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

11	12	13	14	15	16	17	18	19	20

1. 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

2. Which of the following contains the same number of atoms as 25.5 grams of ammonia?

   A 2.0 mol of CO_2 **B** 3.0 mol of He **C** 4.0 mol of CH_4 **D** 6.0 mol of O_2

3. 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 **Q**O **B** $\mathbf{Q}_2$O **C** **Q**O_2 **D** $\mathbf{Q}_2O_2$

4. 0.1 mol **M**SO_4 combines with 5.4 g of water to form the hydrate **M**SO_4.**n**H_2O. What is **n**?

   A 1 **B** 2 **C** 3 **D** 4

5. Which of the following contains the greatest mass of nitrogen **for every 1 gram** of substance?

   A $(NH_4)_3PO_4$ **B** $Mg(NO_3)_2$ **C** NH_3 **D** NH_4NO_3

6. Which of the following contains the greatest mass of nitrogen **for every 1 mole** of substance?

   A $(NH_4)_3PO_4$ **B** $Mg(NO_3)_2$ **C** NH_3 **D** NH_4NO_3

7. The empirical formula of an organic molecule was found to be CH_2O. What other information is required in order to find its molecular formula?

A melting and boiling points
B percentage composition
C products of combustion
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 PCl_3 **B** PCl_5 **C** PCl_6 **D** P_2Cl_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 SO_2 **B** SO_3 **C** S_2O_3 **D** S_3O_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 **X**	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 **X**O **B** **X**O_2 **C** $\mathbf{X}_2O_3$ **D** $\mathbf{X}_3O_4$

12. Pentane fuel is combusted in excess oxygen as shown:

$$\mathbf{C_5H_{12}\ (l) + 8\ O_2\ (g) \longrightarrow 5\ CO_2\ (g) + 6\ H_2O\ (l)}$$

What is the total volume of gas remaining if 0.24 grams of pentane is allowed to react with 800 cm^3 of oxygen? Assume that all volumes are measured at room conditions.

A 160 cm^3 **B** 400 cm^3 **C** 560 cm^3 **D** 880 cm^3

13. 2.00 grams of solid calcium carbonate is allowed to react with 50.0 cm^3 of 0.200 mol dm^{-3} hydrochloric acid, as shown below. What mass of calcium carbonate **remains** after the reaction?

$$\mathbf{CaCO_3\ (g) + 2\ HCl\ (aq) \longrightarrow CaCl_2\ (g) + H_2O\ (l) + CO_2\ (g)}$$

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

14. Silver ions react with chloride ions.

$$Ag^+ (aq) + Cl^- (aq) \longrightarrow AgCl (s)$$

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

What is the formula of the chloride?

A **X**Cl **B** $\mathbf{X_2}$Cl **C** **X**Cl_2 **D** **X**Cl_4

15. Sulfur trioxide, 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 g of impure carbon combusts in an excess of oxygen to form 21.8 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 g of impure sodium hydroxide in water and making it up to 250 cm^3 of solution. 25.0 cm^3 of this solution is neutralized by 30.0 cm^3 of 0.100 mol/dm^3 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 mol of aqueous magnesium chloride was mixed with an excess of aqueous silver nitrate in a beaker. 36.6 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:

	A		**B**		**C**		**D**	
$2\,C + 2\,H_2$	$\longrightarrow$	**C_2H_4**	$\longrightarrow$	**C_2H_5OH**	$\longrightarrow$	**CH_3COOH**	$\longrightarrow$	**CH_3COONa**
38.4 g of C (excess H_2)		*36.0 dm^3 (at r.t.p.)*		*64.4 g*		*2.0 dm^3 of 0.65 M*		*1.2 mol*

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:

$$4\,NH_3\,(g) + 5\,O_2\,(g) \longrightarrow 4\,NO\,(g) + 6\,H_2O\,(g)$$

If 150 g of ammonia reacts with 150 g of oxygen gas to give 87 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.

$$\mathbf{Fe_2O_3\ (s) + 3\ CO\ (g) \longrightarrow 2\ Fe\ (l) + 3\ CO_2\ (g)}$$

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