CHEMISTRY 101
Hour Exam II
October 31, 2017
Andino/McCarren

Name ______________________________

Signature ___________________________

Section _____________________________

## "No matter what costume you wear, when you start eating Halloween candy, you will be a goblin." - Unknown

This exam contains 17 questions on 10 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. A periodic table and one sheet of scratch paper are provided after the exam. Anything written on the periodic table and scratch paper will not be graded.

| | | |
|---|---|---|
| 1-15 | (30 pts.) | _________ |
| 16 | (15 pts.) | _________ |
| 17 | (15 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·atm/mol·K ≈ 0.0821 L·atm/mol·K

K = °C + 273

$N_A = 6.022 \times 10^{23} = 1$ mole

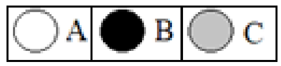
Solubility Rules:

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.

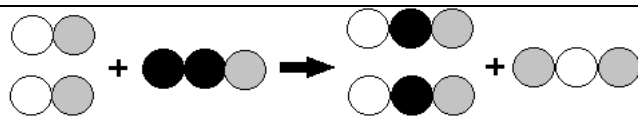
1. Which image shows the correct particle representation of chemical reaction below **<u>after it has been balanced</u>**?

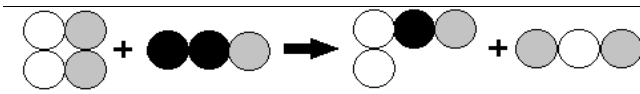
$$AC + B_2C \rightarrow ABC + AC_2$$

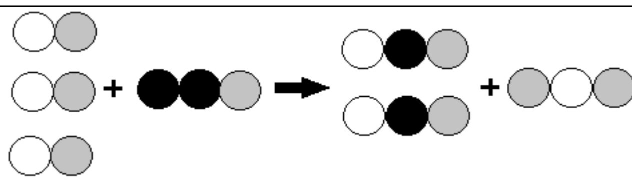
Key:

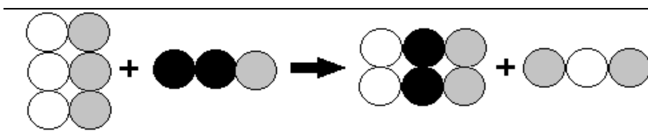



a) 

b) 

c) 

d) 

e) 

2. Each of the following combinations below results in the formation of a precipitate. For how many of the following is the resulting precipitate correctly shown?

| Reactants | Precipitate |
|---|---|
| $AgNO_3(aq) + NaCl(aq)$ | $AgCl(s)$ |
| $KOH(aq) + Cr(NO_3)_3(aq)$ | $Cr(OH)_3(s)$ |
| $Pb(NO_3)_2(aq) + Na_3PO_4(aq)$ | $Pb_3(PO_4)_2(s)$ |
| $Pb(NO_3)_2(aq) + KCl(aq)$ | $PbCl_2(s)$ |
| $Fe(NO_3)_2(aq) + Na_2S(aq)$ | $NaNO_3(s)$ |

a) 1 b) 2 c) 3 d) 4 e) 5 (All show the correct solid.)

3. What volume of a 0.2000 M solution can be made from 18.80 g copper(II) nitrate?
   a) 2,000. mL
   b) 500.0 mL
   c) 94.00 mL
   d) 20.00 mL
   e) 0.5000 mL

4. Consider a solution of 500.0 mL of 0.100 M hydrochloric acid (HCl). How many of the following would exactly double the concentration of the solution?
   i. Adding an additional 500.0 mL of 0.100 M HCl to the solution.
   ii. Adding 500.0 mL of water to the solution.
   iii. Allowing 250.0 mL of water to evaporate from the solution.
   iv. Mixing the solution with 500.0 mL of 0.100 M sodium nitrate.

   a) 0 (None) b) 1 c) 2 d) 3 e) 4 (All would increase the concentration.)

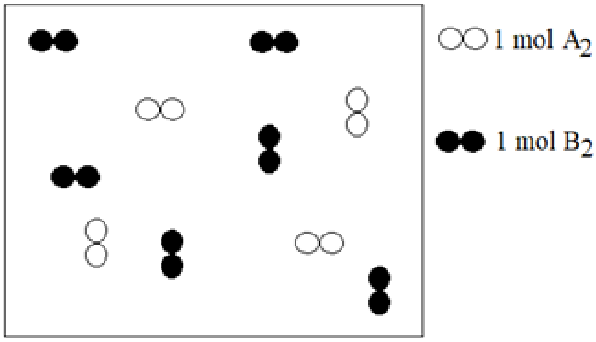
Consider the following reaction between chromium and sulfur to produce chromium(III) sulfide to answer questions 5-6.

$$16Cr(s) + 3S_8(s) \rightarrow 8Cr_2S_3(s)$$

5. If 6.0 moles of chromium(III) sulfide were formed, how many moles of chromium reacted initially, assuming sufficient sulfur to react with the chromium?
   a) 18 moles
   b) 16 moles
   c) 12 moles
   d) 6.0 moles
   e) 3.0 moles

6. If 10.0 grams of sulfur ($S_8$) reacted initially, how many moles of chromium were also needed to react?
   a) 481 moles
   b) 10.8 moles
   c) 1.66 moles
   d) 0.00731 moles
   e) 0.208 moles

7. Consider the following container, displaying molecules of generic diatomic gases $A_2$ and $B_2$ <u>before</u> any chemical reaction has occurred.




After reacting, both reactants are completely consumed and four moles of product are formed. What is the formula of the product?

a) $A_2B_3$
b) $AB_3$
c) $AB$
d) $A_4B_6$
e) $A_2B_2$

8. Hydrogen and nitrogen gases react to form ammonia according to the equation shown below:

$$N_2 + 3H_2 \rightarrow 2NH_3$$

As a result of the reaction, 34.1 grams of ammonia ($NH_3$) was produced. What volume of hydrogen gas at 20.0°C and 1.5 atm was required for this mass of ammonia to be produced, assuming sufficient nitrogen to react?

a) 0.0208 liters $H_2$
b) 0.0311 liters $H_2$
c) 32.0 liters $H_2$
d) 48.0 liters $H_2$
e) 547 liters $H_2$

9. Consider the reaction between magnesium and hydrochloric acid to form magnesium chloride and hydrogen gas.

$$Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$$

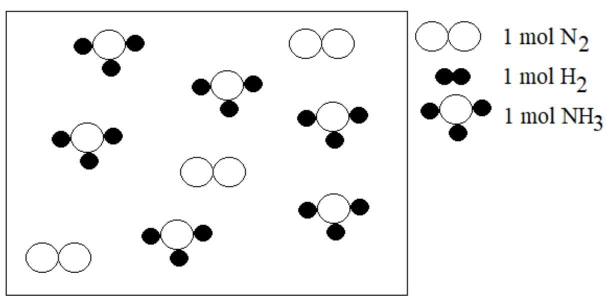
What mass of magnesium will be completely consumed in the reaction between magnesium and 20.0 mL of 3.00 M hydrochloric acid?

a) 0.0300 g Mg
b) 0.729 g Mg
c) 1.46 g Mg
d) 72.9 g Mg
e) 729 g Mg

10. Use the reaction between nitrogen and hydrogen gases to form ammonia to answer the next question:

$$N_2 + 3H_2 \rightarrow 2NH_3$$

The image below depicts the substances present in the container **after** a reaction between some amount of nitrogen and some amount of hydrogen has occurred.




How many moles of nitrogen and hydrogen gases were present in the container **before** the reaction?

a) 6 moles $N_2$, 9 moles $H_2$
b) 6 moles $N_2$, 6 moles $H_2$
c) 3 moles $N_2$, 6 moles $H_2$
d) 3 moles $N_2$, 9 moles $H_2$
e) 9 moles $N_2$, 12 moles $H_2$

For problems 11-15, consider the reaction that occurs when 500.0 mL of 4.00 M silver nitrate reacts with 500.0 mL of 3.00 M sodium carbonate to form a white precipitate.

11. Select the correct <u>complete</u> ionic equation for this reaction.
    a) $2Ag^{+}(aq) + NO_3^{-}(aq) + Na^{+}(aq) + CO_3^{2-}(aq) \rightarrow Na^{+}(aq) + NO_3^{-}(aq) + Ag_2CO_3(s)$
    b) $Ag_2^{+}(aq) + (NO_3)_2^{-}(aq) + Na_2^{+}(aq) + CO_3^{2-}(aq) \rightarrow Na_2^{+}(aq) + (NO_3)_2^{-}(aq) + Ag_2CO_3(s)$
    c) $2Ag^{+}(aq) + 2NO_3^{-}(aq) + 2Na^{+}(aq) + CO_3^{2-}(aq) \rightarrow 2NaNO_3(s) + 2Ag^{+}(aq) + CO_3^{2-}(aq)$
    d) $Ag^{+2}(aq) + NO_3^{-}(aq) + Na^{+}(aq) + CO_3^{2-}(aq) \rightarrow Na^{+}(aq) + NO_3^{-}(aq) + AgCO_3(s)$
    e) $2Ag^{+}(aq) + 2NO_3^{-}(aq) + 2Na^{+}(aq) + CO_3^{2-}(aq) \rightarrow 2Na^{+}(aq) + 2NO_3^{-}(aq) + Ag_2CO_3(s)$

12. Select the correct <u>net</u> ionic equation for this reaction.
    a) $Ag_2^{+}(aq) + CO_3^{2-}(aq) \rightarrow Ag_2CO_3(s)$
    b) $Na_2^{+}(aq) + (NO_3)_2^{-}(aq) \rightarrow Na_2(NO_3)_2(s)$
    c) $2Ag^{+}(aq) + CO_3^{2-}(aq) \rightarrow Ag_2CO_3(s)$
    d) $NO_3^{-}(aq) + Na^{+}(aq) \rightarrow NaNO_3(s)$
    e) $Ag^{+2} + CO_3^{-2}(aq) \rightarrow AgCO_3(s)$

13. What is the concentration of <u>nitrate ions</u> present in solution after the reaction?
    a) 4.00 M
    b) 2.50 M
    c) 2.00 M
    d) 1.00 M
    e) 0 M

14. What is the concentration of <u>carbonate ions</u> remaining after the reaction?
    a) 0 M
    b) 0.500 M
    c) 1.00 M
    d) 1.50 M
    e) 3.00 M

15. After the reaction occurred, which of the following ions had the highest concentration in the solution?
    a) Sodium ions
    b) Silver ions
    c) Nitrate ions
    d) Carbonate ions
    e) No ions were present in the solution after the reaction.

16. Please thoroughly answer the questions below, showing all relevant work.

a) **Unknown solid element X** and nitrogen gas ($N_2$) react to form the solid compound $X_3N$.

**i.** Write the balanced equation for this reaction, including phases.

**ii.** Equal mole samples of nitrogen gas and element X react. Determine the limiting reactant. Support your answer with any relevant work and/or an explanation.

**iii.** When 0.50 moles of $N_2$ react with sufficient element X, about 131 grams of compound $X_3N$ are formed. Identify element X. Show all relevant work.

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b) 100.0 mL of an aqueous solution of 3.00 M sodium hydroxide reacts with an aqueous solution of 200.0 mL of 2.00 M sulfuric acid ($H_2SO_4$).

**i.** Write the balanced equation for this reaction, including phases.

**ii.** Determine the limiting reactant. Support your answer with any relevant work and/or an explanation.

**iii.** As seen in the laboratory, a reaction like this one produces a temperature change. If the same reaction was carried out with 100.00 mL of the 3.00 M sodium hydroxide, but in this case 75.0 mL of 2.00 M sulfuric acid was added, would the temperature change of the reaction mixture be expected to be greater, less than, or equal to the temperature change of the reaction that occurred in part b)? Explain and provide mathematical support.

*Please continue on to the next page.*

17. A reaction occurs in a rigid, closed container between acetylene gas and oxygen gas to form carbon dioxide and water vapor according to the **unbalanced** equation shown below:

$$C_2H_2(g) + O_2(g) \rightarrow CO_2(g) + H_2O(g)$$

a) Determine the mass of each of the products formed after 52.08 g acetylene (molar mass 26.04 g/mol) reacts with 320 g oxygen gas (molar mass = 32.00 g/mol).

b) Prove that mass has been conserved in this reaction by filling in the table below. Show all relevant work below to support the way you have filled in the table.

| | Mass $C_2H_2$ (g) | Mass $O_2$ (g) | Mass $CO_2$ (g) | Mass $H_2O$ (g) | Total mass in container |
|---|---|---|---|---|---|
| Before Reaction | | | | | |
| After Reaction | | | | | |

*Please continue on to the next page.*

c) This reaction occurred in a container with volume of 50.0 L which maintained a constant temperature of 30.0°C after the reaction. What was the total pressure inside the container after the reaction took place?

**STOP** **This is the end of the exam. Nothing written after this page will be graded.**