



Anglo-Chinese School
(Barker Road)

A Methodist Institution
Founded in 1886

CHEMISTRY
DEPARTMENT OF SCIENCE

Name: _____ **ANSWERS** _____ () Class: SEC 3 _____

CHEMICAL CALCULATIONS – ASSIGNMENT

Multiple-Choice Questions [20 Marks]

TOTAL SCORE / 30

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

1 A	2 D	3 A	4 C	5 D	6 D	7 D	8 D	9 C	10 B
11 A	12 C	13 D	14 C	15 B	16 B	17 D	18 C	19 A	20 A

- Which of the following statements about relative atomic mass is the **least correct**?
 - It is measured in grams.
 - It is compared to one-twelfth the mass of a carbon-12 atom.
 - It is the average number of protons and neutrons in an element.
 - It measures the average relative mass *per atom*.
- The Avogadro constant is the number of

A atoms in 6 g of graphite	C molecules in 1 g of hydrogen gas
B electrons in 10 g of neon	D protons in 2 g of helium
- If the number of similar particles in one mole is **x**, the number of chlorine molecules in 35.5 g of gaseous chlorine is

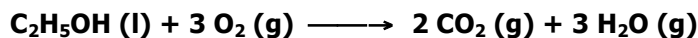
A 0.5 x	B x	C 2 x	D 35.5 x
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- The chloride of an unknown element **E** has a relative atomic mass of 136. Which of the following is most likely to be the formula for this chloride?

A ECl	B E ₂ Cl	C ECl ₂	D ECl ₃
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- What is the mass of one mole of anhydrous aluminium sulfate?

A 123 grams	B 170 grams	C 278 grams	D 342 grams
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- What is the relative molecular mass of copper(II) sulfate crystals, CuSO₄·5H₂O?

A 160	B 178	C 234	D 250
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7. When two moles of magnesium metal becomes ions,
- A** two moles of electrons are gained. **C** four moles of electrons are gained.
B two moles of electrons are lost. **D** four moles of electrons are lost.
8. Which of the following contains 2 moles of **atoms**?
- A** 12 g of carbon **B** 12 g of helium **C** 12 g of methane **D** 12 g of water
9. 0.2 mol of an unknown element **M** combines with 7.2 dm³ of chlorine (measured at r.t.p.) to form the compound **MCl_n**. What is the value of **n**?
- A** 1 **B** 2 **C** 3 **D** 4
10. In 50 grams of calcium carbonate, there are **x** oxygen atoms present. What is **x**?
- A** 0.5 mol **B** 1.5 mol **C** 2.5 mol **D** 3.0 mol
11. In 33 grams of (NH₄)₂SO₄, there are **y** ions present. What is **y**?
- A** 0.75 mol **B** 2.3 mol **C** 3.0 mol **D** 3.8 mol
12. When ethanol is combusted in excess oxygen, the following reaction takes place:



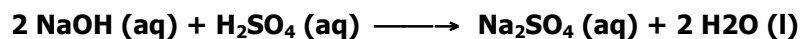
What volume of water vapour is formed, at r.t.p., when 1.0 kilogram of ethanol is combusted?

- A** $\frac{46 \times 3 \times 24}{1000} \text{ dm}^3$ **B** $\frac{46 \times 24}{1000 \times 3} \text{ dm}^3$ **C** $\frac{1000 \times 3 \times 24}{46} \text{ dm}^3$ **D** $\frac{1000 \times 24}{46 \times 3} \text{ dm}^3$
13. In the equation below, methane reacts with steam to form hydrogen and carbon monoxide:
- $$\text{CH}_4 \text{ (g)} + \text{H}_2\text{O (g)} \longrightarrow \text{CO (g)} + 3 \text{ H}_2 \text{ (g)}$$
- The volume of hydrogen that can be obtained from 100 cm³ of methane at r.t.p. is
- A** 100 cm³. **B** 150 cm³. **C** 200 cm³. **D** 300 cm³.
14. What volume of oxygen gas, measured under room conditions, is needed to completely combust 3.60 grams of carbon into carbon dioxide?
- A** 2,700 cm³ **B** 3,600 cm³ **C** 7,200 cm³ **D** 14,400 cm³
15. What volume of 0.120 mol dm⁻³ hydrochloric acid is need to completely react with 0.60 grams of magnesium metal?
- A** 208 cm³ **B** 417 cm³ **C** 600 cm³ **D** 820 cm³

16. What is the concentration of ions, in mol/dm³, in 39.2 g/dm³ sulfuric acid?

- A** 0.400 **B** 1.20 **C** 1.64 **D** 13.0

17. What is the minimum volume of 0.100 mol dm⁻³ sodium hydroxide needed to completely neutralise 22.50 cm³ of 0.250 mol dm⁻³ sulfuric acid in the reaction below?



- A** 1.13 cm³ **B** 9.00 cm³ **C** 45.0 cm³ **D** 113 cm³

18. In an industrial process, 42.5 g of ammonia was allowed to react with 72 dm³ of oxygen (measured at room conditions) to form nitrogen monoxide and water vapour.



Which is the limiting reagent in the above reaction?

- A** NH₃ **B** NO **C** O₂ **D** H₂O

19. Iron metal, when burnt in dry chlorine, forms iron(III) chloride.

Suppose if 1.8 dm³ of chlorine is allowed to react with 1.4 grams of iron, what is the maximum mass of iron(III) chloride that can be formed?

- A** 4.1 grams **B** 8.1 grams **C** 12.2 grams **D** 16.3 grams

20. If 36 dm³ of hydrogen were allowed to react with 32 grams of oxygen, what is the maximum mass of water that can be produced?

- A** 27 grams **B** 32 grams **C** 36 grams **D** 72 grams

Structured Questions [10 Marks]

21. A 4.00 g sample of copper(II) carbonate was allowed to react with 0.750 mol dm⁻³ nitric acid.

(a) Construct a chemical equation, including state symbols, for the reaction. [1]



(b) Find the number of moles of copper(II) carbonate present in the 4.00 g sample. [1]

$$\begin{aligned} \text{Mol of CuCO}_3 &= \text{Mass} \div M_r \\ &= 4.00 \div (64 + 12 + 3 \times 16) \\ &= 0.032258 \\ &= 0.0323 \text{ mol} \end{aligned}$$

(c) Hence find the volume of nitric acid needed. [2]

$$\begin{aligned}\text{Mol of HNO}_3 &= 2 \times \text{Mol of CuCO}_3 \\ &= 2 \times 0.032258 \\ &= 0.064516 \text{ mol}\end{aligned}$$

$$\begin{aligned}\text{Vol of HNO}_3 &= \text{Mol} \div \text{Molar Conc} \\ &= 0.064516 \div 0.750 \\ &= 0.0860 \text{ dm}^3\end{aligned}$$

22. When solutions of iron(II) nitrate and sodium hydroxide are mixed, a green precipitate of iron(II) hydroxide is formed. In an experiment, a student mixes a 5.0 cm³ sample of 0.250 mol dm⁻³ iron(II) nitrate with a 10 cm³ sample of 0.200 mol dm⁻³ sodium hydroxide.

(a) Construct a chemical equation, including state symbols, for the reaction. [1]



(b) By showing the relevant working, identify the limiting reagent. [3]

$$\begin{aligned}\text{Mol of Fe(NO}_3)_2 &= \text{Volume} \times \text{Molar Concentration} \\ &= 0.0050 \times 0.250 \\ &= 0.00125 \text{ mol}\end{aligned}$$

$$\begin{aligned}\text{Mol of NaOH} &= \text{Volume} \times \text{Molar Concentration} \\ &= 0.0100 \times 0.200 \\ &= 0.00200 \text{ mol}\end{aligned}$$

Since 0.00125 mol of Fe(NO₃)₂ requires 0.00250 mol of NaOH for complete reaction, there is insufficient NaOH; i.e. NaOH is limiting.

(c) Hence calculate the mass of precipitate formed. [2]

$$\begin{aligned}\text{Mol of Fe(OH)}_2 &= \frac{1}{2} \times \text{Mol of NaOH} \quad (\text{apply mole ratio to limiting reagent}) \\ &= \frac{1}{2} \times 0.00200 \\ &= 0.00100 \text{ mol}\end{aligned}$$

$$\begin{aligned}\text{Mass of Fe(OH)}_2 &= \text{Mol} \times M_r \\ &= 0.00100 \times (56 + 2 \times 16 + 2) \\ &= 0.0900 \text{ grams}\end{aligned}$$

END