



Anglo-Chinese School  
(Barker Road)

A Methodist Institution  
Founded in 1886

CHEMISTRY  
DEPARTMENT OF SCIENCE

Name: \_\_\_\_\_ ( ) Class: SEC 3 \_\_\_\_\_

CHEMICAL CALCULATIONS (EXTENSIONS) – ASSIGNMENT

Multiple-Choice Questions [20 Marks]

TOTAL SCORE / 30

Write in your selected answer for the multiple-choice questions in the boxes provided.

|                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |
|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
| 1                    | 2                    | 3                    | 4                    | 5                    | 6                    | 7                    | 8                    | 9                    | 10                   |
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| 11                   | 12                   | 13                   | 14                   | 15                   | 16                   | 17                   | 18                   | 19                   | 20                   |
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- The ratio of the number of atoms in 2 moles of oxygen molecules to the number of atoms in 4 moles of helium is  
**A** 1 : 1                      **B** 1 : 2                      **C** 1 : 4                      **D** 2 : 1
- Which of the following contains the same number of atoms as 25.5 grams of ammonia?  
**A** 2.0 mol of CO<sub>2</sub>      **B** 3.0 mol of He      **C** 4.0 mol of CH<sub>4</sub>      **D** 6.0 mol of O<sub>2</sub>
- A 0.25 mol sample of an unknown metal **Q** is burnt in oxygen. The oxide formed was found to have a mass of 18 grams.  
Given that the relative atomic mass of **Q** is 64, what is the oxide formula?  
**A** **QO**                      **B** **Q<sub>2</sub>O**                      **C** **QO<sub>2</sub>**                      **D** **Q<sub>2</sub>O<sub>2</sub>**
- 0.1 mol **MSO<sub>4</sub>** combines with 5.4 g of water to form the hydrate **MSO<sub>4</sub>·nH<sub>2</sub>O**. What is **n**?  
**A** 1                      **B** 2                      **C** 3                      **D** 4
- Which of the following contains the greatest mass of nitrogen **for every 1 gram** of substance?  
**A** (NH<sub>4</sub>)<sub>3</sub>PO<sub>4</sub>      **B** Mg(NO<sub>3</sub>)<sub>2</sub>      **C** NH<sub>3</sub>                      **D** NH<sub>4</sub>NO<sub>3</sub>
- Which of the following contains the greatest mass of nitrogen **for every 1 mole** of substance?  
**A** (NH<sub>4</sub>)<sub>3</sub>PO<sub>4</sub>      **B** Mg(NO<sub>3</sub>)<sub>2</sub>      **C** NH<sub>3</sub>                      **D** NH<sub>4</sub>NO<sub>3</sub>

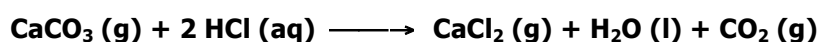
7. The empirical formula of an organic molecule was found to be  $\text{CH}_2\text{O}$ . What other information is required in order to find its molecular formula?
- A** melting and boiling points                      **C** products of combustion  
**B** percentage composition                      **D** relative molecular mass
8. Which of the following statements about empirical formula is **false**?
- A** Ionic compounds are always represented by an empirical, and not molecular, formula.  
**B** Percentage composition by mass of a compound can be found from its empirical formula.  
**C** The empirical formula of a compound can be found from its percentage composition by mass.  
**D** Whether a substance has a simple or giant structure can be seen from its empirical formula.
9. An unknown chloride of phosphorus was found to contain 5.6 g of phosphorus and 32.0 g of chlorine. What is its empirical formula?
- A**  $\text{PCl}_3$                       **B**  $\text{PCl}_5$                       **C**  $\text{PCl}_6$                       **D**  $\text{P}_2\text{Cl}_5$
10. An oxide of sulfur contains 1.5 times the mass of oxygen than sulfur. What is the empirical formula for this oxide?
- A**  $\text{SO}_2$                       **B**  $\text{SO}_3$                       **C**  $\text{S}_2\text{O}_3$                       **D**  $\text{S}_3\text{O}_2$
11. In an experiment to find the empirical formula of a metallic oxide, a strip of the unknown metal **X** is first weighed. Next, the strip of **X** is allowed to react completely in a covered crucible, and the residue allowed to cool. After cooling, the residue is then extracted and weighed.

The results for the experiment are as shown.

|                        |           |
|------------------------|-----------|
| mass of metal <b>X</b> | 3.0 grams |
| mass of residue        | 5.0 grams |

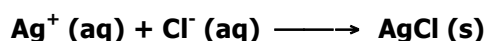
Assuming that the relative atomic mass of **X** is 32, find the empirical formula of the oxide of **X**.

- A**  $\text{XO}$                       **B**  $\text{XO}_2$                       **C**  $\text{X}_2\text{O}_3$                       **D**  $\text{X}_3\text{O}_4$
12. Pentane fuel is combusted in excess oxygen as shown:
- $$\text{C}_5\text{H}_{12} (\text{l}) + 8 \text{O}_2 (\text{g}) \longrightarrow 5 \text{CO}_2 (\text{g}) + 6 \text{H}_2\text{O} (\text{l})$$
- What is the total volume of gas remaining if 0.24 grams of pentane is allowed to react with  $800 \text{ cm}^3$  of oxygen? Assume that all volumes are measured at room conditions.
- A**  $160 \text{ cm}^3$                       **B**  $400 \text{ cm}^3$                       **C**  $560 \text{ cm}^3$                       **D**  $880 \text{ cm}^3$
13. 2.00 grams of solid calcium carbonate is allowed to react with  $50.0 \text{ cm}^3$  of  $0.200 \text{ mol dm}^{-3}$  hydrochloric acid, as shown below. What mass of calcium carbonate **remains** after the reaction?



- A** 0.25 grams                      **B** 0.50 grams                      **C** 1.00 grams                      **D** 1.50 grams

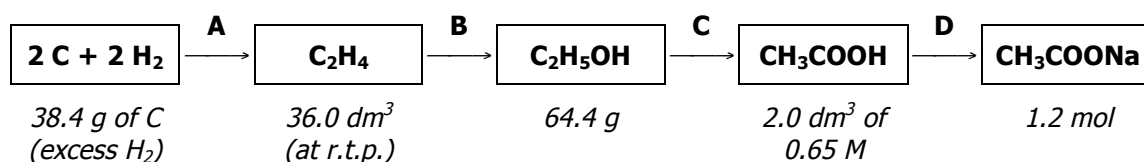
14. Silver ions react with chloride ions.



It is found that  $5.0 \text{ cm}^3$  of a  $0.1 \text{ mol/dm}^3$  solution of the chloride of metal **X** requires  $10.0 \text{ cm}^3$  of  $0.1 \text{ mol/dm}^3$  silver nitrate for complete reaction.

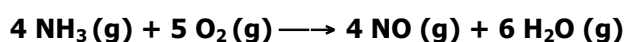
What is the formula of the chloride?

- A**  $\text{XCl}$                       **B**  $\text{X}_2\text{Cl}$                       **C**  $\text{XCl}_2$                       **D**  $\text{XCl}_4$
15. Sulfur trioxide,  $\text{SO}_3$ , is prepared by reacting equal masses of sulfur and oxygen. What percentage of the excess reagent remains unreacted?
- A** 25.5 %                      **B** 28.8 %                      **C** 31.1 %                      **D** 33.3 %
16.  $48.0 \text{ g}$  of impure carbon combusts in an excess of oxygen to form  $21.8 \text{ dm}^3$  of carbon dioxide, measured at room temperature and pressure. What is the percentage purity of the carbon?
- A** 30.3 %                      **B** 22.7 %                      **C** 45.4 %                      **D** 53.8 %
17. A solution is made up by dissolving  $1.25 \text{ g}$  of impure sodium hydroxide in water and making it up to  $250 \text{ cm}^3$  of solution.  $25.0 \text{ cm}^3$  of this solution is neutralized by  $30.0 \text{ cm}^3$  of  $0.100 \text{ mol/dm}^3$   $\text{HCl}$ . What is the percentage purity of the sodium hydroxide?
- A** 9.60 %                      **B** 26.0 %                      **C** 48.0 %                      **D** 96.0 %
18.  $0.2 \text{ mol}$  of aqueous magnesium chloride was mixed with an excess of aqueous silver nitrate in a beaker.  $36.6 \text{ grams}$  of precipitate was formed.
- What is the percentage yield for this reaction?
- A** 63.8 %                      **B** 78.4 %                      **C** 85.0 %                      **D** 89.7 %
19. The conversion of ethene to ethanol can be represented as follows:



Which reaction, **A**, **B**, **C** or **D**, has the greatest percentage yield?

20. The first step in the *Ostwald Process* for producing nitric acid is as follows:



If  $150 \text{ g}$  of ammonia reacts with  $150 \text{ g}$  of oxygen gas to give  $87 \text{ g}$  of nitric oxide, what is the percentage yield for this reaction?

- A** 33 %                      **B** 49 %                      **C** 77 %                      **D** 100 %

Structured Questions [10 Marks]

21. An 16.0 g sample of an unknown oxide of phosphorus contains 9.0 grams of oxygen by mass.

(a) By showing appropriate working, find the empirical formula of this oxide. [2]

(b) Given that relative formula mass of the oxide is 284, find its molecular formula. [2]

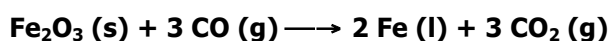
(c) Would you expect this phosphorus oxide to have a high or low boiling point? Explain how you arrived at your answer. [3]

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22. In the industrial extraction of iron, haematite, an iron ore mainly consisting of iron(III) oxide, is heated in the presence of carbon monoxide, as shown.



A 6.00 kg sample of haematite reacts with excess carbon monoxide produce 3.50 kg of iron.

Calculate the percentage purity of the haematite. [3]

**END**