CHEMISTRY DEPARTMENT OF SCIENCE



Name: ANSWERS () 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. 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 \mathbf{Q} is 64, what is the oxide formula?

Α	Q O	B Q ₂ O	C Q O ₂	D	Q_2O_2
---	------------	---------------------------	---------------------------	---	----------

4. 0.1 mol MSO_4 combines with 5.4 g of water to form the hydrate MSO_4 .nH₂O. 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 CH₂O. 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?
 - B PCl₅ C PCl₆ A PCl₃ **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** SO₂ **B** SO₃ **C** S₂O₃ **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**.

D $X_{3}O_{4}$ A XO **B X**O₂ **C** X_2O_3

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

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

What is the total volume of gas remaining if 0.24 grams of pentane is allowed to react with 800 cm³ of oxygen? Assume that all volumes are measured at room conditions.

B 400 cm^3 **C** 560 cm^3 **D** 880 cm^3 **A** 160 cm³

13. 2.00 grams of solid calcium carbonate is allowed to react with 50.0 cm³ of 0.200 mol dm⁻³ hydrochloric acid, as shown below. What mass of calcium carbonate remains after the reaction?

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

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 cm³ of a 0.1 mol/dm³ solution of the chloride of metal **X** requires 10.0 cm³ of 0.1 mol/dm³ silver nitrate for complete reaction.

What is the formula of the chloride?

- **A** XCI **B** X_2 CI **C** XCl₂ **D** XCl₄
- 15. Sulfur trioxide, SO₃, 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 dm³ 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 cm³ of solution. 25.0 cm³ of this solution is neutralized by 30.0 cm³ of 0.100 mol/dm³ HCl. What is the percentage purity of the sodium hydroxide?

A 9.60 % B 26.0 % C 48.0 % D 96.
--

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:

$\begin{array}{c} \mathbf{A} \\ 2 \mathbf{C} + 2 \mathbf{H}_2 \end{array} \xrightarrow{\mathbf{A}} \end{array}$	C ₂ H ₄	B →	C₂H₅OH	 СН₃СООН	D →	CH ₃ COONa
<i>38.4 g of C (excess H₂)</i>	36.0 dm³ (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:

$4 \text{ NH}_3(g) + 5 \text{ O}_2(g) \longrightarrow 4 \text{ NO}(g) + 6 \text{ H}_2\text{O}(g)$

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]

mass ratio of P : O = 7 : 9 mole ratio of P : O = 7/31 : 9/16 = 0.226 : 0.563 = 1 : 2.5 = 2 : 5 Hence the empirical formula is P_2O_5 . [1 mark presentation, 1 mark answer]

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

Molecular formula is $P_{2n}O_{5n}$. M_r of $P_{2n}O_{5n} = 2n (31) + 5n (16)$ = 62 n + 80 n= 142 n= 142 n= 284Hence, n = 2Molecular formula is P_4O_{10} .[1 mark presentation, 1 mark answer]

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

```
Low boiling point [1]. This phosphorus oxide has a simple covalent structure [1].
We can deduce this as its molecular formula is not the empirical formula, whereas
marcomolecules are represented by their empirical formulae (or OWTTE). [1]
```

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.

$$Fe_2O_3(s) + 3 CO(g) \rightarrow 2 Fe(l) + 3 CO_2(g)$$

[3]

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.

mol of Fe = mass + A _r		mass of $Fe_2O_3 = mol \times M_r$	
= 3500 ÷ 56		= 31 .25 × 160	
= 62.5 mol	[1]	= 5000 g	[1]
mol of $Fe_2O_3 = \frac{1}{2}$ mol of Fe		% purity = (5000 + 6000) × 100%	
= ½ (62.5) = 31.25 mol		= 83.3 % (3 s.f.)	[1]

END