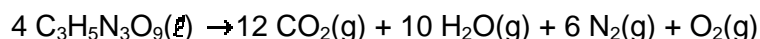
b. What mass of  $\text{Na}_2\text{S}_2\text{O}_4$  is consumed in a reaction with 100.0 L of wastewater having  $[\text{CrO}_4^{2-}] = 0.0148 \text{ M}$ ? (5)

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11. Birmabright is a metal alloy consisting of aluminum, magnesium, and manganese. A 0.273 g sample of Birmabright is dissolved in an excess of hydrochloric acid, producing hydrogen gas as shown in the balanced reaction below. If 355 mL of hydrogen is collected over water at a temperature of 25°C and pressure of 755 mm Hg, what is the mass percent of aluminum in Birmabright?



12. Nitroglycerine ( $\text{C}_3\text{H}_5\text{N}_3\text{O}_9$ , molar mass = 227.088 g/mol) is a contact explosive that rapidly decomposes via the reaction below and releases a large quantity of heat and gas. Assume 10.0 grams of nitroglycerine decomposes in a 2.0 L soda bottle and instantaneously generates a temperature of 5230K.



- a. What will the pressure be inside the bottle once the reaction is complete? (5)
- b. What is the partial pressure of carbon dioxide when the reaction is complete? (5)
- c. What volume would the gas mixture produced occupy at STP? (5)

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**Possibly Useful Information**

$R = 0.08206 \text{ L atm mol}^{-1} \text{ K}^{-1}$	STP = 1 atm, 0°C $K = 273.15 + ^\circ\text{C}$
1 atmosphere = 760 Torr = 760 mm Hg	$\left(P + \frac{n^2a}{V^2}\right)(V - bn) = nRT$
$P_{\text{total}} = n_{\text{total}}RT/V$	$P_A = X_A P_{\text{total}}$
$N_A = 6.02214 \times 10^{23} \text{ mol}^{-1}$	$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$

Molar Masses	
Compound	Molar Mass (g/mol)
aluminum chloride	133.340
carbon dioxide	44.010
chromium (III) hydroxide	103.018
hydrochloric acid	36.461
hydrogen gas	2.016
magnesium hydroxide	58.320
nitric acid	63.013
nitrogen gas	28.0135
nitrogen monoxide	30.006
nitroglycerine	227.088
oxygen gas	31.999
sodium carbonate	105.989
sodium dithionite	174.109
sodium nitrite	68.995
water	18.015

**Vapor Pressure of Water  
at Various Temperatures**

Temperature (°C)	Vapor Pressure (mmHg)
15.0	12.79
17.0	14.53
19.0	16.48
21.0	18.65
23.0	21.07
25.0	23.76
30.0	31.82
50.0	92.51

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**TABLE 5.3 Some Common Gas-Forming Reactions**

Ion	Reaction
$\text{HSO}_3^-$	$\text{HSO}_3^- + \text{H}^+ \longrightarrow \text{SO}_2(\text{g}) + \text{H}_2\text{O}(\text{l})$
$\text{SO}_3^{2-}$	$\text{SO}_3^{2-} + 2 \text{H}^+ \longrightarrow \text{SO}_2(\text{g}) + \text{H}_2\text{O}(\text{l})$
$\text{HCO}_3^-$	$\text{HCO}_3^- + \text{H}^+ \longrightarrow \text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{l})$
$\text{CO}_3^{2-}$	$\text{CO}_3^{2-} + 2 \text{H}^+ \longrightarrow \text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{l})$
$\text{S}^{2-}$	$\text{S}^{2-} + 2 \text{H}^+ \longrightarrow \text{H}_2\text{S}(\text{g})$
$\text{NH}_4^+$	$\text{NH}_4^+ + \text{OH}^- \longrightarrow \text{NH}_3(\text{g}) + \text{H}_2\text{O}(\text{l})$

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**TABLE 5.1 Solubility Guidelines for Common Ionic Solids**

Follow the lower-numbered guideline when two guidelines are in conflict. This leads to the correct prediction in most cases.

1. Salts of group 1 cations (with some exceptions for  $\text{Li}^+$ ) and the  $\text{NH}_4^+$  cation are soluble.
2. Nitrates, acetates, and perchlorates are soluble.
3. Salts of silver, lead, and mercury(I) are insoluble.
4. Chlorides, bromides, and iodides are soluble.
5. Carbonates, phosphates, sulfides, oxides, and hydroxides are insoluble (sulfides of group 2 cations and hydroxides of  $\text{Ca}^{2+}$ ,  $\text{Sr}^{2+}$ , and  $\text{Ba}^{2+}$  are slightly soluble).
6. Sulfates are soluble except for those of calcium, strontium, and barium.

