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	2	3	4	5	6	7	8	9	10
A	D	A	C	D	D	D	D	C	B

11	12	13	14	15	16	17	18	19	20
A	C	D	C	B	B	D	C	A	A

1. Which of the following statements about relative atomic mass is the **least correct**?

   A It is measured in grams.
   B It is compared to one-twelfth the mass of a carbon-12 atom.
   C It is the average number of protons and neutrons in an element.
   D It measures the average relative mass *per atom*.

2. The Avogadro constant is the number of

   A atoms in 6 g of graphite
   B electrons in 10 g of neon
   C molecules in 1 g of hydrogen gas
   D protons in 2 g of helium

3. 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**

4. 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 **E**Cl **B** $\mathbf{E}_2$Cl **C** **E**Cl_2 **D** **E**Cl_3

5. What is the mass of one mole of anhydrous aluminium sulfate?

   A 123 grams **B** 170 grams **C** 278 grams **D** 342 grams

6. What is the relative molecular mass of copper(II) sulfate crystals, $CuSO_4.5H_2O$?

   A 160 **B** 178 **C** 234 **D** 250

7. When two moles of magnesium metal becomes ions,

A two moles of electrons are gained.
B two moles of electrons are lost.
C four moles of electrons are gained.
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 dm^3 of chlorine (measured at r.t.p.) to form the compound $\mathbf{MCl_n}$. 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 $(NH_4)_2SO_4$, 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:

$$\mathbf{C_2H_5OH\ (l) + 3\ O_2\ (g) \longrightarrow 2\ CO_2\ (g) + 3\ H_2O\ (g)}$$

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

A $\frac{46 \times 3 \times 24}{1000}\,dm^3$ **B** $\frac{46 \times 24}{1000 \times 3}\,dm^3$ **C** $\frac{1000 \times 3 \times 24}{46}\,dm^3$ **D** $\frac{1000 \times 24}{46 \times 3}\,dm^3$

13. In the equation below, methane reacts with steam to form hydrogen and carbon monoxide:

$$\mathbf{CH_4\ (g) + H_2O\ (g) \longrightarrow CO\ (g) + 3\ H_2\ (g)}$$

The volume of hydrogen that can be obtained from 100 cm^3 of methane at r.t.p. is

A 100 cm^3. **B** 150 cm^3. **C** 200 cm^3. **D** 300 cm^3.

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 cm^3 **B** 3,600 cm^3 **C** 7,200 cm^3 **D** 14,400 cm^3

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 cm^3 **B** 417 cm^3 **C** 600 cm^3 **D** 820 cm^3

16. What is the concentration of ions, in mol/dm^3, in 39.2 g/dm^3 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 cm^3 of 0.250 mol dm^{-3} sulfuric acid in the reaction below?

$$\mathbf{2\ NaOH\ (aq) + H_2SO_4\ (aq) \longrightarrow Na_2SO_4\ (aq) + 2\ H2O\ (l)}$$

A 1.13 cm^3 **B** 9.00 cm^3 **C** 45.0 cm^3 **D** 113 cm^3

18. In an industrial process, 42.5 g of ammonia was allowed to react with 72 dm^3 of oxygen (measured at room conditions) to form nitrogen monoxide and water vapour.

$$\mathbf{4\ NH_3\ (g) + 5\ O_2\ (g) \longrightarrow 4\ NO\ (g) + 6\ H_2O\ (g)}$$

Which is the limiting reagent in the above reaction?

A NH_3 **B** NO **C** O_2 **D** H_2O

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

Suppose if 1.8 dm^3 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 dm^3 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]

$CuCO_3\ (s) + 2\ HNO_3\ (aq) \longrightarrow Cu(NO_3)_2\ (aq) + CO_2\ (g) + H_2O\ (l)$

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

Mol of $CuCO_3$ = Mass ÷ M_r
= 2.20 ÷ (64 + 12 + 3 × 16)
= 0.032258
= 0.0323 mol

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

Mol of HNO_3 = 2 × Mol of $CuCO_3$
= 2 × 0.032258
= 0.064516 mol

Vol of HNO_3 = Mol ÷ Molar Conc
= 0.064516 ÷ 0.750
= 0.0860 dm^3

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 cm^3 sample of 0.250 mol dm^{-3} iron(II) nitrate with a 10 cm^3 sample of 0.200 mol dm^{-3} sodium hydroxide.

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

$Fe(NO_3)_2$ (aq) + 2 NaOH (aq) ⟶ $Fe(OH)_2$ (s) + 2 $NaNO_3$ (aq)

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

Mol of $Fe(NO_3)_2$ = Volume × Molar Concentration
= 0.0050 × 0.250
= 0.00125 mol

Mol of NaOH = Volume × Molar Concentration
= 0.0100 × 0.200
= 0.00200 mol

Since 0.00125 mol of $Fe(NO_3)_2$ 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]

Mol of $Fe(OH)_2$ = ½ × Mol of NaOH (apply mole ratio to limiting reagent)
= ½ × 0.00200
= 0.00100 mol

Mass of $Fe(OH)_2$ = Mol × M_r
= 0.00100 × (56 + 2 × 16 + 2)
= 0.0900 grams

END