AN ROINN OIDEACHAIS

LEAVING CERTIFICATE EXAMINATION, 1996

6452

CHEMISTRY — ORDINARY LEVEL

MONDAY, 17 JUNE — AFTERNOON 2.00 to 5.00

Question 1 and **five** other questions must be answered.

These five *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, K = 39, Ca = 40.

Molar volume at STP = 22.4 dm^3. Avogadro constant = 6×10^{23} mol^{-1}.

1. Answer *eleven* of the following items (*a*), (*b*), (*c*), etc. All items carry the same number of 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) What is meant by *the relative atomic mass* of an element?

(c) A solution contains 0.1 g of calcium hydrogencarbonate per litre (dm^3). What is the concentration of the solution in parts per million (p.p.m.)?

(d) Write down the structural formula of 2,2–dimethylpropane.

(e) What is the pH of a 0.1 M solution of sodium hydroxide?

(f) Define the *heat of neutralisation* of a substance

(g) How would an increase in pressure effect the equilibrium position of $N_2 + 3H_2 \rightleftharpoons 2NH_3$?

(h) What volume of ethanol is present in 1 litre (dm^3) of wine which containes 12 % of ethanol by volume?

(i) Write down the ideal gas equation.

(j) Give an example of (i) a pyramidal shaped molecule and, (ii) a trigonal planar molecule.

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

(l) Write the equilibrium constant expression for $H_2 + I_2 \rightleftharpoons 2HI$.

(m) How many molecules are present in 4.0 g of hydrogen gas?

(n) Give the name and a possible source of a gas which causes atmospheric pollution.

(o) If a strip of magnesium were added to copper(II) sulphate solution, what would be seen to happen?

(11 x 6)

2. A student prepared a saturated aqueous solution of calcium hydroxide in the laboratory. When titrated with 25.0 cm^3 portions of 0.1 M hydrocholoric acid, using methyl orange indicator, the following results were obtained:

TITRATION	1	2	3
Volume of calcium hydroxide/cm^3	15.5	15.0	15.0

The equation for the reaction is: $Ca(OH)_2 + 2HCl = CaCl_2 + 2H_2O$

(a) A burette, pipette and conical flask were used in the titration. State the correct washing procedures for each of these items before starting the titration. (18)

(b) Calculate the concentration of the calcium hydroxide solution in (i) mol l^{-1} (dm^{-3}) and (ii) g l^{-1} (dm^{-3}). (15)

(c) State the colour change expected at the end point. (6)

(d) By what name is the calcium hydroxide solution commonly known? State one common use it is put to in laboratory analysis. Describe what you would see when it is used for this purpose. (9)

(e) Suggest an approximate value for the pH of the calcium hydroxide solution. (6)

(f) An aqueous solution of calcium chloride is the product of this neutralisation.

(i) What type of hardness does this solution exhibit? (3)

(ii) Describe how this type of hardness could be removed? (9)

3. To prepare a sample of ethanoic acid, a solution of ethanol in water was added to an oxidising mixture in a flask. The contents of the flask were then heated gently for 20 minutes (**Fig. 1**) using a waterbath. The ethanoic acid was recovered from the reaction mixture by distillation.

(i) Name a suitable oxidising mixture for this reaction. (9)

(ii) What is the purpose of the reflux condenser? How should it be connected to the cold water tap? (12)

(iii) Why should the ethanol solution be added in small amounts and the flask cooled after each addition? (6)

(iv) Draw a sketch of the apparatus showing the water bath in position. (6)

(v) Describe the colour change which takes place during the reaction. (6)

(vi) Sketch the experimental arrangement used for carrying out the distillation. (9)

(vii) Name one impurity that might have been present in the distilled product. (6)

(viii) Write an equation for any reaction of ethanoic acid and name any products formed. (12)

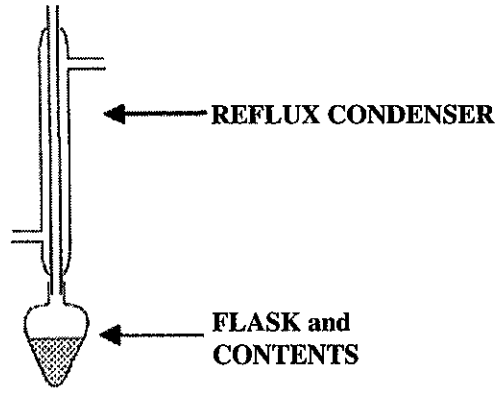

Fig. 1

4. In an experiment, 25 cm^3 of 1 M hydrochloric acid were added to an excess of marble chips using the apparatus shown in **Fig. 2**. The total mass of the flask and contents was noted at time intervals and the experimental readings are shown in the following table:

Time/minute	0.0	0.5	1.0	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0
Mass/g		159.5	159.38	159.3	159.24	159.17	159.14	159.12	159.11	159.1	159.1
Loss in mass/g	0.0	0.16	0.28	0.35	0.42	0.49	0.52	0.54	0.55	0.56	0.56

(i) The table has one blank space corresponding to the mass of the flask and contents at the start of the experiment. What is it value? (6)

(ii) Why was a cotton wool plug used? (6)

(iii) Why did the mass of the flask and contents decrease during the experiment? (6)

(iv) Using graph paper, plot a graph of loss in mass agains time. (12)

(v) After what time was the reaction half way to completion? (6)

(vi) What mass of carbon dioxide had been evolved after 8.0 minutes? What volume would this mass of gas occupy at STP? (12)

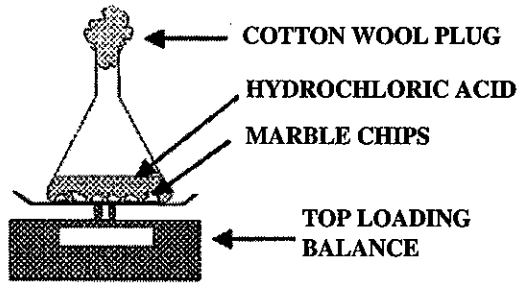

Fig. 2

(vii) The graph obtained would have been different if (a) the concentration of hydrochloric acid were greater or (b) if larger marble chips had been used. In the case of either (a) or (b), sketch the shape of the graph you might expect to obtain and state one way in which it differs from that in (iv) above. (12)

(viii) Why did the reaction cease? (6)

5. (a) In an experiment, a student burned 4.6 g (0.1 moles) of ethanol and discovered that 135.2 kJ of heat were liberated. The reaction carried out is represented by the equation

$$C_2H_5OH + 3O_2 = 2CO_2 + 3H_2O$$

Using this information, calculate:

(i) the heat combustion of ethanol. (6)

(ii) the kilogram calorific value of ethanol. (12)

Describe, with the aid of a diagram, how this experiment might have been carried out. (12)

(b) Define (i) Hess's law, (ii) Heat of formation. (12)

Calculate the heat of formation of ethanol given by the equation:

$$2C + 3H_2 + {}^1/_2O_2 = C_2H_5OH$$

using the the heat of combustion value calculated in part (*a*) above together with the following equations:

$C + O_2 = CO_2$ $\quad \Delta H = -393\ kJ\ mol^{-1}$

$2H_2 + O_2 = 2H_2O$ $\quad \Delta H = -572\ kJ\ mol^{-1}$ (24)

OVER➡

6. Answer the following questions with reference to the seven elements labelled **(k)** to **(q)** in the part of the Periodic Table shown below:

							1 **(k)**	2				5	6	7	8	9	10 **(l)**
3	4																
11	12											13	14	15 **(m)**	16	17 **(n)**	18
19 **(o)**	20	21	22	23	24 **(p)**	25	26 **(q)**	27	28	29	30	31	32	33	34	35	36

(*a*) Write down the electonic configuration (s, p etc.) of element **(o)**. (6)

(*b*) Which elements are non-metals? (6)

(*c*) Write down the element whose simplest atom contains no neutrons. (6)

(*d*) Which two elements combine in the ratio 1:5? (6)

(*e*) Which elements form coloured compounds? (6)

(*f*) Which elements are in the fourth period? (6)

(*g*) Write down the formula of a compound with a high melting point. (6)

(*h*) Write down the formula of a gaseous compound. (6)

(*i*) By referring to the compounds chosen in part **(g)** and **(h)** above, state:

(i) the type of bonding present in each compound. (6)

(ii) one property of each compound not already mentioned. (6)

(iii) what happens to the outer electrons of each atom in each compound when it is formed. (6)

7. (*a*) **Fig. 3** shows alkanes as a source of ethene and some of the compound's reactions.

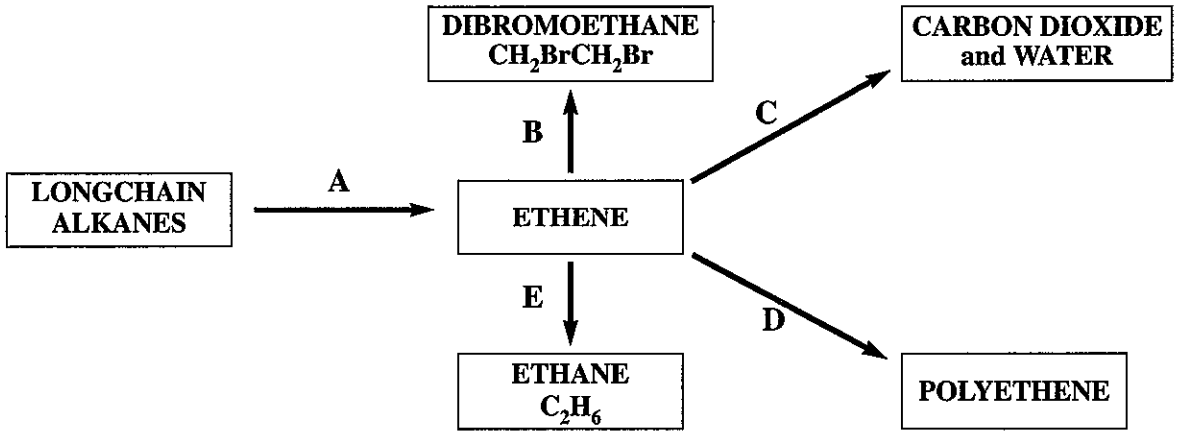

Fig. 3

(i) What name is given to the type of reaction **A** in which long chain alkanes are broken down into shorter chain alkanes and alkenes such as ethene? (6)

(ii) A different name is used to describe each of the reaction types **B**, **C** and **D**. Give the name in each case. (18)

(iii) What reagent would you use to carry out reaction **B** and what would you see during the reaction? (9)

(iv) What reagent and catalyst would you use to carry out reaction **E**? Is heating required? (15)

(*b*) (i) Describe, with the aid of a sketch, the laboratory preparation of ethanal or propanone. (12)

(ii) Describe a chemical test which can be used to distinguish ethanal from propanone. (6)

8. (a) Two industrial processes, the Haber Process and the Contact Process, are shown in **Fig. 4**. Raw materials, nitrogen for the Haber Process and oxygen for the Contact Process, are each obtained from air. Substance **B**, from the Haber Process, and sulphuric acid, from the Contact Process, react to form substance **D**.

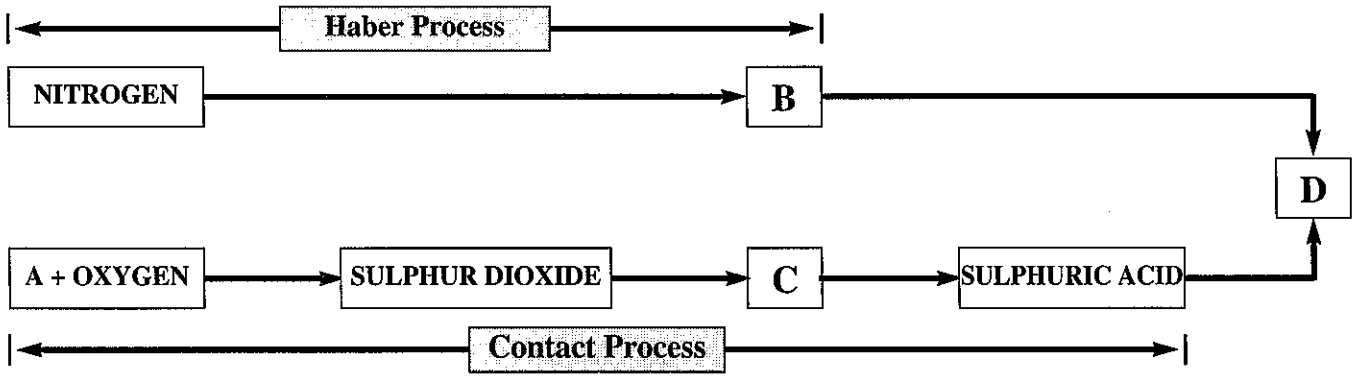

Fig. 4

(i) Explain, briefly, how oxygen and nitrogen are separated from air. (3)

(ii) Name a source for the hydrogen required in the Haber process. (3)

(iii) Name the substances represented by **A, B, C** and **D**. (24)

(iv) Name the catalyst used in (i) the Haber process and (ii) the Contact process. (6)

(b) **Fig. 5** shows a Blast furnace used for the production of iron.

(i) Limestone is one of the substances added to the furnace at **E**. Name the two other solids. (6)

(ii) What is pumped into the furnace at **X**. (6)

(iii) Name the substance that collects at **A**. (6)

(iv) Name the substance that collects at **B**. (6)

(v) Three important reactions involving carbon and carbon compounds occur in the furnace. The equations for the first two are shown. The third reaction, the reduction of the iron ore, occurs at **D** on the diagram. Write an equation for this reaction. (6)

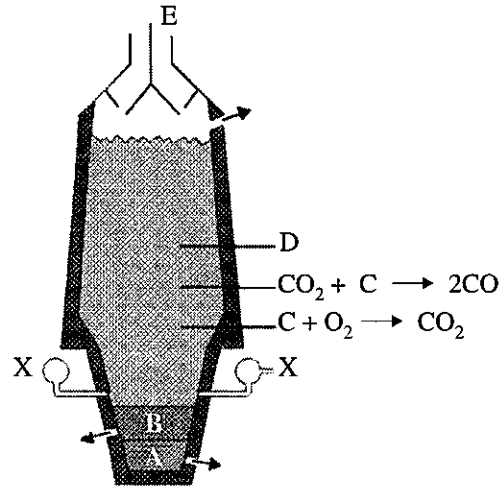

Fig. 5

9. (a) Write down in your answer book the missing words, phrases or formulae in the following passage:

The chemical formula for water is ___(1)___. The water molecule is polar due to an ___(2)___ difference between the oxygen atom and the hydrogen atoms. The shape of the water molecule is ___(3)___. The crystalline structure of water (i.e. ice) is ___(4)___. Water's melting point and boiling point are higher than expected due to the existence of ___(5)___ bonding between its molecules. Hard water is caused by the presence of ___(6)___ ions in solution. When water is acidifed, with dilute sulphuric acid, and electrolysed using intert electrodes, the product at the cathode is ___(7)___. Electrolysis is a redox reaction with reduction, which is a ___(8)___ of electrons, taking place at the ___(9)___ electrode. Water is classified as an ___(10)___ oxide. Pure water has a pH of ___(11)___.

(11 x 3)

(b) Outline the treatments carried out on water to make it fit for human consumption. (21)

(c) The following reaction takes place in water:

$$H_2O_{(\ell)} + NH_{3(aq.)} \rightleftharpoons NH^+_{4(aq.)} + OH^-_{(aq.)}$$

In terms of the Bronsted-Lowry theory, indicate the acid, the base, the conjugate acids and the conjugate bases in the above equation. (4 x 3)

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

(*a*) Write down one word for each of the following:

(i) Different atoms of the same element with the same number of protons but different numbers of neutrons in their nuclei.

(ii) the element which gives a characteristic yellow colour to a bunsen flame.

(iii) the hydrocarbon which is the main constituent of natural gas.

(iv) different structural forms of the same element which exist in the same physical state.

(v) compounds with the same molecular formula but different structural formulae.

(vi) enrichment of water by nutrients resulting in deoxygenation of the water.

(vii) the separation of a solid from a liquid.

(viii) the colour of litmus in acid solution.

(ix) a method of separation of the coloured substances present in an ink.

(x) the type of crystalline structure found, for example, in iodine.

(xi) an organic compound produced by a fermentation process. (11 x 3)

(*b*) A hydrocarbon has an empirical formula CH and its relative molecular mass is 78.

(i) Write down the molecular structure and the structural formula of the hydrocarbon. (9)

(ii) Name the hydrocarbon. (6)

(iii) State whether the hydrocarbon is aliphatic or aromatic. (6)

(iv) This hydrocarbon reacts with oxygen as shown by the equation

$$\textbf{Hydrocarbon} + 7^1/_2O_2 = 6CO_2 + 3H_2O$$

What mass of the hydrocarbon would be needed to produce 22.4 litres (dm^3) of carbon dioxide? What mass of water would be produced at the same time? (12)

(*c*) Three fertilizers **A, B** and **C** were incorrectly labelled but were known to be ammonium sulphate $(NH_4)_2SO_4$, ammonium nitrate NH_4NO_3 and potassium chloride **KCl**. The following tests were carried out in order to identify **A, B** and**C**.

TEST	RESULT
Addition of dilute nitric acid followed by acquous silver nitrate to a solution of **A**	White precipitate formed.
Addition of iron(II) sulphate followed by conc. sulphuric acid to a solution of **C**.	Brown ring formed.
Addition of dilute hydrochloric acid followed by barium chloride solution to a solution of **B**	White precipitate formed.

(i) Identify the fertilizers **A, B** and **C**. (9)

(ii) Which of the fertilizers are nitrogenous fertilizers? (6)

(ii) Show, by calculation, which of the fertilizers has the greatest percentage of nitrogen. (12)

(iv) A compound fertilizer is marked 7:6:17. What does this information mean? (6)

(d) Describe a laboratory experiment to determine either the relative molecular mass of a volatile liquid or the chemical formula of a named compound. (33)