

Chemistry I

003

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ORDINARY LEVEL NATIONAL EXAMINATIONS 2010

SUBJECT: CHEMISTRY I

DURATION: 3 HOURS

INSTRUCTIONS :

This paper consists of **three** sections: **A**, **B** and **C**.

Section A : Attempt **all** questions.

(55 marks)

Section B: Attempt any **three** questions.

(30 marks)

Section C: Attempt only one question.

(15 marks)

You do not need the Periodic Table.

SECTION A: Attempt all questions.**(55 marks)**

1. The stomach secretes gastric juice, which contains hydrochloric acid. The gastric juice helps with digestion. Sometimes there is an overproduction of acid, leading to indigestion. Antacids, such as milk of magnesia, can be taken to neutralise the excess acid. Milk of magnesia is only slightly soluble in water and has the chemical formula $\text{Mg}(\text{OH})_2$.
 - a) Write a balanced chemical equation to show how the antacid reacts with the acid. **(1 mark)**
 - b) The directions on the bottle recommend that children under the age of 12 years take one teaspoon of milk of magnesia, whereas adults can take two teaspoons of the antacid. Briefly explain why the dosages are different. **(1 mark)**
 - c) Why is it not advisable to take an overdose of the antacid in the stomach? Refer to the hydrochloric acid concentration in the stomach in your answer. **(1 mark)**
2. An unknown substance has a molar mass of 162.2 g mol^{-1} and consists of the following elements: 74.07 % carbon, 17.28 % nitrogen and 8.65 % hydrogen.
 - a) Determine the empirical formula of the substance. **(2.5 marks)**
 - b) What is the molecular formula of the substance? **(1.5 marks)**
(Atomic mass: H:1, C:12, N:14)
3. Two test tubes, A and B, both contain HCl at a concentration of 1M. One gram of calcium carbonate powder is added to test tube A. In test tube B, one gram of calcium carbonate chunks is added. The reaction that takes place in the two test tubes is:
$$\text{CaCO}_3 + 2\text{HCl} \rightarrow \text{CaCl}_2 + \text{H}_2\text{O} + \text{CO}_2(\text{g})$$
 - a)
 - i) In which test tube (A or B) will the formation of $\text{CO}_2(\text{g})$ take place at a higher rate? **(0.5 mark)**
 - ii) Give a reason for your answer. **(1 mark)**
 - b) Will the rate at which $\text{CO}_2(\text{g})$ is formed in test tube A be influenced (yes or no) if more of the HCl solution of the same concentration is poured into the test tube? **(0.5 mark)**

- c) Name two ways in which the rate of CO₂ formation in both test tubes can be increased, excluding the option of adding more CaCO₃. **(1 mark)**
4. 0.72 g of O₃ reacts with 0.66 g NO according to the following equation:

$$\text{O}_3(\text{g}) + \text{NO}(\text{g}) \rightarrow \text{O}_2(\text{g}) + \text{NO}_2(\text{g})$$
- a) Calculate the number of moles of O₃ and of NO present at the start of the reaction. **(2 marks)**
- b) Identify the limiting reagent (reactant) in the reaction and justify your answer. **(2 marks)**
 (Atomic mass: O:16; N:14)
5. Research has shown that the temperature on Earth is gradually rising.
- a) What term has been given to this phenomenon? **(1 mark)**
- b) What is the likely cause of this phenomenon? **(1 mark)**
- c) What are the consequences of this phenomenon? **(1 mark)**
- d) What can be done about it? **(1 mark)**
6. Study the formula of the compound: crystalline magnesium sulphate: MgSO₄·7H₂O
- a) Determine the percentage of sulphur present in the compound. **(2 marks)**
- b) If we have 5 g of this substance available, what mass will comprise of water? **(2 marks)**
 (Atomic mass: H:1, O:16, S:32, Mg:24)
7. Write only the word/term for each of the following descriptions:
- a) The distance between two atoms in a molecule. **(0.5 mark)**
- b) A chemical reaction during which electrons are transferred. **(0.5 mark)**
- c) A measure of how much solute is dissolved in a solvent. **(0.5 mark)**
- d) An ionic solution that conducts electricity. **(0.5 mark)**

8. a) Hydrogen is not a metal, but it is classified in IA group (alkali metals), why? **(1 mark)**

b) 15 cm³ N₂ react with 30 cm³ of H₂ to produce ammonia gas [NH₃ (g)]. Determine the total volume of gas left in the container if the reaction runs to completion and if the volumes are measured at the same temperature and pressure before and after the reaction. **(3 marks)**

9. Read the following statements and then choose the best answer(s) from the column marked possible answers. There could be more than one correct answer and the possible answers may be used more than once. **(4 marks)**

Statement	Possible answers
1. The extent to which a salt dissolves in water is known as the of the salt.	A. Element
2. Sand and water is an example of a	B. Compound
3. In the case of a cup of a black coffee, the coffee is the	C. Solution
4. A homogenous mixture can also be called a	D. Homogenous mixture
5. Salt dissolved in water is an example of a	E. Heterogeneous mixture
6. When AgNO ₃ and NaCl are mixed a is formed.	F. Solvent
	G. Precipitate
	H. Solubility
	I. Solute
	J. Mixture

10. a) Name the following compounds:
i) NaHCO₃ **(1 mark)**
ii) CS₂ **(1 mark)**

b) Write down the chemical formulae for the following compounds:
i) Ammonium sulphate **(1 mark)**
ii) Aluminium hydroxide **(1 mark)**

11. a) What is an element? **(1 mark)**

b) Write down the name of seven elements on the periodic table which always occur as diatomic molecules in nature. **(3 marks)**

12. a) Define dilution. (1 mark)

b) What volume of 15M sulphuric acid must be used to prepare 1.5L of a 0.1 M H_2SO_4 solution? (2 marks)

13. a) Name the type of chemical bond that occurs between the atoms in water molecule. (1 mark)

b) Comment on the following table: Boiling points of the hydrides of VIA group elements against molecular weights. (3 marks)

Compound	H_2O	H_2S	H_2Se	H_2Te
Molecular weight	18	34	81	130
Boiling point (K)	373	213	231	271

14. Sketch a diagram showing a water cycle. (4 marks)

15. a) The atomic number of phosphorus is 15. What does this mean? (1 mark)

b) Phosphorus is also classified as a non-metal. Name four physical properties phosphorus should have because of its non-metallic status. (2 marks)

c) Phosphorus has only one naturally occurring isotope. The isotope has 16 neutrons. The two radioactive isotopes of phosphorus have 17 and 18 neutrons respectively. Represent the two radioactive isotopes of phosphorus according to the notation ${}^A_Z\text{X}$. (1 mark)

SECTION B: Attempt any three questions from this section. (30 marks)

16. Study the following reaction: $\text{Fe}_2\text{O}_3(\text{s}) + 3\text{CO}(\text{g}) \rightarrow 2\text{Fe}(\text{s}) + 3\text{CO}_2(\text{g})$

Carbon monoxide is added to 500 kg of iron (III) oxide at STD.

Determine:

- a) The mass of iron formed. (4 marks)
- b) The volume of carbon dioxide released. (2 marks)
- c) The number of iron atoms formed. (2 marks)
- d) The number of atoms present in 500 kg of Fe_2O_3 . (2 marks)
(Atomic mass: Fe : 56; O : 16; C : 12; Number of Avogadro, $N_A = 6.023 \times 10^{23}$; molar volume = 22.4 l.mol^{-1})

17. A student wants to test sea water for the presence of chloride ions.

- a) Make a list of the chemicals and apparatus that he will need to conduct his test. (2 marks)
 - b) Suggest a method (procedure) to test sea water for the presence of chloride ions. (4 marks)
 - c) Write balanced ionic equations for all reactions that take place. (2 marks)
 - d) If chloride ions are present, a precipitate forms. What is the colour of the precipitate? (1 mark)
 - e) Do you think the precipitate will contain other ions as well? Give a reason for your answer. (1 mark)
18. Bauxite is the principal ore of aluminium.
- a) Describe briefly how bauxite is purified. (2 marks)
 - b) Explain why cryolite is added to the purified ore before it is electrolysed. (1 mark)
 - c) Write equations to show the reactions that take place at the electrodes during the electrolysis of the purified ore (Al_2O_3). (2 marks)
 - d) Explain why the anode is replaced from time to time. (1 mark)
 - e) State two reasons why aluminium is not obtained from bauxite by heating the purified ore with carbon. (2 marks)

- f) What is the reason why certain metals (such as gold) are more expensive than others (such as aluminium, copper)? **(2 marks)**
19. Because the world population is increasing so rapidly, the demand for food is incredibly high. The largest percentage of the world's soil is used for the cultivation of the crops, but large shortages of nutrients and minerals to allow good crop growth exist. The solution is the use of fertilisers.
- a) Where do plants get the elements carbon, hydrogen and oxygen from? **(1 mark)**
- b) The fertiliser: NPK is sold as NPK 14-26-16. What does this mean? **(2 marks)**
- c) Why are liquid fertilisers used more and more in agriculture? **(3 marks)**
- d) Write two paragraphs in which you address the impact of fertilisers on the environment. **(4 marks)**
20. a) Hydrocarbons are obtained from crude oil through fractional distillation.
- i) Which physical property is used to separate the various hydrocarbons from crude oil? **(1 mark)**
- ii) Which of the hydrocarbons, ethane or butane, will be removed first during distillation? Give a reason for your answer. **(1.5 marks)**
- b) Consider the following organic compound: $\text{CH}_3\text{-CO-O-CH}_3$.
- i) Write down the name of this compound. **(1 mark)**
- ii) Write down the names of the two organic compounds that were used to prepare this compound. **(1 mark)**
- iii) Write down the structural formula and name of one isomer of this compound. **(2 marks)**
- c) Write the functional group of an amine, a ketone. **(2 marks)**
- d) Is butane saturated or unsaturated hydrocarbon? Give a reason for your answer. **(1.5 marks)**

SECTION C: Attempt only one question from this section.**(15 marks)**

21. A chemist conducts an investigation and makes use of the following:

- 0.1 mol.dm⁻³ NaOH
- unknown concentration HCl
- bromothymol blue indicator
- burette
- stand
- erlenmeyer flask

20 cm³ of the HCl and a few drops of the indicator are placed in the erlenmeyer flask. The burette is filled with NaOH. The latter is added to an acid solution until a permanent colour change occurs. The reaction mixture heats up slightly. The whole process is repeated three times.

Results:

Volume acid	20	20	20
Volume base	15.3	15.15	15.2

- a) Supply a possible hypothesis for the investigation. **(2 marks)**
- b) Name the dependent and independent variables in this investigation. **(2 marks)**
- c) i) Write the ionic equation for the neutralising reaction. **(1 mark)**
ii) Use a calculation to determine the unknown value. **(3 marks)**
iii) Give the common name of salt formed. **(1 mark)**
- d) What will happen to the pH of the acid during this reaction? **(2 marks)**
- e) Is the reaction endothermic or exothermic? Explain. **(2 marks)**
- f) Supply the name of the method used for neutralising reaction. **(1 mark)**
- g) Define acid-base indicator. **(1 mark)**

22. A group of learners was asked to investigate the reactivity of alkanes and alkenes. They chose ethane and ethene as examples. They then carried out the following experiments.

Experiments A: The learners poured a few drops of ethane and ethene onto two separate watch glasses and lit the liquids in a fume cupboard.

Their observations are indicated in the table below:

Compound	Colour of flame	Sootiness
Ethane	Orange and blue flame	No soot observed
Ethene	Orange and blue flame	Slightly sooty

Experiments B: The learners perform the reaction of ethane and ethene firstly in a darkened room. They poured 2 cm³ of ethane and 2 cm³ of ethene into two separate test tubes and then added a few drops of bromine to the contents of each test tube. They then repeated the experiment in sunlight.

Their observations are indicated in the table below:

Compound	Action of liquid bromine in the dark	Action of liquid bromine in sunlight
Ethane	No visible reaction	Liquids mix and decolourise after a long time. A gas evolves
Ethene	Bromine decolourises slowly	Liquids mix and decolourise rapidly. No gas evolves

- a) Write down four safety precautions that the learners took during the experiment. **(2 marks)**
- b) Write down a possible hypothesis for investigation. **(2 marks)**
- c) What conclusion should the learners reach about the reactivity of the compounds as a result of
- i) the experiment A? **(1 mark)**
- ii) the experiment B? **(1 mark)**

- d) i) Write down the balanced equations for the combustion reactions involved in the experiment A. **(2 marks)**
- ii) Write down the balanced equations for the bromation reactions involved in the experiment B. **(2 marks)**
- e) Ethene molecules bond with one another to form long polymer chains. What are these ethene units known as? **(1 mark)**
- f) Give the general molecular formula of the alkenes. **(1 mark)**
- g) Calculate the mass of gas evolved in experiment B.
(Atomic mass: H: 1, C : 12, Br : 80; density of ethane = 1.212g/l). **(3 marks)**