AN ROINN OIDEACHAIS

LEAVING CERTIFICATE EXAMINATION, 1990

CHEMISTRY—ORDINARY LEVEL   **13434**

THURSDAY, 14 JUNE — AFTERNOON, 2 to 5

**Question 1** and **five** other questions must be answered.
These 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, N = 14, O = 16, Na = 23, S = 32, Cl = 35·5, Cu = 63·5, Zn = 65.
Molar volume 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*)   What element is represented by the following electronic configuration $1s^2 2s^2 2p^6 3s^2 3p^5$?

   (*b*)   Define the relative atomic mass of an element.

   (*c*)   What is meant by isotopes?

   (*d*)   Give the structural formula of methylbenzene.

   (*e*)   What is the oxidation number of phosphorus in H_3PO_4?

   (*f*)   State the effect of an increase in temperature on the equilibrium in the following endothermic reaction:

   $$C_{(s)} + H_2O_{(g)} \rightleftharpoons CO_{(g)} + H_{2(g)}$$
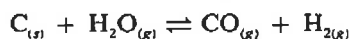
   (*g*)   What is the systematic (IUPAC) name for the compound $CH_3CHClCH_3$?

   (*h*)   Write down (i) the conjugate acid of H_2O, (ii) the conjugate base of H_3O^+.

   (*i*)   The organic compound naphthalene has a melting point at 80°C. A sample of naphthalene was found to melt over the range 74—76°C. What does this tell about the substance?

   (*j*)   What is the pH of a 0·01 M HCl solution?

   (*k*)   Write the equilibrium constant expression, K_c, for the reaction:

   $$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$$

   (*l*)   Give a chemical test to distinguish between an aldehyde and a ketone.

   (*m*)   Name (i) one example of an ionic crystal, (ii) one example of a molecular crystal.

   (*n*)   What is understood by catalytic cracking?

   (*o*)   What is the percentage by mass of nitrogen in ammonium chloride (NH_4Cl)?   (11 × 6)

2. In a titration experiment to determine the concentration of sodium hydroxide in a solution, a hydrochloric acid solution of known concentration is added to 25·0 cm^3 portions of the sodium hydroxide solution until the colour of an added indicator changes.

   (*a*)   Give the name of a suitable piece of apparatus to measure accurately the (i) 25·0 cm^3 portions of sodium hydroxide solution, (ii) volume of hydrochloric acid solution needed for complete reaction.   (12)

   (*b*)   State *one* precaution that should be taken for accurate measurement when the apparatus named in (*a*)(i) and *a*(ii) above is being used.   (12)

   (*c*)   Name a suitable indicator stating the colour change it would undergo at the endpoint of the titration. (9)

   (*d*)   State *two* important operations which should be carried out during the titration to ensure an accurate endpoint.   (12)

   (*e*)   The hydrochloric acid solution contains 7·3 g of hydrogen chloride in 1 dm^3 of solution. 22·5 cm^3 of this solution are needed to react with 25·0 cm^3 of the sodium hydroxide solution in the reaction:

   $$NaOH_{(aq)} + HCl_{(aq)} \rightarrow NaCl_{(aq)} + H_2O_{(l)}$$
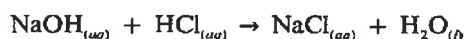
   Calculate (i)   the number of moles of hydrogen chloride (HCl) in 1 dm^3 of solution,   (6)
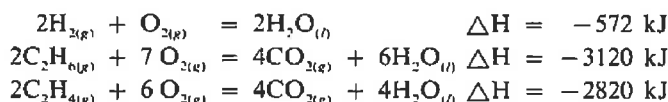
   (ii)   the concentration of the sodium hydroxide solution in (*a*) mol dm^{-3}, (*b*) g dm^{-3}.   (15)

3. The following apparatus may be used to prepare ethyne in the laboratory.
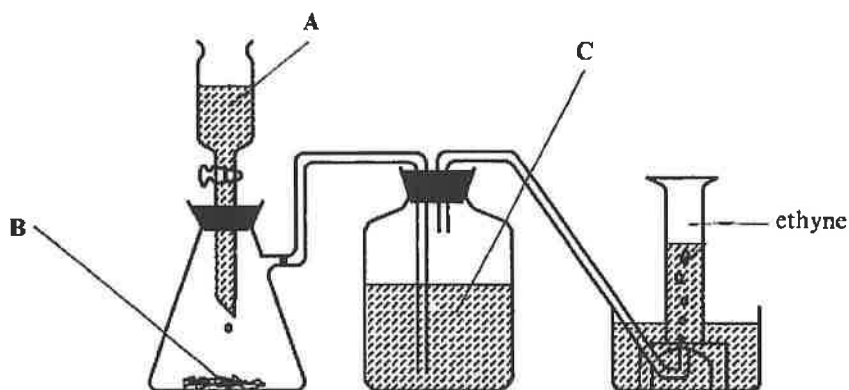
(i) Name the liquid A, the solid B and the solution C. (18)
(ii) What is the purpose of the solution C? (6)
(iii) A test tube of ethyne was burned and then limewater was added to the test-tube which was shaken. Describe the flame that was obtained and state and account for what happens to the limewater. (12)
(iv) Outline a chemical test which can be carried out to show that ethyne is unsaturated stating what would be observed during the test. (12)
(v) From the evidence of the tests carried out in (iii) and (iv) above, state why you would conclude that ethyne is (a) non-polar and (b) contains carbon. (12)
(vi) Give one industrial use of ethyne. (6)

4. (a) What is meant by (i) heat of combustion, (ii) heat of reaction, (iii) an endothermic reaction? (18)

(b) Given the following data:

$$2H_{2(g)} + O_{2(g)} = 2H_2O_{(l)} \qquad \Delta H = -572 \text{ kJ}$$
$$2C_2H_{6(g)} + 7 O_{2(g)} = 4CO_{2(g)} + 6H_2O_{(l)} \quad \Delta H = -3120 \text{ kJ}$$
$$2C_2H_{4(g)} + 6 O_{2(g)} = 4CO_{2(g)} + 4H_2O_{(l)} \quad \Delta H = -2820 \text{ kJ}$$

(i) Write down the heat of combustion of ethane in kJ mol^{-1}. (6)
(ii) Calculate the heat change for the reaction:
$$C_2H_{4(g)} + H_{2(g)} = C_2H_{6(g)} \qquad (24)$$

(c) What is meant by the kilogram calorific value of a fuel? From the data given in (b) calculate which of the gases ethane or ethene would have the higher kilogram calorific value. (18)
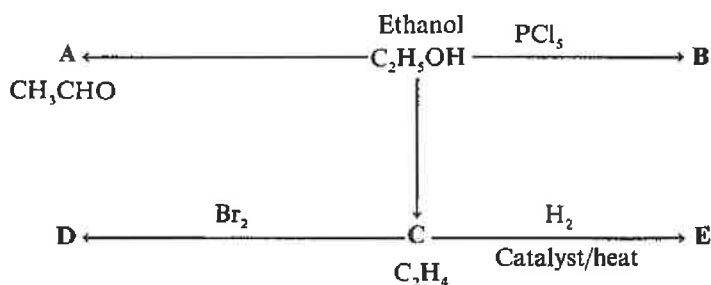
5. What is meant by the rate of a chemical reaction? (9)

In an experiment 5 g of granulated zinc were put in a conical flask and covered with 100 cm^3 (an excess) of 2 M hydrochloric acid solution at 20 C. The volume of hydrogen produced was measured at intervals of one minute for 10 minutes.

$$Zn_{(s)} + 2HCl_{(aq)} \rightarrow ZnCl_{2(aq)} + H_{2(g)}\uparrow$$

(a) Draw a sketch of an apparatus suitable for carrying out this experiment. (9)

(b) Draw a rough sketch of the graph you would expect to obtain by plotting time on the horizontal axis and volume of hydrogen produced on the vertical axis. (12)

(c) How would you expect the rate of production of hydrogen to be affected if each of the following changes in reaction conditions was made in turn, all other experimental conditions remaining identical?

(i) using 5 g of powdered zinc,
(ii) using 3 g of granulated zinc,
(iii) raising the temperature to 40°C. (24)

(d) Calculate the volume of hydrogen produced at S.T.P. when 5 g of zinc reacts with 100 cm^3 of 2 M hydrochloric acid solution. (12)

6. Study the following reaction scheme and then answer the questions which follow.

$$A \xleftarrow{\quad\quad} \underset{CH_3CHO}{\qquad} \overset{\text{Ethanol}}{C_2H_5OH} \xrightarrow{PCl_5} B$$

$$D \xleftarrow{Br_2} \underset{C_2H_4}{C} \xrightarrow[\text{Catalyst/heat}]{H_2} E$$

(a) Give the name and structural formula for compounds **A**, **B** and **D**. (18)

(b) Name and give the structural formula for compound **C**. In what way can compound **C** be converted into compound **B**? (12)

(c) Which of the reactions shown in the scheme above is (i) an addition reaction, (ii) a substitution reaction, (iii) an oxidation reaction? (18)

(d) Draw a sketch of the apparatus used to prepare compound **A** from ethanol showing clearly the chemicals used. Describe briefly how the reaction is carried out. (18)

7. The manufacture of sulphuric acid by the Contact process takes place in the three stages, (i) the production of sulphur dioxide, (ii) the conversion of sulphur dioxide to sulphur trioxide, (iii) the reaction of sulphur trioxide with water.

(a) How is the sulphur dioxide for this process produced? Write an equation for the reaction. (12)

(b) What catalyst is used in the conversion of sulphur dioxide to sulphur trioxide? Give an equation for the reaction that takes place. (12)

(c) Give an equation for the reaction of sulphur trioxide with water. (6)

(d) State two industrial uses of sulphuric acid. (12)

(e) Sulphur dioxide is a source of atmospheric pollution producing acid rain. Name one source of sulphur dioxide in the atmosphere and show how sulphur dioxide produces acid rain. (12)

(f) Outline a chemical test to show the presence of sulphite ions in a solution of sodium sulphite. (12)

8. (a) Answer the questions below from the following list of metals:

Potassium (K), Aluminium (Al), Zinc (Zn), Iron (Fe)

Name
(i) a metal which forms coloured compounds,
(ii) a metal which forms compounds that give off a lilac coloured flame when heated in a Bunsen flame,
(iii) the metal which is most reactive to water,
(iv) a metal that is used for galvanising,
(v) a metal which forms an amphoteric oxide,
(vi) a metal which forms a basic oxide,
(vii) a metal with a variable valence. (7×6)

(b) Write down in your answer book the missing words or equations 1 to 8 from the following passage.

Copper can be purified by electrolysis using copper(II) sulphate solution. A pure copper plate is used as the ___(1)___ and an impure copper plate is used as the ___(2)___. Pure copper is deposited on the ___(3)___. Oxidation occurs at the ___(4)___ and reduction occurs at the ___(5)___. The colour of the copper sulphate solution ___(6)___ if the electrolysis is continued for some time. The equation for the reaction occurring at the cathode (negative electrode) is ___(7)___ and the equation for the reaction occurring at the anode is ___(8)___. (8×3)

P.T.O.

9. (a) What is meant by hardness in water? (6)

State *one* advantage and *one* disadvantage of hard water. Outline how an ion exchange resin removes permanent hardness in water. (30)

(b) 500 cm³ of a water sample was filtered into a flask and it was found that the mass of the filter paper, after drying, had increased by 0·10 g. The water was then evaporated and it was found that the mass of the empty flask had increased by 0·24 g.

Calculate (i) the total suspended solids content, (ii) the total dissolved solids content, expressed as p.p.m., in the water sample. (30)

10. Answer any *two* of the following.

(a) 12·7 g copper reacts with 3·2 g of sulphur to give a compound X which has a relative molecular mass of 159.
   (i) How many moles of copper reacted? (6)
   (ii) How many moles of sulphur reacted? (6)
   (iii) In what ratio did copper and sulphur combine? (6)
   (iv) What is the molecular formula for compound X? Name the compound X. (15)

(b) What is understood by (i) a period, (ii) a group, in the Periodic Table? (6)
   How does the electronic structure change from one element to the next within a group in the Periodic Table? (6)
   What is meant by the electronegativity of an element? (6)
   Using electronegativity values (Mathematics Tables p. 46) predict the type of bonding present in each of the following compounds.

$$PCl_3, \quad NaBr, \quad NO_2 \qquad (15)$$

(c) Give an example of (i) a linear molecule, (ii) a trigonal planar molecule. What is the bond angle in each case? (18)
   In terms of the electron pair repulsion theory explain why a molecule of methane, CH_4, has a tetrahedral shape. (15)

(d) What does R represent in the equation of state for an ideal gas $PV = nRT$? (6)
   Describe an experiment to find the relative molecular mass of *either* a volatile liquid *or* a gas. (27)