

**Course: SCH 3U**  
**Teacher: J.N. Frink Jr.**  
**Length of Exam: 1.5 h**

**Student Name: \_\_\_\_\_**  
**Number of pages: 8 (plus data tables)**  
**Total marks: 74 marks**

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**General Instructions:**

- read instructions carefully
  - look at the marks assigned to help budget time for each question
  - answer all multiple choice questions on the scantron card provided
  - answer all other questions in the spaces provided on this package
  - don't bang your head on the table
  - the data tables attached at the back of the exam may be removed for ease of use
  - **nonprogrammable** calculators only may be used
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**Multiple Choice**

*Identify the choice that best completes the statement or answers the question. 1 mark each*

- \_\_\_\_\_ 1. Which of the following matches of group number and common name is incorrect?
- |                                    |                           |
|------------------------------------|---------------------------|
| a. Group 2 - alkaline earth metals | d. Group 17 - halogens    |
| b. Group 6 - lanthanides           | e. Group 18 - noble gases |
| c. Group 1 - alkali metals         |                           |
- \_\_\_\_\_ 2. When elements are arranged in order of increasing atomic mass, their chemical properties repeat at regular intervals. This statement is the definition of
- |                                      |                                |
|--------------------------------------|--------------------------------|
| a. atomic mass                       | d. law of constant composition |
| b. periodic law                      | e. law of conservation of mass |
| c. limitations of the periodic table |                                |
- \_\_\_\_\_ 3. An electron dot diagram for a nitrogen atom should show
- |   |   |
|---|---|
| a. 1 lone pair and 3 bonding electrons  | d. 3 lone pairs and 1 bonding electrons |
| b. 2 lone pairs and 2 bonding electrons | e. 3 bonding electrons                  |
| c. 2 lone pairs and 3 bonding electrons |   |
- \_\_\_\_\_ 4. The formula for carbon tetrachloride is
- |                   |                   |
|-------------------|-------------------|
| a. $C_1Cl_{4(l)}$ | d. $CCl_{4(l)}$   |
| b. $C_4Cl_{4(l)}$ | e. $C_4Cl_{1(l)}$ |
| c. $C_1Cl_{(l)}$  |                   |
- \_\_\_\_\_ 5. An example of a physical change process in a chemical industry is
- deposit of gold on a metal through electrolysis
  - decomposition of limestone in the Solvay process
  - combustion of sulfur in the contact process for sulfuric acid
  - recovery of salt by evaporation of water from a salt lake
  - production of ammonia from nitrogen and hydrogen in the Haber process
- \_\_\_\_\_ 6. The reaction of silver nitrate with zinc would be classified as a
- |                                 |                                 |
|---------------------------------|---------------------------------|
| a. combustion reaction          | d. decomposition reaction       |
| b. synthesis reaction           | e. single displacement reaction |
| c. double displacement reaction |                                 |

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- \_\_\_\_\_ 7. When baking soda is heated, sodium carbonate, water, and carbon dioxide gas are formed. This reaction can be classified as
- synthesis
  - combustion
  - decomposition
  - single displacement
  - double displacement
- \_\_\_\_\_ 8. Classify the following reaction:  $\text{Mg(OH)}_2 + 2\text{HNO}_3 \rightarrow \text{Mg(NO}_3)_2 + 2\text{H}_2\text{O}$
- combustion
  - synthesis
  - decomposition
  - single displacement
  - double displacement
- \_\_\_\_\_ 9. Your favorite part of the course was
- balancing equations
  - predicting precipitation reactions
  - significant digits
  - stoichiometry
  - all of the above
- \_\_\_\_\_ 10. Which metal would not displace lead, Pb, in a lead nitrate,  $\text{Pb(NO}_3)_2$ , solution?
- copper, Cu
  - potassium, K
  - lithium, Li
  - magnesium, Mg
  - none of the above
- \_\_\_\_\_ 11. Which ion could a technician add to water to test for chloride ions,  $\text{Cl}^-$ ?
- $\text{Na}^+$
  - $\text{Ag}^+$
  - $\text{NH}_4^+$
  - $\text{Cu}^{2+}$
  - $\text{K}^+$
- \_\_\_\_\_ 12. What is the molar mass (g/mol) of the antacid  $\text{Al(OH)}_3$ ?
- 61.0
  - 44.0
  - 78.0
  - 122.0
  - 16.0
- \_\_\_\_\_ 13. How many ions are present in the formula unit  $(\text{NH}_4)_3\text{PO}_3$ ?
- $6.02 \times 10^{23}$
  - 19
  - 12
  - 10
  - 4
- \_\_\_\_\_ 14. Which of the following statements is/are true about one mole of ammonia ( $\text{NH}_3$ )?
- It contains 7.0 g of nitrogen
  - It contains  $6.02 \times 10^{23}$  atoms of nitrogen
  - It contains  $6.02 \times 10^{23}$  molecules
  - It contains 14.01 g of nitrogen
- i), ii), and iii)
  - ii), iii), and iv)
  - i) and ii)
  - iv) only
  - none are correct
- \_\_\_\_\_ 15. How do isotopes differ?
- in their mass numbers
  - in their atomic numbers
  - in their number of protons
  - in their number of electrons
- \_\_\_\_\_ 16. What is the percentage of magnesium in  $\text{Mg(OH)}_2$ ?
- 35.4
  - 41.7
  - 21.3
  - 31.8



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- \_\_\_\_\_ 26. A solution can be both:  
a. dilute and concentrated. c. saturated and unsaturated.  
b. saturated and dilute. d. supersaturated and saturated.
- \_\_\_\_\_ 27. The state of matter characterized by a definite volume and a shape based on the form of the container is  
a. gas d. plasma  
b. liquid e. glass  
c. solid
- \_\_\_\_\_ 28. Which of the following is NOT a characteristic of a gas at STP?  
a. high rate of diffusion d. highly defined shape  
b. high compressibility e. high level of translational motion  
c. high fluidity
- \_\_\_\_\_ 29. A sealed 4.0-L pickle jar is filled with O<sub>2</sub> gas by the downward displacement of water. The jar is placed into the refrigerator. What will happen to the O<sub>2</sub> gas?  
a. The O<sub>2</sub> molecules will move farther apart.  
b. The gas will liquefy.  
c. The O<sub>2</sub> molecules will collide more frequently with the sides of the jar.  
d. The translational motion of the O<sub>2</sub> molecules will increase.  
e. The kinetic energy of the O<sub>2</sub> molecules will be reduced.
- \_\_\_\_\_ 30. Assuming constant volume, the pressure of an ideal gas such as N<sub>2</sub>, increases with temperature because the  
a. volume of N atoms increases d. molecules of N<sub>2</sub> move more rapidly  
b. density of the gas decreases e. collisions are less elastic  
c. density of the gas increases
- \_\_\_\_\_ 31. At a fixed temperature and pressure, the average distance between molecules would be greater in a sample of  
a. air d. NaCl  
b. concrete e. liquid perfume  
c. sponge
- \_\_\_\_\_ 32. A sample of a gas with a volume of 1 L at 25°C and a pressure of 101.325 kPa is subjected to an increase in pressure and temperature. The volume of the gas will  
a. decrease  
b. increase  
c. remain the same  
d. become zero  
e. either increase or decrease, depending on the magnitude of the pressure and temperature changes
- \_\_\_\_\_ 33. A sample of O<sub>2</sub> occupies a volume of 47.2 L under a pressure of 165.320 kPa at 298 K. What volume would it occupy at 298 K if the pressure was reduced to 97.325 kPa?  
a. 27.8 L d. 47.8 L  
b. 29.3 L e. 80.2 L  
c. 32.3 L
- \_\_\_\_\_ 34. For a gas, which pair of variables are inversely proportional to one another if all other conditions remain constant?  
a.  $P$  and  $T$  d.  $n$  and  $V$   
b.  $P$  and  $V$  e.  $n$  and  $P$   
c.  $V$  and  $T$

- \_\_\_\_\_ 35. Which of the following is NOT an observed property of gases?
- Gases are compressible and can liquefy under pressure.
  - Gases have variable shape and volume.
  - Gases expand to fill their container.
  - Gases have a density greater than 1.00 g/mol.
  - Gases diffuse and are completely miscible.

**Application. Answer the following questions in the spaces provided.**

1. For a science fair project, a student wants to design a simple device for removing certain gases from polluted air. He knows that polar molecules dissolve well in water, so he bubbles polluted air through a jug of water to remove unwanted gases. For his project, the student uses air containing the following gases:
- |                       |  |
|-----------------------|--|
| 1. N <sub>2(g)</sub>  | 5. CH <sub>4(g)</sub>                  |
| 2. O <sub>2(g)</sub>  | 6. OCl <sub>2(g)</sub>                 |
| 3. HF <sub>(g)</sub>  | 7. C <sub>3</sub> H <sub>8(g)</sub>    |
| 4. NH <sub>3(g)</sub> | 8. CH <sub>3</sub> OCH <sub>3(g)</sub> |

List the gases that will dissolve by writing down their corresponding numbers. **2 marks**

2. Write the complete balanced equation for the following reaction.  
A phosphoric acid spill is neutralized by a sodium hydroxide solution. **4 marks**
3. Predict the products and write a balanced chemical equation for the following chemical reaction:  
Copper wire is added to an aqueous solution of silver nitrate to recover the silver. **3 marks**
4. What is the mass of  $5.00 \times 10^{26}$  atoms of lead? **2 marks**

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5. The analysis of a rocket fuel showed that it contained 87.4% nitrogen and 12.6% hydrogen by weight. The fuel's molar mass was determined to be 32.05 g by mass spectral analysis. Determine the empirical and molecular formulas of the fuel. **4 marks**

5. In this reaction:  $6 \text{PbO}(s) + \text{O}_2(g) \rightarrow 2 \text{Pb}_3\text{O}_4(s)$ , if 225 g of PbO are combined with 225 g of  $\text{O}_2$ , what mass of  $\text{Pb}_3\text{O}_4$  is produced (think limiting reagent!)? **4 marks**

**Communication. Answer the following questions in the spaces provided.**

1. Write the name of the following compounds; **1 mark each**
- |   |                                       |
|---|---------------------------------------|
| a) $\text{H}_2\text{O}_2$                     | b) $\text{H}_3\text{PO}_4(\text{aq})$ |
| b) $\text{CoCl}_2 \cdot 6 \text{H}_2\text{O}$ | d) $\text{CuO}$                       |

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2. A chemist has a large container of 12.0 M solution of  $\text{H}_2\text{SO}_{4(\text{aq})}$ . She needs 250 mL of 0.100 M  $\text{H}_2\text{SO}_{4(\text{aq})}$ . Describe how she would prepare this new solution (don't include calculations) ? **4 marks**
3. Write a balanced equation for the reaction of water with hydrogen sulfide,  $\text{H}_2\text{S}$ , which is a weak acid. Assume that only one hydrogen ion is transferred in this reaction. Identify the conjugate acid-base pairs in this reaction. **3 marks**

**Inquiry. Answer the questions in the spaces provided.**

1. A gas was collected over water in a gas bottle in the lab. The temperature of the water and air was 21.0 °C. A check of the weather network showed the air pressure was 99.87 kPa and steady. 425 mL of gas was collected. The vapour pressure of water at 21 °C is 2.49 kPa. The gas was the result of a reaction that produced carbonic acid and aqueous sodium chloride.
- a) What 2 gases are in the gas bottle? **1 mark**

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1. (continued)

b) Make up an observation table that you would have used to collect the data from this experiment and enter all the pertinent data. **3 marks**

c) Calculate the mass of the gas produced. **5 marks**