

CHEMISTRY 101
Hour Exam II
March 26, 2024
Dr. E. McCarren

Name _____

Signature _____

Section _____

“You must believe in spring.” – Bill Evans

This exam contains 17 questions on 8 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	(12 pts.)	_____
17	(18 pts.)	_____
Total	(60 pts)	_____

Useful Information:

1 L = 1000 mL (exactly)

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

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

$K = ^\circ\text{C} + 273$ $N_A = 6.022 \times 10^{23} = 1 \text{ mole}$

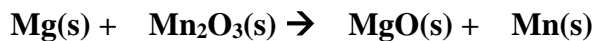
Standard temperature and pressure (STP) is 1.0 atm and 273 K.

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.

Section 1: Multiple Choice

1. Balance the follow chemical equation in standard form and determine the sum of the coefficients.



- 4
 - 6
 - 7
 - 8
 - 9
2. The arrow symbol (\rightarrow) separates the left and right sides of a balanced chemical equation. Consider the portion of a chemical equation to the left side of the arrow. Which is **true** about the left side of a balanced equation?

The left side of a balanced equation shows....

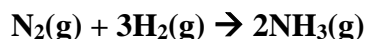
- the number of moles of each substance which are present in the reaction container before a reaction happens.
- the identities of the substances which are required for a reaction to occur.
- which substances can be formed as a result of a reaction.
- Two of the above (a-c) are true.
- All of the above (a-c) are true.

Consider the reaction for the elephant's toothpaste demonstration, which involves the decomposition of hydrogen peroxide to form liquid water and gaseous oxygen shown by the balanced equation below. Use this equation to answer the next two questions.



3. If 4.50 moles of hydrogen peroxide decompose, how many moles of oxygen gas will be formed?
- 1.13 moles
 - 2.25 moles
 - 4.50 moles
 - 6.75 moles
 - 9.00 moles
4. In a separate reaction, some hydrogen peroxide decomposes and 60.0 grams of water forms. How many moles of oxygen gas were also produced in this process?
- 53.3 moles
 - 30.0 moles
 - 6.66 moles
 - 3.33 moles
 - 1.66 moles

Nitrogen gas and hydrogen gas react to form ammonia gas according to the balanced equation below. Use this equation to answer the next two questions.



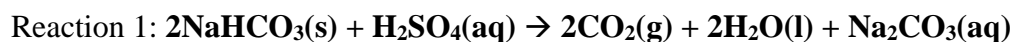
5. Consider a scenario in which 20.0 L of hydrogen gas at 25.0°C and 1.0 atm of pressure react with sufficient nitrogen gas to form ammonia. How many moles of ammonia can be produced from this quantity of hydrogen gas?
- 0.545 mol
 - 0.818 mol
 - 0.975 mol
 - 1.22 mol
 - 6.50 mol
6. In a separate scenario, some nitrogen and some hydrogen react. **After** this reaction, 12 moles ammonia were formed and 4.0 moles of nitrogen gas were leftover. How many moles of **nitrogen gas** were present **before** the reaction?
- 4.0 moles
 - 6.0 moles
 10. moles
 - 12 moles
 - 18 moles

7. Recall the lab activity when you observed the combinations of several aqueous solutions, similar to those combinations shown in the table below. For how many of the combinations below are precipitates expected to form?

	silver nitrate	barium nitrate
sodium sulfate		
potassium carbonate		

- 0 (None of the combinations will form precipitates.)
 - 1
 - 2
 - 3
 - 4 (All four combinations will form precipitates.)
8. For the combination of potassium carbonate and barium nitrate, what is the formula of the precipitate?
- KNO_3
 - K_2NO_3
 - Ba_2CO_3
 - BaCO_3
 - No precipitate was formed in this combination.

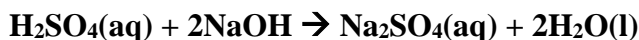
In the lab, we saw reactions between two acids and baking soda, which is basic. One of the reactions is shown below. Finish filling in the table below, determining the moles of carbon dioxide produced for trials 1 and 2. Use this information to answer the next three questions.



	Moles NaHCO_3	Moles H_2SO_4	Moles CO_2 produced	Limiting reactant
Trial #1	0.200	0.200		
Trial #2	0.200	0.100		

9. How many moles of carbon dioxide are expected to be produced in trial #1?
- 0.100 mol
 - 0.200 mol
 - 0.300 mol
 - 0.400 mol
 - 0.500 mol
10. What quantity of excess reactant is left over after the reaction in trial #1 occurs? Select the correct quantity and identity.
- 0.100 mol H_2SO_4
 - 0.050 mol H_2SO_4
 - 0.100 mol NaHCO_3
 - 0.050 mol NaHCO_3
 - There was a complete reaction, so there was no limiting reactant.
11. In the lab, we saw that the acid and baking soda reacted to inflate a balloon. How does the size of the balloon inflated in trial #1 compare to the size of the balloon inflated in trial #2? Assume that the size of the balloon corresponds to the amount of carbon dioxide produced.
- The size of the balloon inflated in trial #1 is _____ the size of the balloon inflated in trial #2.*
- one-quarter
 - half
 - equal to
 - double
 - four times greater than

Consider the reaction between aqueous sulfuric acid and aqueous sodium hydroxide. The balanced molecular equation for this reaction is shown below. Use this reaction to answer the next four questions.



12. What is the balanced net ionic equation for this reaction?

- $\text{SO}_4^{2-}(\text{aq}) + 2\text{Na}^+(\text{aq}) \rightarrow \text{Na}_2\text{SO}_4(\text{aq})$
- $\text{SO}_4^{2-}(\text{aq}) + \text{Na}_2^+(\text{aq}) \rightarrow \text{Na}_2\text{SO}_4(\text{aq})$
- $\text{H}_2^+(\text{aq}) + 2\text{OH}^-(\text{aq}) \rightarrow 2\text{H}_2\text{O}(\text{l})$
- $\text{H}^+(\text{aq}) + \text{OH}^-(\text{aq}) \rightarrow \text{H}_2\text{O}(\text{l})$
- It is not possible to write a balanced net ionic equation for this reaction.

You completely neutralize a 200.0 mL solution of 2.50 M H_2SO_4 by adding 300.0 mL NaOH.

13. What was the initial concentration of the NaOH solution before it was added to the sulfuric acid?

- 3.33 M
- 1.88 M
- 1.67 M
- 1.50 M
- 1.00 M

14. After the reaction, is the sulfate ion still present in the solution? Select yes or no and then the best corresponding explanation.

- Yes*, it formed part of the precipitate.
- Yes*, it was a spectator and did not react at all.
- Yes*, was only partially used in forming the product.
- No*, it was completely used in forming the product.
- No*, it was negatively charged.

15. What was the **concentration** of the sulfate ion in the solution after the reaction?

- 0 M
- 0.500 M
- 1.00 M
- 1.67 M
- 2.50 M

Please go on to the next page.

Please go on to the next page.

17. For each of the two scenarios shown below, write the balanced equation for the scenario, including phases. Then, provide explanations and calculations as directed to support your answers to each of the questions.

Scenario 1: Hydrogen gas and oxygen gas react to form liquid water.

- a. Give the balanced equation for this reaction, including phases.

In a sealed container, 20.0 grams of hydrogen gas reacts with some mass of oxygen gas to form 40.0 grams of water. In this case, the oxygen gas *has* to be the limiting reactant.

- b. Explain in words how you know oxygen has to be limiting. In your explanation, be sure to compare the 20.0 g of hydrogen you have to the amount of hydrogen needed to form 40.0 grams of water. Support your answer with calculations.

- c. Determine the exact mass of oxygen needed to form 40.0 grams of water. Show your work.

Please go on to the next page.


Scenario 2: Aqueous sodium chloride reacts with aqueous silver nitrate (AgNO_3).

- d. Give the balanced equation for this reaction, including phases. Note that you will need to determine the products for this reaction.

A beaker containing 20.0 mL of a 2.00 M aqueous solution of sodium chloride is mixed with 100.0 mL of a 1.00 M aqueous solution of silver nitrate. In this scenario, the sodium chloride was limiting.

- e. Explain in words how you know sodium chloride had to be limiting. In your explanation, be sure to compare the starting amount of sodium chloride with the amount needed to completely react with the silver nitrate. Support your answer with calculations.

- f. Determine the exact mass of precipitate which can be formed when this amount of silver nitrate and sodium chloride react. Show your work.

 **STOP.** You have reached the end of the exam. Nothing written after this page will be graded.