

LEAVING CERTIFICATE EXAMINATION, 1987

CHEMISTRY—ORDINARY LEVEL

WEDNESDAY, 24 JUNE—MORNING 9.30 to 12.30

Question 1 and five other questions must be answered. These five questions *must* include question 2 or question 3 but may include *both* question 2 and question 3.

All questions carry the same number of marks.

Relative atomic masses: H = 1, C = 12, O = 16, Na = 23, Cl = 35.5, Ca = 40.

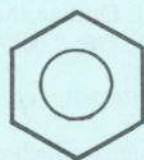
Avogadro constant = $6 \times 10^{23} \text{ mol}^{-1}$

Molar volume at S.T.P. = 22.4 dm^3

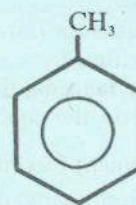
1. Answer *eleven* of the following items (a), (b), (c) etc. All items carry the same marks. *Keep your answers short.*

- (a) Write down the electronic configuration (s, p, etc.) of scandium (atomic number 21).
 (b) What shape is used to describe a molecule of
 (i) CH_4 , (ii) CO_2 ?
 (c) What is the oxidation number of sulphur in H_2SO_4 ?
 (d) What is the percentage of calcium by mass in CaCO_3 ?
 (e) Name each of the compounds

(i)



(ii)



- (f) Define (i) oxidation, (ii) reduction, in terms of electron transfer.
 (g) What colour changes would you see when (i) a sodium salt, (ii) a copper salt is heated in a flame?
 (h) Which is the acid and which is the conjugate base in the following reaction:

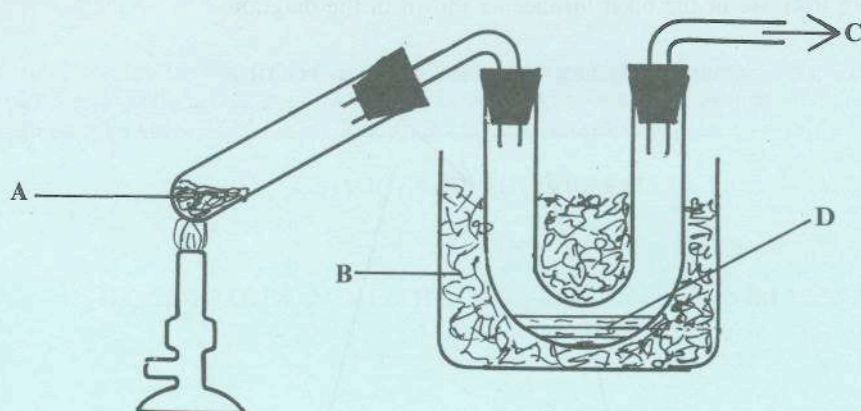


- (i) Name an addition polymer and give the name of its monomer.
 (j) Calculate the number of molecules in 9 g of water.
 (k) Name one oxide which is a major source of air pollution and state from where it might come.
 (l) What is the meaning of the term "the fractionation of crude oil"?
 (m) What is removed during the tertiary treatment of sewage?
 (n) What is the pH of 0.1 M NaOH?
 (o) Arrange the following metals in order of *decreasing* chemical reactivity in the electrochemical series:

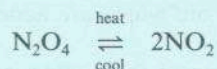
Mg Na Cu Fe

2. A solution of sulphuric acid was standardised and was found to be exactly 0.1 M. A solution containing approximately 6.5 g dm^{-3} of sodium hydroxide was prepared. 25 cm^3 of the sodium hydroxide solution was titrated with the sulphuric acid solution and it was found that 20.0 cm^3 of the acid were required for neutralisation.
- Why was it necessary to standardise the H_2SO_4 solution? (6)
 - Name the items of glassware used
 - to contain the sodium hydroxide solution, (12)
 - to remove 25 cm^3 of the sodium hydroxide solution for titration. (12)
 - Suggest why the exact mass of sodium hydroxide was not recorded. (6)
 - Name a suitable indicator for the reaction and state its colour change at the end point. (12)
 - Why would sulphuric acid be used in the burette rather than sodium hydroxide? (6)
 - Write an equation for the reaction between sulphuric acid and sodium hydroxide. Calculate (a) the molarity of the sodium hydroxide solution, (b) the concentration of the sodium hydroxide in g dm^{-3} . (24)
3. (a) In testing a solution of a fertiliser for the presence of a nitrate, a student carried out the following procedure. "A cold saturated solution of iron(II) sulphate was added to the test solution and mixed. Concentrated sulphuric acid was then carefully poured down the inside of the test tube." In what way should sulphuric acid be added carefully? Indicate where the sulphuric acid forms a layer and state what colour can be seen at the junction of the two layers. (18)
- (b) "The solution in the test tube contained chloride ions and not iodide ions." This statement was written by a student after the solution was tested. Outline the procedures followed by the student, stating the reagents used. What observations led to the conclusion given in the above statement? (24)
- (c) The following is a statement recorded in a student's practical notebook. "I used acidified potassium manganate(VII) solution (KMnO_4) to distinguish which of the two solutions given was (a) ethanal (acetaldehyde) and which was (b) ethanoic acid (acetic acid)". What procedures were followed and what observations were made which enabled the student to identify the solutions? (24)
4. (a) In 1808, John Dalton proposed his atomic theory to explain the laws of chemistry known at that time. Two of the proposals made by Dalton were: (i) that atoms were indivisible (i.e. could not be broken) and (ii) that atoms of any one element were all exactly alike and had the same mass. Using present day knowledge, state why Dalton's theory is inaccurate and use the terms, protons, neutrons, electrons, atomic numbers, mass numbers and isotopes to illustrate your answer. (36)
- (b) What is meant by electronegativity? (6)
Using electronegativity values, predict the type of bond in each of *two* of the following molecules:
- CH_4 , MgO , Cl_2
- (Refer to Mathematics Tables p. 46)
(18)
- (c) What bonds contribute to the force holding water molecules together? These bonds can be used to explain abnormal properties of water. Name *one* of these abnormal properties. (6)

5. (a) Nitrogen dioxide may be prepared using the apparatus as shown.



- (i) Name the substances A, B, C and D. (12)
- (ii) Write an equation for the reaction. (12)
- (iii) What is the colour of D? (6)
- (iv) Is nitrogen dioxide an acidic, basic or amphoteric oxide and say why? (12)
- (b) Nitrogen dioxide (NO_2) normally exists in equilibrium with dinitrogen tetroxide (N_2O_4) as follows



Write the equilibrium constant (K_c) for this reaction. Explain what you would expect to happen if (i) the mixture was heated, (ii) the pressure was reduced. (24)

6. In an experiment 20 g of marble chips were added to a conical flask containing excess hydrochloric acid. A cotton wool plug was quickly inserted into the mouth of the flask. The contents were swirled. The mass of the flask and contents were measured and recorded every half minute as shown below.

Time/minutes	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5
Mass/g	139.4	138.2	137.2	136.5	136.0	135.6	135.3	135.1	135.0	135.0	135.0	135.0

- (i) Write an equation for the reaction. (6)
- (ii) Draw a diagram of the apparatus used. (12)
- (iii) Why is a cotton wool plug used? (6)
- (iv) Using graph paper, plot a graph of mass against time. (12)
- (v) After how many minutes was the reaction (a) half complete, (b) fully completed? (12)
- (vi) What was the total loss in mass and how many moles of carbon dioxide were formed by the end of the reaction? (18)
7. What is meant by the terms (i) homologous series, (ii) a functional group? (12)

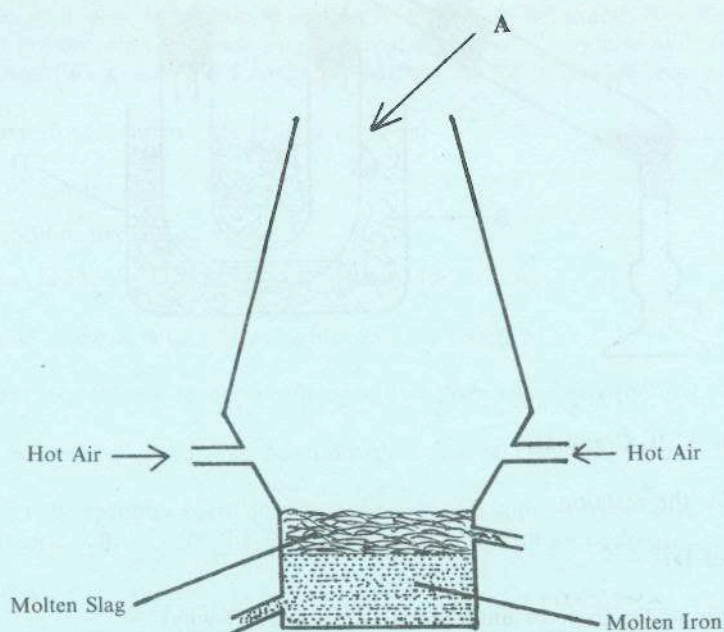
Give the name and structural formula of the first member of *three* of the following:

- (a) alkenes, (b) primary alcohols, (c) aldehydes, (d) carboxylic acids. (18)

Describe, with the aid of a diagram, how a primary alcohol may be converted to *either* (i) an alkene *or* (ii) an aldehyde. Mention the reagents used. State one physical and one chemical property of the product you have chosen. (36)

8. (a) What is meant by hardness of water? (6)
Distinguish between temporary and permanent hardness of water and state how each type is caused. How may temporary hardness be removed? (24)
Describe briefly how an ion exchange resin may be used to remove permanent hardness. (12)
- (b) 1,000 cm^3 of a water sample was filtered and it was found that the mass of the filter paper, after drying, had increased by 0.25 g. Calculate the total suspended solids content of the water sample in parts per million (p.p.m.). How might the total dissolved solids content of the water sample be obtained? (24)

9. Iron is extracted from iron ore in the blast furnace as shown in the diagram



- (i) Name two materials *other* than iron ore which are added to the blast furnace at A. (12)
- (ii) Why does the molten slag float on top of the molten iron? (6)
- (iii) What type of reaction occurs when a metal is extracted from a metal oxide? (6)
- (iv) How might the iron be converted to steel? (12)
- (v) Mention two ways in which steel is more useful than iron. (12)
- (vi) Corrosion is a problem with iron machinery. State *three* factors that cause corrosion and suggest *two* methods to help prevent it. (18)

10. Answer any *two* of the following.

- (a) Sulphur trioxide is converted to sulphuric acid using the Contact Process. The catalyst used is vanadium(V)oxide.
 - (i) What is the meaning of the term catalyst? (6)
 - (ii) Of which group of elements in the Periodic Table is vanadium a member? (6)
 - (iii) Mention *one* other property you would expect of a vanadium compound. (6)
 - (iv) Mention any *two* uses of sulphuric acid and give an example of *one* of them. (15)

- (b) Define heat of neutralisation. (6)

Explain why the heat of neutralisation of any strong acid (e.g. HCl) by a strong alkali (e.g. KOH) is always around the same value (57 kJ mol^{-1}). (12)

Describe briefly how you would find the heat of neutralisation of an acid. (15)

- (c) A compound was found to contain 37.2% carbon, 7.8% hydrogen and 55% chlorine by mass. If the relative molecular mass is 64.5, calculate the molecular formula and name the compound. (24)

When this compound was added to a solution of sodium hydroxide, ethanol and sodium chloride were formed. Write an equation for this reaction and state what this type of reaction is called. (9)

- (d) The general gas equation for an ideal gas is given as $pV = nRT$. What does n represent in this equation? (6)

Express n in terms of actual mass (m) and relative molecular mass (M) of the gas. (6)

Describe, with the help of a diagram, how you would find the relative molecular mass of a volatile liquid. (21)