AN ROINN OIDEACHAIS AGUS EOLAÍOCHTA

LEAVING CERTIFICATE EXAMINATION, 1999

CHEMISTRY — ORDINARY LEVEL

TUESDAY, 22 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.
Question 1 carries a total of 70 marks. All other questions carry a total of 66 marks each.

Relative atomic masses: C = 12, O = 16, Na = 23, S = 32.
Molar volume at STP = 22.4 litres (dm^3).
Avogadro constant = 6 x 10^{23} mol^{-1}.

1. Answer *eleven* of the following items (a), (b), (c), etc. All items carry the same number of marks. However, one additional mark will be given to each of the first four items for which the highest marks are obtained.
   Keep your answers short.

   (a) What element has the following electronic configuration $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^1$?

   (b) Name one scientist who contributed to the development of the Periodic Table.

   (c) What is *an atomic orbital*?

   (d) Give the name and formula of a basic oxide.

   (e) What process is used to convert long chain hydrocarbons to short chain hydrocarbons?

   (f) What is the oxidation number of manganese in $KMnO_4$?

   (g) How would you confirm the presence of chloride ions in aqueous solution?

   (h) What is the pH of a 0.10 M solution of sodium hydroxide?

   (i) Write the equilibrium constant expression for: $\mathbf{H_2}\ +\ \mathbf{I_2}\ \rightleftharpoons\ \mathbf{2HI}$

   (j) Write down the conjugate base of (i) $\mathbf{H_2O}$, (ii) $\mathbf{H_3O^+}$.

   (k) Give an example of (i) a linear molecule, (ii) a trigonal planar molecule.

   (l) Define (i) oxidation, (ii) reduction, in terms of electron transfer.

   (m) A solution contains 20 mg of solute in 100 cm^3 of solution.
   Express this concentration in parts per million (p.p.m.).

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

   (o) Give the systematic (IUPAC) name for: $\mathbf{CH_3}$ —— $\mathbf{CH}$ —— $\mathbf{CH_3}$
   $$\mathbf{CH_3}$$

(70)

2. A student used a standard 0.10 mol litre^{-1} (mol dm^{-3}) solution of sodium carbonate to determine the concentration of a solution of sulphuric acid. Three titrations were carried out using 25.0 cm^3 portions of the sodium carbonate solution.

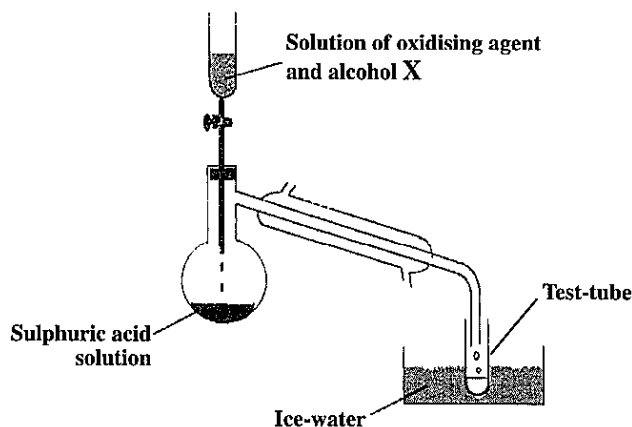The volumes of sulphuric acid used in the titrations were:

Titration	1	2	3
Volume/cm^3	20.5	20.1	20.1

The equation for the neutralisation of sodium carbonate by sulphuric acid is:

$$Na_2CO_3 + H_2SO_4 \rightarrow Na_2SO_4 + H_2O + CO_2$$

(i) What is meant by (a) a standard solution, (b) neutralisation? (12)

(ii) What piece of equipment should the student have used to measure the portions of the sodium carbonate solution? List two precautions which should be taken when using this piece of equipment. (15)

(iii) Name the piece of equipment the student should have used to add the sulphuric acid during the titration. What is the procedure for washing and filling this piece of equipment before use in the titration? (15)

(iv) Name a suitable indicator for the titration and state the colour change at the end-point. (9)

(v) What mass of anhydrous sodium carbonate, Na_2CO_3, is required to prepare 1 litre (1 dm^3) of 0.10 mol litre^{-1} (mol dm^{-3}) sodium carbonate solution? (6)

(vi) Calculate the concentration of the sulphuric acid in the solution in mol litre^{-1} (mol dm^{-3}). (9)

3. Ethanal can be prepared using the apparatus shown in the diagram.

(i) Give the name and the structural formula of the alcohol, X, from which ethanal is prepared. (9)

(ii) Write down the structural formula of ethanal. To what family of organic compounds does ethanal belong? (9)

(iii) Name a suitable agent for the oxidation of alcohol X to ethanal.

What is the colour of the mixture in the reaction flask after the reaction? (9)

(iv) Why is the test-tube cooled in ice-water? (6)

(v) Ethanal is easily oxidised. What is the name of the organic compound formed when ethanal is oxidised? Write down the structural formula of the compound formed. (12)

(vi) Propanone may also be obtained by the oxidation of an alcohol. Name this alcohol and write down its structural formula. (12)

(vii) Describe a chemical test to distinguish between ethanal and propanone. (9)

4. In an experiment to investigate the rate at which hydrogen gas was produced, zinc granules were reacted with excess dilute hydrochloric acid. The following readings were taken during the experiment:

Time/minutes	0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5
Vol. of H_2/cm^3	0	26	44	58	68	76	82	86	88	88

(i) Draw a sketch of a suitable apparatus for carrying out this experiment. (12)

(ii) Plot a graph of the volume of hydrogen (y-axis) against time. (15)

(iii) Use your graph to determine (a) the volume of hydrogen produced after 1.25 minutes,

(b) the time taken for 30 cm^3 of hydrogen to be produced. (12)

(iv) Using the graph, find the volume of gas produced in the first fifteen seconds and hence calculate the average rate (in cm^3/second) of gas production over the first fifteen seconds. (9)

(v) Indicate on the same sheet of graph paper the curve you might expect if the experiment were repeated using the same mass of zinc, but with excess hydrochloric acid of greater concentration. (6)

(vi) If the experiment were repeated using powdered zinc instead of granules, state the effect this would have on the rate of reaction. Give a reason for you answer. (12)

5. Answer the following items with reference to the eight elements indicated by the letters (a) to (h) in the section of the Periodic Table shown below. (Mathematics Tables p 44).

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

(a) Name (i) two elements from the same group,

(ii) two elements from the same period, of the Periodic Table. (12)

(b) Give the electronic configurations of the elements (c) and (h). (12)

(c) Name (i) a halogen, (ii) a transition metal.

State one characteristic property of transition metals. (9)

(d) Write down the name of

(i) the metal often used in street lights;

(ii) the non-metal often used in illuminated advertising signs;

(iii) the non-metal often used in making electronic devices. (9)

(e) Describe, using a diagram, the arrangement of electrons in the simplest compound formed between hydrogen and the element (a). What is the shape of this molecule? (12)

(f) What is meant by *electronegativity*?

Use electronegativity values (Mathematics Tables p 46) to predict the type of bonding that occurs between the elements (c) and (f). Give a reason for your answer. (12)

OVER➡

6. (a) A sample of tap water is found to contain both calcium hydrogencarbonate and calcium sulphate. These compounds cause *hardness* in water.

    (i) What is meant by *hardness* in water?

        Distinguish between *temporary* and *permanent* hardness.   (9)

    (ii) Which of the two compounds named above gives rise to temporary hardness?

        Write the chemical formula of this compound. Give a chemical equation showing how the compound can be removed from the water sample.   (15)

    (iii) How is permanent hardness removed?   (6)

    (iv) Give <u>one</u> advantage and <u>one</u> disadvantage of hard water.   (6)

(b) Water treatment can be divided into a number of stages. State the purpose of each of the following:

    (i) flocculation;

    (ii) pH adjustment;

    (iii) chlorination;

    (iv) fluoridation;

    (v) filtration.   (30)

7. (a) The formulae of three organic compounds are given in the reaction scheme below:

$$C_2H_4 \longrightarrow C_2H_6$$
$$A \qquad \qquad B$$
$$C_2H_5Cl$$
$$C$$
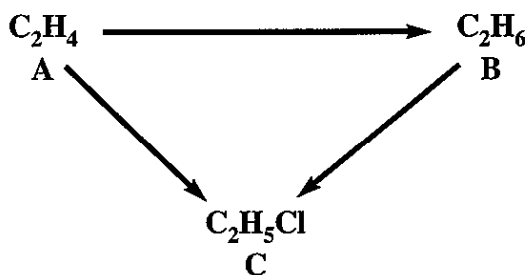
Name each of the compounds A, B and C.   (9)

State how

    (i) compound A may be converted to compound B,

    (ii) compound A may be converted to compound C,

    (iii) compound B may be converted to compound C.   (18)

(b) Describe, with the aid of a diagram, the preparation of compound A in the laboratory.   (12)

What is observed when compound A is bubbled through a solution of bromine?

Give an equation for this reaction.   (9)

What is the name of the polymer formed from compound A?

Give <u>one</u> use of this polymer.   (6)

(c) When compound B is burned in excess oxygen, carbon dioxide and water are formed.

What test could be carried out to show that carbon dioxide is produced?

State the observation made in the test.

Write a balanced equation for the combustion of compound B.   (12)

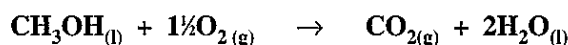**8.** Define (i) heat of combustion, (ii) kilogram calorific value. (12)

(a) The apparatus shown on the right can be used in an experiment to measure the heat of combustion of methanol. Give a brief account of this experiment. (15)

This experiment does not give an accurate result for the heat of combustion of methanol. Suggest <u>one</u> reason for this. (6)
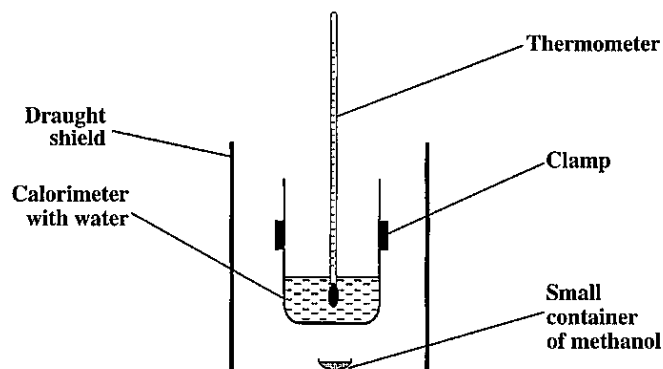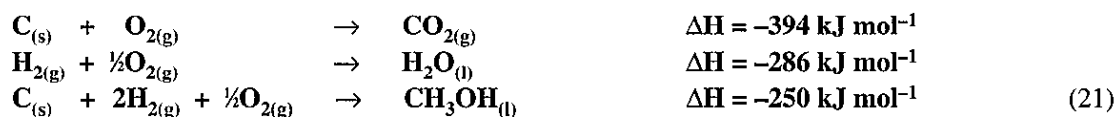

(b) State *Hess's law.* (6)

Methanol burns in oxygen according to the equation:

$$CH_3OH_{(l)} + 1\tfrac{1}{2}O_{2\,(g)} \rightarrow CO_{2(g)} + 2H_2O_{(l)}$$

Use the following heat of formation data to calculate the heat of combustion of methanol.

$$C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)} \qquad \Delta H = -394 \text{ kJ mol}^{-1}$$
$$H_{2(g)} + \tfrac{1}{2}O_{2(g)} \rightarrow H_2O_{(l)} \qquad \Delta H = -286 \text{ kJ mol}^{-1}$$
$$C_{(s)} + 2H_{2(g)} + \tfrac{1}{2}O_{2(g)} \rightarrow CH_3OH_{(l)} \qquad \Delta H = -250 \text{ kJ mol}^{-1} \qquad (21)$$

From the heat of combustion of methanol calculated above find the kilogram calorific value for methanol (relative molecular mass = 32). (6)

9. What is *nitrogen fixation*? State <u>one</u> way in which nitrogen is fixed in nature. (9)

(a) Ammonia can be made from nitrogen and hydrogen using the Haber Process.

   (i) What is the main source of nitrogen gas for the Haber Process? (6)

   (ii) Name the main source of hydrogen gas for the Haber Process. (6)

   (iii) Write a balanced chemical equation for the production of ammonia from nitrogen and hydrogen. (9)

   (iv) What is a catalyst? Name the catalyst used in the Haber Process. (12)

(b) Ammonia may be converted to nitric acid. Both ammonia and nitric acid are used in the manufacture of fertilisers.

   (i) The first step in converting ammonia to nitric acid involves burning the ammonia over a metal gauze catalyst. What two metals make up this gauze? (6)

   (ii) Ammonia reacts with nitric acid to form ammonium nitrate. Write an equation for this reaction. (6)

   (iii) The brown ring test is used as a test for nitrate ions in solution. Name the reagents used in the brown ring test and describe how to carry out this test. (12)

OVER→

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

(*a*) (i) Write the chemical formula for iron(III) oxide. (3)

(ii) Give the chemical name and formula for limestone. (6)

(iii) Apart from iron ore and limestone what other substance is added at the top of a Blast Furnace? (3)

(iv) What is the name and the formula of the gas which reduces the iron oxide to iron in a Blast Furnace? Write an equation for the reduction of the iron oxide to iron by this gas. (12)

(v) What is an alloy? Apart from iron what is the other essential element present in steel? (9)

(*b*) The following elements or compounds are omitted from the passage below:

copper, copper sulphate, sodium, sodium hydroxide, sodium sulphate, zinc, zinc sulphate

Write down in your answer book the appropriate missing element or compound corresponding to each of the numbers 1 to 11.

When a piece of _____(1)_____ is added to cold water a violent reaction occurs in which hydrogen gas is evolved. If the water contains a little red litmus the colour of the litmus changes to blue as this reaction proceeds. The substance produced which gives rise to this colour change is _____(2)_____.

When _____(3)_____ is added to cold water no reaction occurs but it does react with steam to produce hydrogen gas and a metal oxide. No reaction occurs between the metal _____(4)_____ and cold water or steam. The reaction of _____(5)_____ with dilute sulphuric acid is so vigorous that it should not be attempted in a school laboratory. The salt produced in this reaction is _____(6)_____.

When zinc powder is added to a solution of _____(7)_____ a reddish-brown precipitate of _____(8)_____ is produced and the salt _____(9)_____ is formed. Of the three metals listed above, _____(10)_____ occupies the highest position in the electrochemical series and _____(11)_____ the lowest position in the electrochemical series. (11 x 3)

(*c*) Sodium sulphite reacts with dilute hydrochloric acid according to the equation:

$$Na_2SO_3 + 2HCl \rightarrow 2NaCl + SO_2 + H_2O$$

A mass of 6.3 g of sodium sulphite was reacted with hydrochloric acid according to the above equation.

(i) How many moles of sodium sulphite were used? (9)

(ii) How many moles of hydrochloric acid were needed for complete reaction with the sodium sulphite? (6)

(iii) How many moles of sulphur dioxide were produced in the reaction? What is the volume (measured at STP) of this number of moles of sulphur dioxide? (12)

(iv) How many molecules of sulphur dioxide were produced in the reaction? (6)

(*d*) Sodium chloride, diamond, iodine and graphite are all crystalline solids.

State which of these solids

(i) exists as ionic crystals; (3)

(ii) exists as covalent molecular crystals; (3)

(iii) exist as covalent macromolecular crystals; (2 x 3)

(iv) conducts electricity in the *solid* state; (3)

(v) conducts electricity in the *molten* state; (3)

(vi) is a hard substance, which is used in cutting tools; (3)

(vii) is very soluble in water; (3)

(viii) sublimes easily to give purple vapour; (3)

(ix) are allotropes of the same element. (2 x 3)