AN ROINN OIDEACHAIS

4614

LEAVING CERTIFICATE EXAMINATION, 1993

CHEMISTRY — ORDINARY LEVEL

MONDAY, 21 JUNE — AFTERNOON, 2.00 to 5.00

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, O = 16, Na = 23, S = 32, Ca = 40, Zn = 65.

Molar volume at S.T.P. = 22·4 l (dm^3).

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

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

(*a*) Write down the electronic configuration (s, p etc.) of potassium.

(*b*) State *Le Chatelier's principle.*

(*c*) Indicate (i) a base, (ii) its conjugate acid, in the following equation:

$$HCl + H_2O \rightarrow H_3O^+ + Cl^-$$

(*d*) What is the pH of 0·001 M H_2SO_4?

(*e*) Write an equilibrium constant expression for:

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

(*f*) What is the systematic (IUPAC) name for $CH_3C(CH_3)_2CH_2CH_3$?

(*g*) Write down the ideal gas equation.

(*h*) What is the oxidation number of chromium in $K_2Cr_2O_7$?

(*i*) What is meant by *electronegativity*?

(*j*) How many molecules are present in 8 g of oxygen gas?

(*k*) What is meant by the *first ionisation energy* of an atom?

(*l*) What volume of hydrogen, measured at S.T.P., is released when 6·5 g of zinc react with hydrochloric acid?

(*m*) A metal **X** is displaced from a solution of one of its salts by metal **Y**. Metal **Z** displaces **Y** from a solution of one of its salts. Place the metals in order of decreasing chemical reactivity.

(*n*) What is meant by *nitrogen fixation*?

(*o*) Draw the structure of the repeat unit in poly(chloroethene) (= polyvinyl chloride). (11 × 6)

2. In an experiment to standardise a solution of sodium hydroxide, a student was provided with the following apparatus and solutions: a pipette, burette, a conical flask, a wash bottle of deionised water, a standard solution of sulphuric acid of known concentration and an indicator solution.

(*a*) Balance the equation for the reaction: (6)

$$NaOH + H_2SO_4 \longrightarrow Na_2SO_4 + H_2O.$$

(*b*) Describe, briefly, the washing/rinsing procedure for the apparatus before starting the titration. (9)

(*c*) Mention two other precautions that should be taken to ensure accuracy when using a pipette. (6)

(*d*) Which solution should be put into the burette? Explain. (6)

(*e*) Name a suitable indicator for the titration and state the colour change which occurs. (6)

(*f*) What is the concentration, in mol l^{-1} (dm^{-3}), of the standard solution of sulphuric acid which contains 4·5 g of the acid in 500 cm^3 of solution? (12)

(*g*) The following table shows the readings obtained when 25·0 cm^3 portions of sodium hydroxide were titrated with the standard solution of sulphuric acid:

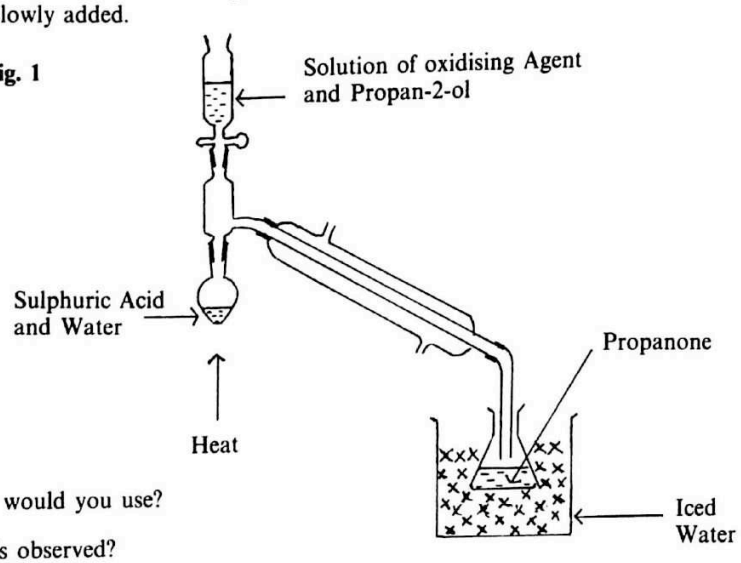
TITRATION	FIRST	SECOND	THIRD
INITIAL READING/cm^3	0·0	20·5	0·0
FINAL READING/cm^3	20·3	40·5	20·0

What was the concentration of the sodium hydroxide solution in (i) mol l^{-1} (dm^{-3}), (ii) g l^{-1} (dm^{-3})? (15)

(*h*) Give one major industrial use for sulphuric acid? (6)

3. Propanone (acetone) may be prepared in the laboratory by the oxidation of propan-2-ol using the apparatus shown in **Fig. 1**. The flask was heated until boiling occurred and then heating was stopped. The mixture in the dropping funnel was then slowly added.

Fig. 1



(i) What oxidising agent would you use? (6)

(ii) What colour change is observed? (6)

(iii) Why is the alcohol mixture added slowly? (6)

(iv) Why was heating stopped before the mixture was added? (6)

(v) The same arrangement of apparatus can be used to prepare ethanal. What would you use instead of propan-2-ol? Name one by-product you would expect. (12)

(vi) How would you arrange the apparatus if preparing ethanoic acid? (6)

(vii) Give the structural formula of propanone. (6)

(viii) Briefly describe appropriate tests to distinguish between samples of ethanal, ethanoic acid and propanone. (18)

4. (*a*) State Hess's Law. (9)

Methanol burns in oxygen according to the equation:

$$CH_3OH + \tfrac{3}{2}O_2 = CO_2 + 2H_2O$$

Calculate the heat of combustion of methanol given the following data:

$$\begin{array}{lllll} C + O_2 & = & CO_2 & \Delta H = -394 \text{ kJ mol}^{-1} \\ H_2 + \tfrac{1}{2}O_2 & = & H_2O & \Delta H = -286 \text{ kJ mol}^{-1} \\ C + 2H_2 + \tfrac{1}{2}O_2 & = & CH_3OH & \Delta H = -239 \text{ kJ mol}^{-1} \end{array}$$ (24)

(*b*) The apparatus shown in **Fig. 2** can be used for an approximate measurement of the heat of combustion of methanol. Give a brief account of this experiment. (12)

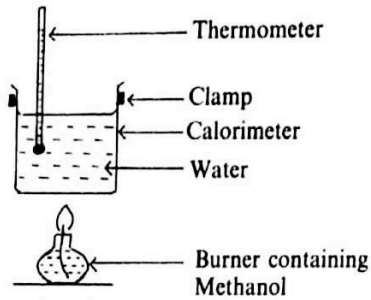


Fig. 2

In such an experiment, 0·05 moles of methanol were burned and the heat produced raised the temperature of 100 g of water by 40 °C.

(i) How much heat was produced? [Specific Heat Capacity of water = 4 200 J kg^{-1} K^{-1}]. (9)

(ii) Calculate the heat produced by burning 1 mole of methanol (i.e. the heat of combustion).

Suggest one reason why the value of the heat of combustion in (*a*) differs from that measured in (*b*). (12)

5. What is meant by the *rate of a chemical reaction?* (9)

When sodium thiosulphate reacts with hydrochloric acid, a suspension of sulphur is produced:

$$Na_2S_2O_{3(aq)} + 2HCl_{(aq)} = S_{(s)} + 2NaCl_{(aq)} + SO_{2(g)} + H_2O_{(l)}$$

50 cm^3 of sodium thiosulphate solution was placed in a conical flask. An X was drawn on a piece of paper underneath the flask. An excess of hydrochloric acid was added to the flask and the temperature taken. The time taken for the X to disappear (= "reaction time") was noted. The experiment was repeated at different temperatures and the following results were obtained:

Temperature/°C	20	30	40	50	60
Reaction Time/s	330	210	135	90	55

(i) Plot a graph of time against temperature. (9)

(ii) From the graph determine the "reaction time" at 35 °C. (6)

(iii) If the "reaction time" was 2 minutes, at what temperature did the reaction take place? (6)

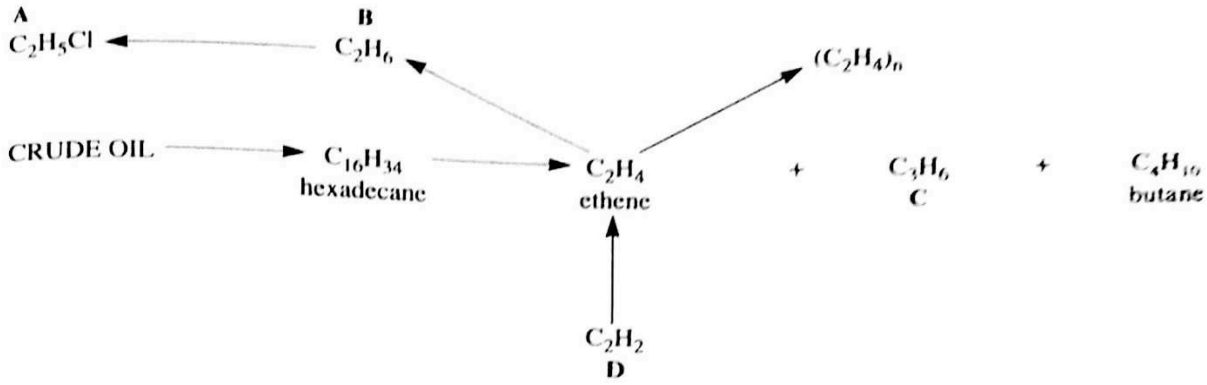
(iv) Explain the following symbols which appear in the given equation: (aq), (s), (g), (l). (12)

(v) What conclusion do you draw from the graph about the relationship between temperature and reaction rate. (9)

(vi) What reaction time would you expect at 30 °C, if the concentration of thiosulphate was doubled. (6)

(vii) Sketch the graph you would expect to obtain when the concentration of the thiosulphate solution is plotted against reaction rate. (9)

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



(*a*) From the compounds labelled **A, B, C** and **D** name (i) an alkane, (ii) an alkyne, (iii) a chloroalkane, and give the structural formula of each. (18)

(*b*) Explain the following terms and give an example of each from the reaction scheme above: (i) unsaturated compound, (ii) substitution reaction, (iii) polymerisation reaction. (18)

(*c*) What is a homologous series? Write down two compounds, from the above scheme, which belong to the same homologous series. (9)

(*d*) What are isomers? Write down the structural formulae of a branched isomer of C_4H_{10}. (6)

(*e*) How are products such as hexadecane obtained from crude oil? (6)

(*f*) *Outline* a laboratory preparation of **D**. (9)

7. (*a*) The following is an account of the extraction of iron from iron ore in the blast furnace.

Iron ore and substances **A** and **B** are fed into the top of the furnace. **A** burns to form carbon dioxide which reacts, higher up the furnace, with more of **A** to form **C**. **C** is the main reducing agent which converts the oxide ore to **D**. **B** decomposes in the blast furnace to form **E** and carbon dioxide. **E** reacts with impurities to form **F**.

(i) Name five of the substances represented by the letters **A, B, C, D, E** and **F**. (15)

(ii) How is iron converted to steel? (12)

(iii) State the conditions which promote rusting and mention one way to prevent the rusting of steel structures. (9)

(*b*) Copper is extracted from its ore by roasting. The resulting impure copper can then be refined by electrolysis using apparatus such as is shown in **Fig. 3.**

(i) What electrolyte is used? (6)

(ii) What material is used for the (*a*) anode, (*b*) cathode? (6)

(iii) Write equations for the reactions occurring at each of the electrodes. (12)

(iv) At which electrode does reduction take place? (6)

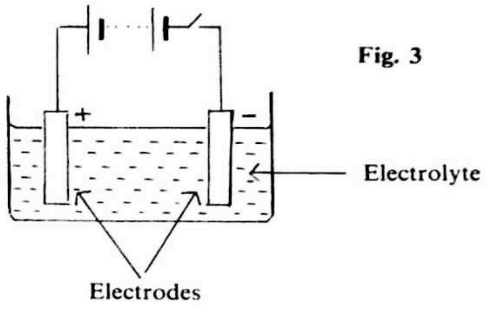


Fig. 3

8. (*a*) Answer the following question with reference to the six elements (*a*) to (*f*) in the section of the Periodic Table shown below. (Refer to Mathematical Tables p. 44).

									1	2							
3	4											5	6	7	8	9 (a)	10 (b)
11 (c)	12											13 (d)	14	15	16 (e)	17	18
19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35 (f)	36

(i) Which element is stored under oil?

(ii) Which element is a noble gas?

(iii) Which element forms a tripositive ion (M^{3+})?

(iv) Which is the element whose oxides are a major cause of acid rain?

(v) Which element may be used to disinfect a domestic water supply?

(vi) Which element is added to water to prevent tooth decay? (18)

(*b*) One of the six elements has a red-brown colour, a melting point of $-7\ ^{\circ}C$ and a boiling point of $59\ ^{\circ}C$. In solution it loses its colour when it reacts with certain organic compounds.

(i) What structural feature do these organic compounds have in common?

(ii) Name the element.

(iii) In what state is this element found at room temperature?

(iv) Write down the formula of the compound formed when this element combines with lead. What is the bond type for this compound?

(v) What are the products at the cathode and at the anode, when the compound at (iv) is electrolysed. (36)

(*c*) How do the values of atomic radii vary from (i) left to right across a period, (ii) top to bottom down a group? Give one reason, in each case, to explain these trends. (12)

9. (*a*) State the types of bonds and the types of crystals that are found in sodium chloride and iodine. (18)

(*b*) Explain how the following *three* properties help to show whether a compound is ionic or covalent:

(i) melting point, (ii) solubility in water, (iii) ability to conduct electricity. (18)

(*c*) Draw labelled diagrams to show the structures of diamond and graphite. In terms of their structures, explain why:

(i) graphite is soft but diamond is hard,

(ii) graphite conducts electricity but diamond does not. (18)

(*d*) Assign shapes to any *two* of the following molecules using the electron pair repulsion theory:

H_2O BeH_2 BF_3.

Justify your answer in each case. (12)

10. Answer any **two** of the following (*a*), (*b*), (*c*), (*d*):

(*a*) Nitric acid is an important industrial chemical.

(i) Describe how it is manufactured from ammonia.

(ii) Give the name of a fertiliser made from nitric acid and indicate how it is made, giving an equation.

(iii) Explain why inorganic fertilisers cause water pollution. (33)

(*b*) Write a note on the primary, secondary and tertiary treatment of sewage.

A town of 1 000 people discharges raw sewage into a river containing 10 p.p.m. of oxygen. The average daily sewage from one person requires 60 g of oxygen from the water.

(i) How many mg of oxygen are present in each litre (dm^3) of river water?

(ii) What is the total oxygen demand of the town's sewage in kg.

(iii) How many litres of water are completely deoxygenated by the town's sewage output? (33)

(*c*) Calcium (0·80 g) reacts with oxygen (0·32 g) to give a compound **X** which has a relative molecular mass of 56.

Answer (i) to (v) below showing your calculations.

(i) How many moles of calcium reacted?

(ii) How many moles of oxygen reacted?

(iii) In what molar ratio did calcium and oxygen combine?

(iv) What is the formula of the compound **X**? What type of bonding would you expect?

(v) What type of oxide is **X**?

(v) Give examples of *three* other types of oxides? (33)

(*d*) A school ordered five compounds, all of which were solids and soluble in water. When the order was delivered the labels were missing. The delivery should have contained a nitrate, a carbonate, a sulphate, a sulphite and a chloride. All compounds were either the sodium or the potassium salt.

Describe the tests you would use to identify the five compounds. (33)