CHEMISTRY 101
Hour Exam II
October 28, 2014
Adams/Esbenshade

Name _____

Signature _____

Section _____

"Believe in yourself. You must do that which you think you cannot."
--Eleanor Roosevelt--

This exam contains 17 questions on 7 numbered pages. Check now to make sure you have a complete exam. You have one hour and thirty minutes to complete the exam. Determine the best answer to the first 15 questions and enter these on the special answer sheet. Also, circle your responses in this exam booklet. Show all of your work and provide complete answers to questions 16 and 17.

1-15	(30 pts.)	_____
16	(14 pts.)	_____
17	(16 pts.)	_____
Total	(60 pts)	_____

Useful Information:
1 L = 1000 mL (exactly)

Always assume ideal behavior for gases (unless explicitly told otherwise).

$PV = nRT$ $R = 0.08206\ L \cdot atm/mol \cdot K$

$K = °C + 273$ $N_A = 6.022 \times 10^{23}$

Solubility Rules:
1. Most nitrate salts are soluble.
2. Most salts of sodium, potassium, and ammonium cations are soluble.
3. Most chloride salts are soluble. Exceptions: silver(I), lead(II), and mercury(I) chloride.
4. Most sulfate salts are soluble. Exceptions: calcium, barium, and lead(II) sulfate.
5. Most hydroxide salts can be considered insoluble. Soluble ones: sodium, potassium, ammonium, and calcium hydroxide.
6. Consider sulfide, carbonate, and phosphate salts to be insoluble. Soluble ones: sodium, potassium, and ammonium.

1. The limiting reactant is the reactant (choose the best answer):

   a) that is present as the smallest mass in grams.
   b) that has the smallest coefficient in the balanced equation.
   c) that is left over after the reaction has gone to completion.
   d) that has the smallest molar mass.
   e) none of the above

2. Which of the following statements is **false** for the reaction of hydrogen gas with oxygen gas to produce water? (*a*, *b*, and *c* represent the respective coefficients)

   a) Subscripts can also be used to balance this equation, just as they can be used to balance the charges in an ionic compound (metal with nonmetal).
   b) The sum of $a + b + c$ equals 5 when balanced in standard form.
   c) Coefficient *b* can equal ½ because coefficients can be fractions.
   d) The number of atoms on the reactant side must equal the number of atoms on the product side.
   e) The ratio of "*a*/*c*" must always equal one.

Consider the following scenario to answer questions 3 and 4: Boron nitride reacts with iodine monofluoride in trichlorofluoromethane at –30°C to produce pure nitrogen triiodide and byproduct (BF_3). See the balanced equation below.

$$BN + 3IF \rightarrow NI_3 + BF_3$$

3. What mass of iodine monofluoride must be used to produce 30.0 g of nitrogen triiodide?

   a) 0.0760 g b) 3.70 g c) 11.1 g d) 27.1 g e) 33.3 g

4. When 30.0 g of nitrogen triiodide is produced, what is the maximum mass of byproduct (BF_3) created?

   a) 0.0760 g b) 0.206 g c) 4.65 g d) 5.15 g e) 13.9 g

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5. You add 40.0 mL of water to 60.0 mL of a 2.00 *M* calcium chloride solution. How many moles of calcium chloride are in the new solution?

   a) 0.120 mol b) 0.200 mol c) 0.240 mol d) 0.360 mol e) 1.20 mol

6. Crude gunpowders often contain a mixture of potassium nitrate and charcoal (carbon). When such a mixture is heated until reaction occurs, a solid residue of potassium carbonate is produced. The explosive force of the gunpowder comes from the fact that two gases are also produced (carbon monoxide and nitrogen), which increase in volume with great force and speed. Write the balanced chemical equation for this process and determine the sum of the coefficients.

   a) 3 b) 5 c) 8 d) 10 e) 11

7. What volume of a 0.500 *M* NaOH solution would be required to neutralize (exactly react with) 40.0 mL of a 0.400 *M* H_2SO_4 solution?

   a) 16.0 mL b) 32.0 mL c) 40.0 mL d) 50.0 mL e) 64.0 mL

Consider the following **unbalanced** chemical equation:

$$Al_4C_3 + H_2O \rightarrow Al(OH)_3 + CH_4$$

Balance the equation above and then answer questions 8 and 9.

8. If 5.00 moles of Al_4C_3 react with 5.00 moles of H_2O, how many moles of $Al(OH)_3$ would be produced after the reaction is complete?

   a) 1.25 mol b) 1.67 mol c) 5.00 mol d) 20.0 mol e) 130. mol

9. Determine the mole(s) of reactant leftover.

   a) 0.417 mol b) 1.67 mol c) 4.58 mol d) 5.00 mol e) 18.3 mol

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10. Which of the following solutions contains the **greatest** number of ions?

    a) 100.0 mL of 1.0 *M* sodium nitrate
    b) 100.0 mL of 1.0 *M* iron(III) nitrate
    c) 100.0 mL of 1.0 *M* copper(II) nitrate
    d) 100.0 mL of 1.0 *M* calcium nitrate
    e) All of the solutions above (a – d) contain the same number of ions.

11. Consider the following **unbalanced** chemical equation in which element X is unknown.

$$X(s) + F_2(g) \rightarrow XF_3(s)$$

    If 9.15 g of element X(*s*) is completely reacted with 4.00 L of fluorine gas at 250.°C and 2.50 atm, what is the identity of X?

    a) K b) Co c) Al d) Si e) H_2

For questions 12 and 13, consider the reaction between 0.156 L of 0.105 *M* magnesium nitrate and 0.166 L of 0.106 *M* potassium hydroxide.

12. What mass of precipitate will form?

a) 0.513 g b) 0.677 g c) 0.955 g d) 1.03 g e) 1.78 g

13. What is the concentration of **nitrate ions** left in solution after the reaction is complete?

a) 0.00 *M* b) 0.0254 *M* c) 0.0509 *M* d) 0.102 *M* e) 0.210 *M*

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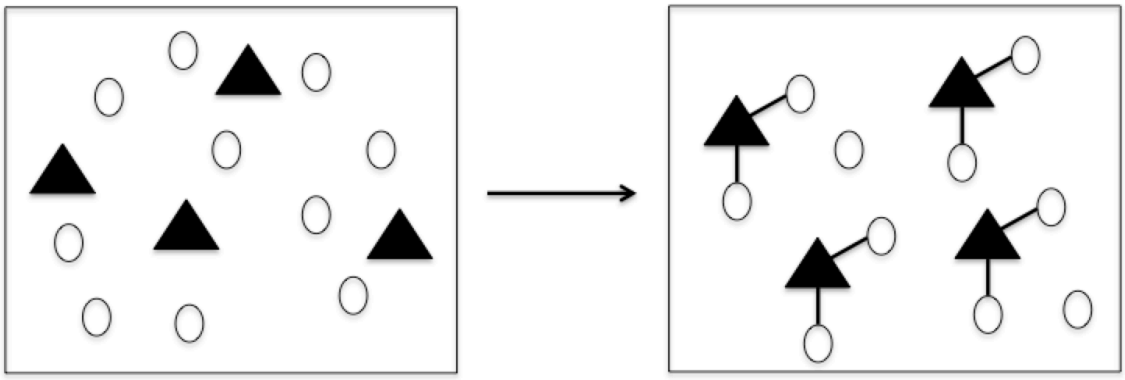
14. The reaction of an element X (▲) with element Y (○) is represented in the following diagram. What is the **balanced equation** for this reaction? Choose the best answer.



a) $4X + 10Y \rightarrow 4XY_2 + 2Y$
b) $4X + 8Y \rightarrow X_4Y_8$
c) $4X + 10Y \rightarrow X_4Y_{10}$
d) $X + 2Y \rightarrow XY_2$
e) $X + Y_2 \rightarrow XY_2$

15. How many grams of formaldehyde are in 113.1 mL of a 3.0 *M* aqueous solution of formaldehyde? The formula for formaldehyde is HCHO.

a) 0.34 g b) 1.1 g c) 10. g d) 27 g e) 88 g

16. Answer the questions below as thoroughly as you can. **Please limit your answers to the space provided.**

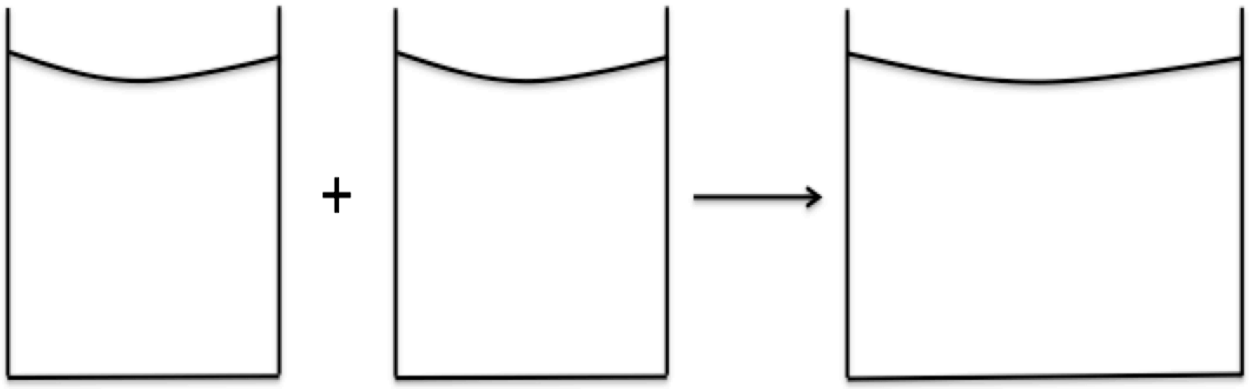
a) All starting solutions in the table below are aqueous. Fill in the table below as if it were a well-plate, like in your lab (thus you are mixing two aqueous compounds at a time to see if a precipitate forms). If a precipitate is expected to form, indicate that by writing the correct formula for the **precipitate** in the corresponding box below. If no precipitate is expected to form, write "No" in the box.

	$CaCl_2$	$Pb(NO_3)_2$	$(NH_4)_3PO_4$
Na_2CO_3			
$AgNO_3$			
K_2SO_4			

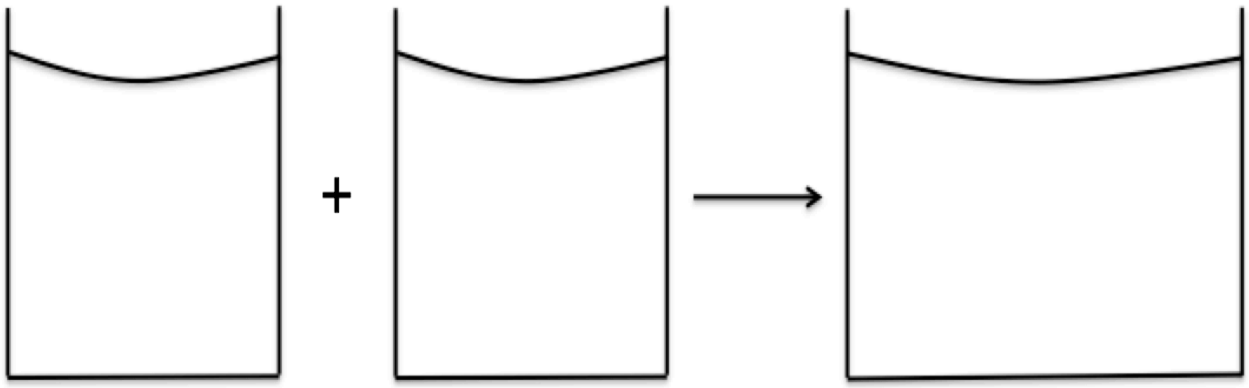
b) How do you prepare 300.0 mL of a 0.250 *M* $CaCl_2$ solution using an available 2.00 *M* solution? Support your answer with calculations, but also make sure you **describe** how to prepare the solution.

(Problem #16 continues on to the next page.)

c) (i) Draw a "magnified" (microscopic) view when Na_2CO_3 and $(NH_4)_3PO_4$ are mixed. (Be sure to show the correct number and charge of each ion.)



(ii) Draw a "magnified" (microscopic) view when K_2SO_4 and $Pb(NO_3)_2$ are mixed. (Be sure to show the correct number and charge of each ion.)



17. The following demonstration takes place in a two-step process:

First, solid calcium carbide (CaC_2) reacts with liquid water to produce acetylene gas (C_2H_2) and aqueous calcium hydroxide. Second, the acetylene gas produced is then ignited with a match causing the combustion reaction of acetylene with oxygen gas to produce gaseous carbon dioxide and gaseous water.

a) Write the balanced equations in standard form for each reaction that is occurring, including all phases.

b) If a 100.0 g sample of calcium carbide (CaC_2) is initially reacted with 50.0 g of water, which reactant is limiting in this case? Clearly state which reactant is limiting and show all work in a clear and organized manner.

(Problem #17 continues on to the next page.)

c) Now imagine that the final gases produced are collected in a large balloon and allowed to cool to room temperature. Using the information from above (100.0 g of CaC_2 reacting with 50.0 g of H_2O), how many liters of carbon dioxide gas was produced in the balloon at a pressure of 1.00 atm and 25°C? Show all work in a clear and organized manner.

d) Using the information from above (100.0 g of CaC_2 reacting with 50.0 g of H_2O), prove that mass was conserved for the first reaction in which calcium carbide reacted with water to produce acetylene and calcium hydroxide. Show all work in a clear and organized manner. (Note: Round your calculations at the end.)