SCOTTISH CERTIFICATE OF EDUCATION

CHEMISTRY

Higher Grade—PAPER II

Friday, 16th May—1.30 p.m. to 4.00 p.m.

Candidates are reminded that 4 marks in this paper are allocated for communication skills.

Working should be shown in all answers involving calculations.

Necessary tables and data will be found in the booklets of Mathematical Tables and Science Data (1982 editions).

All questions should be attempted. It should be noted, however, that questions 1 and 5 contain a choice.

It is suggested that about $1\frac{1}{4}$ hours be spent on this part of the paper.

Marks

1. Answer **EITHER** A **OR** B.

    A. An organic compound has the formula $HCOOCH_3$.

        (*a*) Name this compound.   **1**

        (*b*) Write its empirical formula.   **1**

                                            (2)

OR
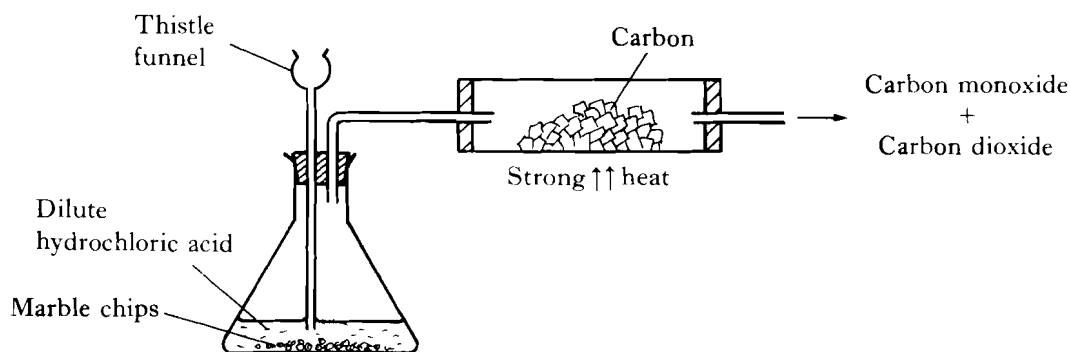
    B. Draw the full structural formula of 2,2,4-trimethylpentane. (**All** bonds must be shown.)   **(2)**

2. A sample of carbon monoxide, contaminated with carbon dioxide, may be obtained as shown below.

Sketch and label **ADDITIONAL** apparatus (and reagents) required to remove the carbon dioxide and collect the carbon monoxide over water.   **(2)**

3. Calculate the volume (at s.t.p.) of oxygen required for the complete combustion of 1 g of ethene.   **(3)**

4. Calculate the number of electrons in 6 g of magnesium (II) ions.   **(3)**

5. Answer **EITHER** A **OR** B.

   A. (*a*) Which type of bonding exists in (i) sulphur;

                                       (ii) aluminium?   **1**

       (*b*) Use the Data Booklet (page 2) to find the melting points of these elements.   **1**

       (*c*) Explain why the melting point of aluminium is high.   **1**

                                        (3)

   OR

   B. (*a*) Which type of bonding exists in (i) sulphur dioxide;

                                       (ii) silicon dioxide?   **1**

       (*b*) Use the Data Booklet (page 9) to find the boiling points of these compounds.   **1**

       (*c*) Explain why the boiling point of sulphur dioxide is low.   **1**

                                        (3)

6. Some fuel cells are based on the fact that electricity can be produced by supplying oxygen and hydrogen to platinum electrodes immersed in sodium hydroxide solution.
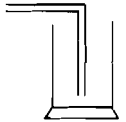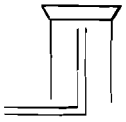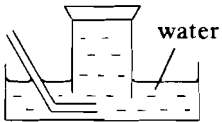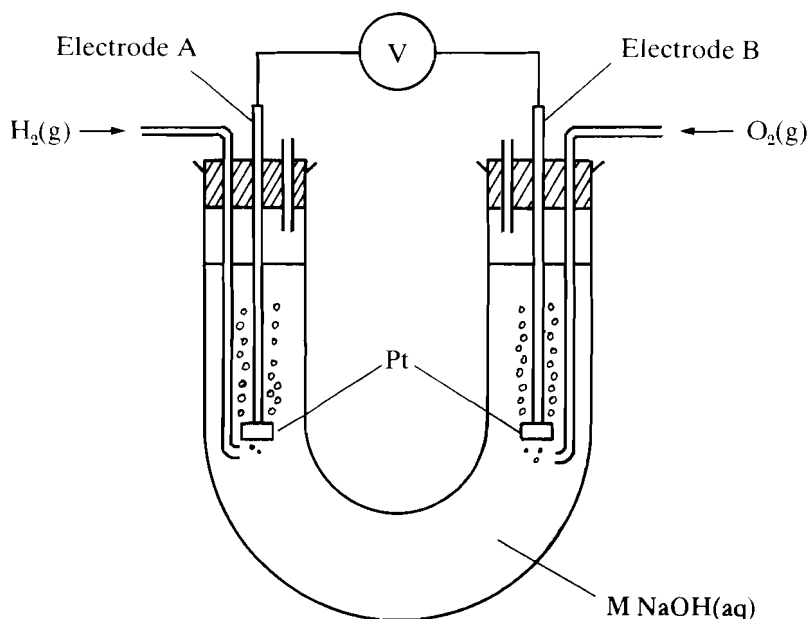

   (*a*) Using the Data Booklet (page 7), write an ion-electron equation for the reaction taking place at (i) electrode A,

                                  (ii) electrode B.   **2**

   (*b*) Calculate the voltage that would be expected from this fuel cell. (Assume standard conditions.)   **1**

                                        (3)

[Turn over

7.

Drying agent	(A) CaO	(B) H_2SO_4

Method of collection	(C)	(D)	(E) water

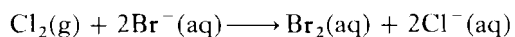For the preparation of a sample of dry ammonia,

(a) select a suitable drying agent and **explain** your choice; 2

(b) select a suitable method of collection and **explain** your choice. 2
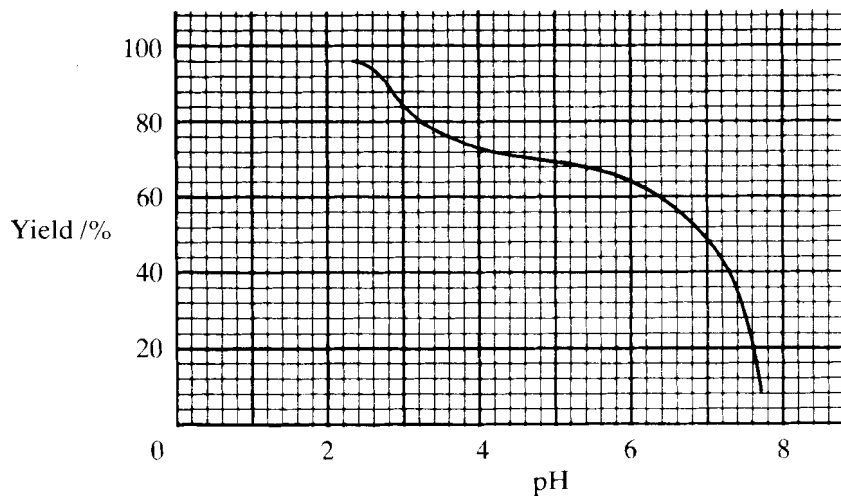
(4)

8. The following equation shows how bromine can be extracted from sea water.

$$Cl_2(g) + 2Br^-(aq) \longrightarrow Br_2(aq) + 2Cl^-(aq)$$

(a) Which type of chemical reaction is represented by this equation? 1

(b) The graph shows the effect of pH on the yield of bromine obtained.

What happens to the yield of bromine as the sea water becomes more acidic? 1

(c) Would chlorine be a suitable reagent for obtaining fluorine from fluoride ions?
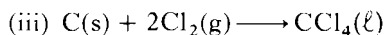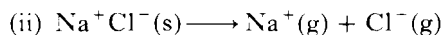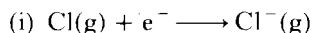**Explain your answer.** 2

(4)

9. The following terms are used in thermochemistry:

Ionisation energy (enthalpy)	Sublimation enthalpy	Electron affinity
Enthalpy of formation	Lattice enthalpy	Dissociation enthalpy

   (a) Which term is associated with each of the following?

      (i) $Cl(g) + e^- \longrightarrow Cl^-(g)$

      (ii) $Na^+Cl^-(s) \longrightarrow Na^+(g) + Cl^-(g)$

      (iii) $C(s) + 2Cl_2(g) \longrightarrow CCl_4(\ell)$ **3**

   (b) Which of the above equations represents an endothermic process?   **1**

          (4)

10. A copper compound was known to contain either copper (I) or copper (II) ions.

The compound was dissolved in water and electrolysed. It was found that $0.32\,g$ of copper was formed after the electrolysis cell had been operating for 16 minutes with a steady current of $1.0\,A$.

   (a) At which electrode would copper have been formed?   **1**

   (b) Using the above information, determine which copper ion was present. **Working must be shown.**   **3**
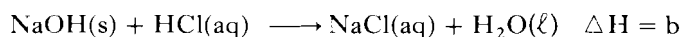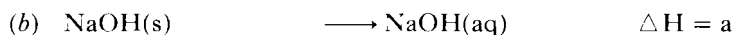
          (4)

11. (a)   (i) What shape are the crystals of both sodium chloride and caesium chloride?   **1**

      (ii) In these crystals, each sodium ion is surrounded by six chloride ions whereas each caesium ion is surrounded by eight chloride ions.

        Describe the lattice arrangement in each of these compounds and explain why they are different.   **2**

   (b) $NaOH(s) \longrightarrow NaOH(aq)$ $\triangle H = a$

      $NaOH(s) + HCl(aq) \longrightarrow NaCl(aq) + H_2O(\ell)$ $\triangle H = b$

      $NaOH(aq) + HCl(aq) \longrightarrow NaCl(aq) + H_2O(\ell)$ $\triangle H = c$

      From the above data, write an equation to show the relationship between a, b, and c.   **2**

          (5)

12. Two isomeric straight-chain alkanols, having four carbon atoms, are known.

   (a) Draw a structural formula for each of these alkanols.   **2**

   (b) Name a reagent which could be used to oxidise each of these alkanols to a carbonyl compound.   **1**

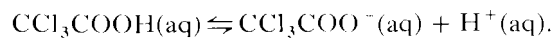   (c) How could the carbonyl compounds be distinguished by a chemical test? State the results of the test.   **2**

          (5)

[Turn over

13.

Acid	pH of 2M aqueous solution
A CCl_3COOH	0·50
B $CHCl_2COOH$	0·90

(a) Which is the stronger acid? **Explain** your choice.   2

(b) Acid A dissociates in water as follows:

$$CCl_3COOH(aq) \rightleftharpoons CCl_3COO^-(aq) + H^+(aq).$$

How would the equilibrium be affected by the addition of

(i) solid NaOH;

(ii) solid NaCl;

(iii) solid CH_3COONa?   3

(c) Explain your answer in the case of solid CH_3COONa.   1

(6)

All four questions should be attempted. It should be noted however that question 17 contains a choice.

Candidates are advised to spend about $1\frac{1}{4}$ hours on this part.

Marks

14. The following are variables which can affect the progress of a chemical reaction.

temperature	light	catalyst	concentration
particle size	stirring	pressure	inhibitor

(a) (i) In the chain reaction between hydrogen and chlorine, which of the above is commonly used to initiate (start) the reaction? — 1

(ii) Explain how this causes the reaction to begin. — 1

(iii) Name the two other stages in a chain reaction. — 1

(b) Which of the above variables will alter the position of equilibrium in the following reaction?

$$N_2(g) + O_2(g) \rightleftharpoons 2NO(g) \quad \triangle H = +90 \, kJ \, mol^{-1}$$ — 2

(c) Explain why reactions involving solids tend to go faster when the solids are finely divided. — 2

(d) A mixture of hydrogen and oxygen does not react at room temperature. When a piece of clean platinum is placed in the mixture, the hydrogen and oxygen react explosively.

(i) Explain why hydrogen and oxygen do not react at room temperature. — 1

(ii) What is the purpose of the platinum? — 1

(iii) Discuss and explain how the platinum functions. — 3

(12)

[Turn over

15. The names or formulae of some compounds are shown in the table below.

The questions which follow are based on the table.

propane	$C_2H_5NH_2$	ethyl propanoate	hex-l-ene
C_2H_5CHO	phenol	C_3H_6	propyne
phenylamine (aniline)	CH_3COCH_3	propan-l-ol	C_6H_6

(*a*) Name the compound with formula C_3H_4.   **1**

(*b*) Which compound is an ester?   **1**

(*c*) Which substances are basic in character?   **2**

(*d*) Select **two** compounds which can be prepared directly (in one step) from propan-l-ol.   **2**

(*e*) Which two compounds are isomers?   **1**

(*f*)   (i) Which chemical (**not** in the table) would be suitable for removing phenol from a sample of benzene contaminated with phenol?   **1**

      (ii) Describe briefly how this would be done in the laboratory.   **1**

(*g*) Discuss any differences in structure or chemical behaviour between benzene (C_6H_6) and hex-l-ene (C_6H_{12}).

Mention three differences apart from the number of hydrogen atoms.   **3**

   **(12)**

16. (*a*) The extraction of phosphorus is similar to that of iron. Calcium phosphate is heated with sand and coke in an electric furnace at about 1500°C. The sand (SiO_2) combines with the calcium phosphate forming slag and phosphorus (V) oxide. The phosphorus (V) oxide is reduced by the coke to phosphorus which is removed from the furnace and stored under water.

   (i) What is the chemical name for the molten slag which forms during the reaction?   **1**

   (ii) Why is it relatively easy to remove the phosphorus from the furnace? (You may wish to consult the Data Booklet.)   **1**

   (iii) Why is the phosphorus stored under water?   **1**

(*b*) Phosphoric acid, (H_3PO_4), is triprotic (tribasic).

   (i) Write correct formulae for **two** of the three calcium salts of this acid.   **2**

   (ii) For **one** of the salts you have chosen, calculate the percentage by mass of phosphorus present.   **2**

(*c*) Phosphorus forms two hydrides PH_3 and P_2H_4.

   (i) 0·152 g of a hydride of phosphorus has a volume of 100 cm^3 at s.t.p.
   Calculate the mass of one mole of the hydride **and** identify it.   **3**

   (ii) Liquid ammonia boils at −33°C but liquid phosphine (PH_3) boils at −87·5°C. Explain this difference in terms of bonding.   **1**

   (iii) Both ammonia and phosphine molecules have the same shape. Draw this shape.   **1**

   (12)

[Turn over

17. Answer **EITHER** A **OR** B.

A. (a) A radioisotope X decays to a stable product as shown in the following graph.

Intensity of radiation (y-axis, 15 to 40)

Time/days (x-axis, 0 to 200)
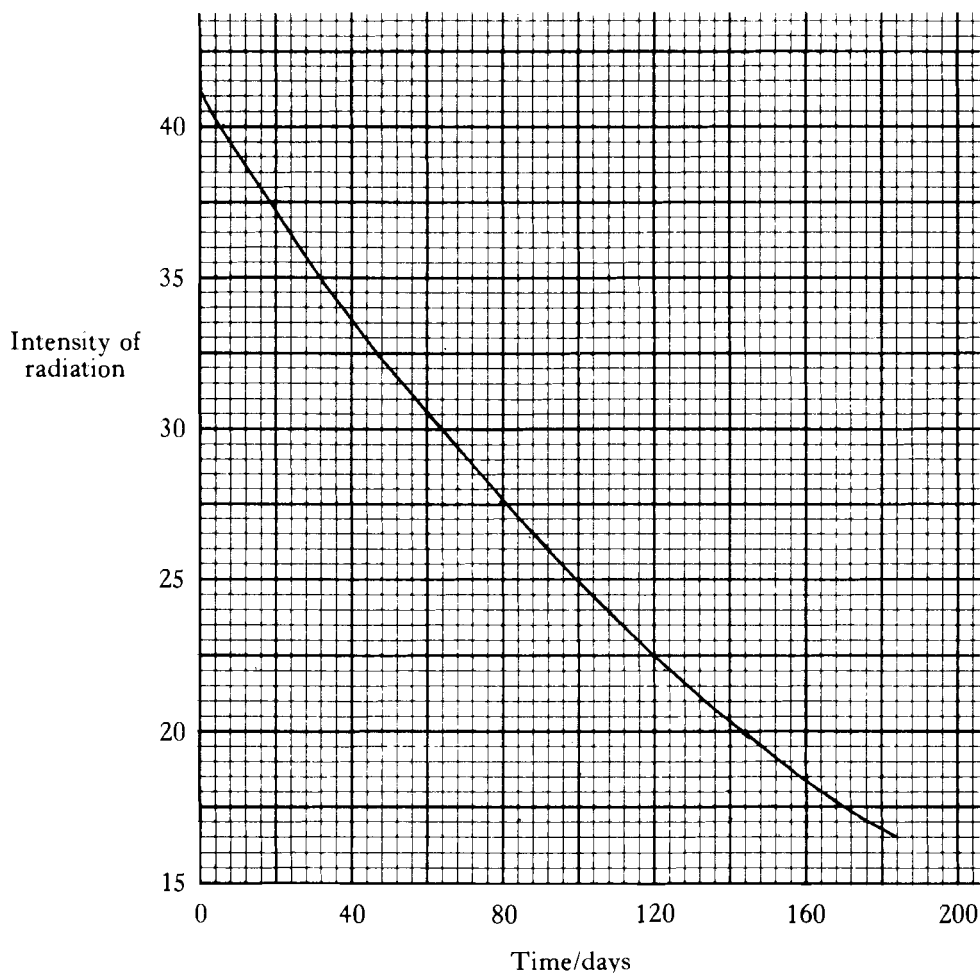
    (i) Determine the half-life of X.   **1**

    (ii) Identify X. (Use the Data Booklet, page 3.)   **1**

    (iii) Write a nuclear equation for the decay of X.   **1**

(b) The mass spectrometer is used to determine mass numbers.

    (i) Which type of particle moves through a mass spectrometer?   **1**

    (ii) Explain the significance of the word relative in the term "relative atomic mass".   **1**

    (iii) Neon has two isotopes ^{20}Ne and ^{x}Ne.

        If the relative atomic mass of neon is 20·2 and the abundance of ^{20}Ne is 90%, calculate the mass number, x, of the second isotope. (**Working must be shown.**)   **2**

(c) Many radioisotopes are made by bombarding stable atoms with alpha particles, neutrons or protons.

    (i) Explain why neutrons are widely used for producing radioisotopes.   **1**

    (ii) Why are beta particles not used to produce radioisotopes?   **1**

    (iii) Explain how radioactivity can be used to estimate the age of organic remains.   **3**
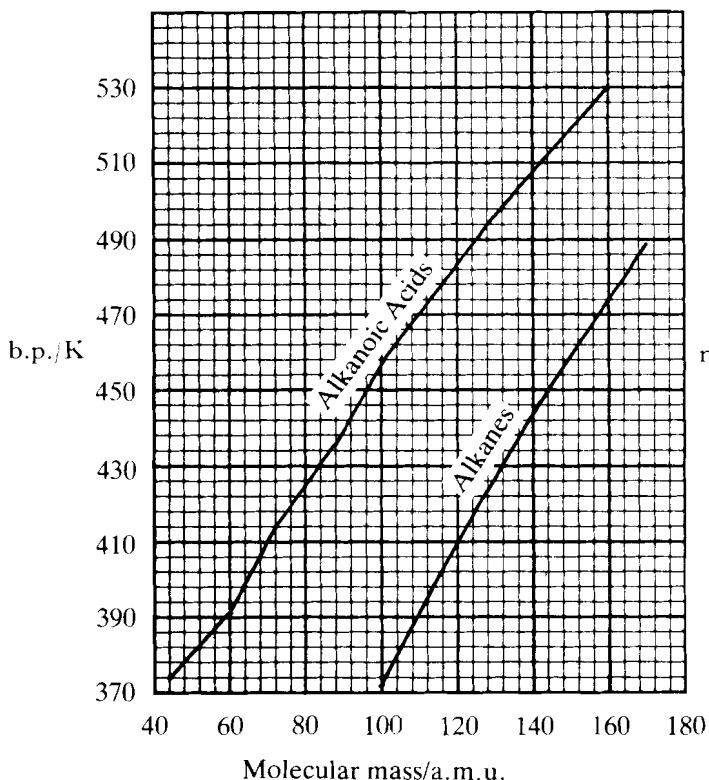
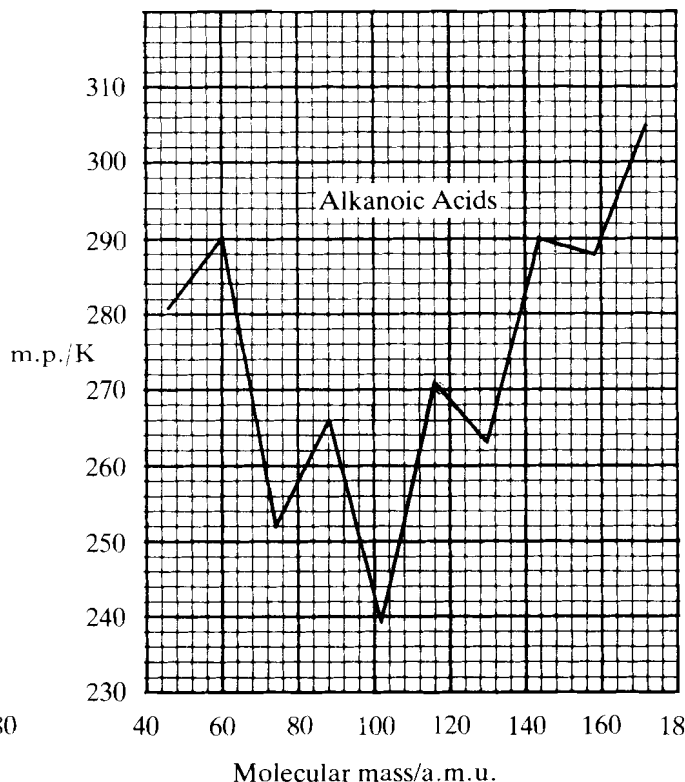   **(12)**

OR

B. Graph 1 shows how the boiling points of the straight-chain alkanoic acids and the straight-chain alkanes vary with molecular mass.

Graph 2 shows how the melting points of the straight-chain alkanoic acids vary with molecular mass.

GRAPH 1 — BOILING POINTS

GRAPH 2 — MELTING POINTS

The following questions relate to Graph 1.

(a) What are the boiling points of the **alkanes** of molecular mass

    (i) 100 a.m.u.;

    (ii) 128 a.m.u.?   2

(b) Why do the boiling points of the alkanes increase with increasing molecular mass?   1

(c) An alkanoic acid contains 6 carbon atoms.

    (i) Give its formula and molecular mass.   2

    (ii) Name the alkane of comparable mass.   1

    (iii) What accounts for the higher boiling point of the alkanoic acid?   1

The following questions relate to Graph 2.

(d) The melting points of the alkanoic acids are anomalous. Explain what is meant by the word "anomalous".   1

(e) How many carbon atoms are there in the alkanoic acid which is a solid at room temperature (assume 293 K)?   2

(f) Explain why propanoic acid is found in the laboratory as a liquid but ethanoic acid is found sometimes as a liquid and sometimes as a solid.   2

    (12)

[END OF QUESTION PAPER]