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LEAVING CERTIFICATE EXAMINATION, 1998

CHEMISTRY — ORDINARY LEVEL

WEDNESDAY, 24 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; Mg = 24.** Molar volume at STP = 22.4 litres (dm³).

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

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

(a) Write down the electronic configuration (s,p,d etc.) of potassium (atomic number 19).

(b) What is meant by *atomic number*?

(c) Write down the *equation of state* for an ideal gas.

(d) Name an *aromatic hydrocarbon*.

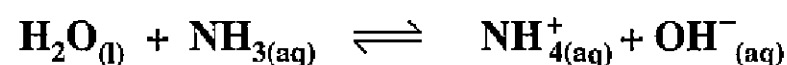
(e) How would you confirm the presence of sulphate ions in aqueous solution?

(f) What is the systematic (IUPAC) name for **CH₃CHClCH₂CH₃**?

(g) An aqueous solution of alcohol is labelled 40% (w/v). Explain what is meant.

(h) State *Hess's law*.

(i) In terms of the Bronsted-Lowry theory, indicate a base and its conjugate acid in the equation:



(j) What is the pH of a **0.01 M** solution of sulphuric acid?

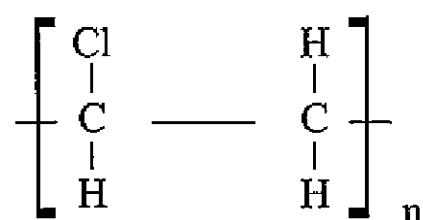
(k) What is the shape of (i) the ammonia molecule, (ii) the water molecule?

(l) Give an example of (i) a covalent crystal, (ii) a molecular crystal.

(m) Use electronegativity values to determine the type of bonding present in sodium oxide (**Na₂O**).

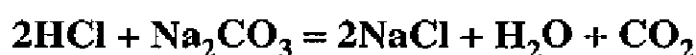
(n) Balance the following equation: **C₂H₅OH + O₂ = CO₂ + H₂O**

(o) Name and give a major use of the polymer represented by the following structure:



(11 x 6)

2. A student made up 250 cm³ of a 0.1 mol litre⁻¹ (dm⁻³) solution of sodium carbonate and used 25.0 cm³ portions to standardise a given solution of hydrochloric acid according to the equation:



The titration was carried out three times and the following results were obtained:

Titration	1	2	3
Volume/cm ³	22.1	19.95	20.05

- (a) Draw a labelled sketch which shows the apparatus assembled for the titration. (6)
- (b) When carrying out this experiment, state:
- the washing procedures for the pipette, burette and conical flask before use. (9)
 - the solution which was placed in the burette. (6)
 - one precaution needed for accurate use of the pipette. (6)
 - two operations which should be carried out *during* the titration to improve accuracy. (6)
 - a suitable indicator, giving the colour before and after the end-point. (9)
- (c) Calculate: (i) the concentration of the hydrochloric acid solution in (a) moles litre⁻¹ (dm⁻³) and (b) g litre⁻¹ (dm⁻³). (15)
- (ii) The mass of sodium carbonate required to make up accurately 250 cm³ of a 0.1 mol litre⁻¹ (dm⁻³) solution. (9)

3. (a) Ethanol may be used to prepare ethene, ethanal and ethanoic acid in the laboratory. Indicate by letter (A, B or C) which of the experimental arrangements in Fig. 1 could be used to prepare (i) ethene, (ii) ethanal, (iii) ethanoic acid. (18)

- (b) Classify each of the laboratory preparations in (a) above as either an oxidation or a dehydration. (9)

- (c) In the case of an oxidation in (b) above, state the oxidising agent used and the colour change that occurs during the reaction. (12)

- (d) Which of the experimental arrangements (A, B or C) is suitable for reflux? (6)

- (e) In which arrangement may "suck back" occur when heating is stopped? What precautions would you take? (12)

- (f) Which arrangement would be suitable for the preparation of propanone? (9)

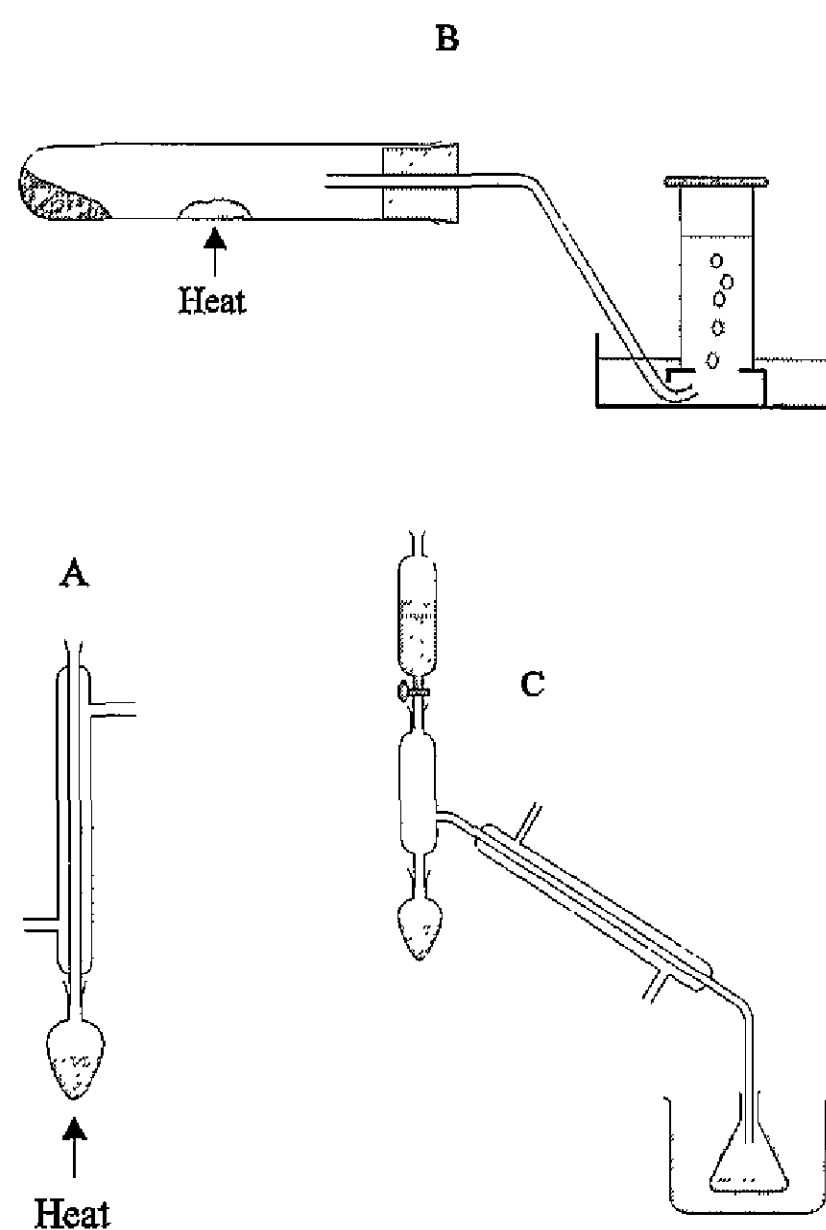


Fig. 1

4. (a) Some of the following statements concerning the Periodic Table are true and others are false. Write out the statements in your answer book correcting any that are false.
- (i) The elements are arranged strictly in order of increasing relative atomic mass. (6)
 - (ii) Each horizontal row of elements is called a period. (6)
 - (iii) In moving from left to right across the Table, elements become more metallic. (6)
 - (iv) The alkali metals become more reactive as we descend the group. (6)
 - (v) Elements in group 2 are called halogens. (6)

- (b) Answer the following items with reference to the eight elements indicated by letters in the section of the Periodic Table shown below.

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

Choose the letter corresponding to an element which

- (i) forms a hydroxide which is strongly alkaline.
 - (ii) combines with oxygen in the ratio of 1 : 2 atoms, forming a gaseous, acidic oxide.
 - (iii) is formed at the cathode in the electrolysis of an aqueous solution of one of its salts.
 - (iv) has the electron configuration $1s^2 2s^2 2p^6 3s^2 3p^5$.
 - (v) readily forms an ion carrying the charge -2 .
 - (vi) has an allotrope which conducts electricity.
 - (vii) readily forms an ion which has the same electron configuration as (f). (7x3)
- (c) Describe, or show using a diagram, how the arrangement of outer electrons of the atoms change when:
 (i) element (g) combines with element (e), (ii) element (a) combines with element (c). (15)

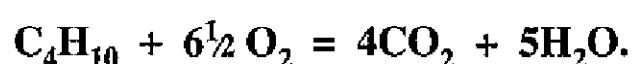
5. (a) Define the *heat of neutralisation* of an acid. (6)

In an experiment to determine the heat of neutralisation of hydrochloric acid, 0.1 moles of hydrochloric acid were neutralised by 0.1 moles of aqueous sodium hydroxide and the heat released in the experiment was 5.6 kJ.

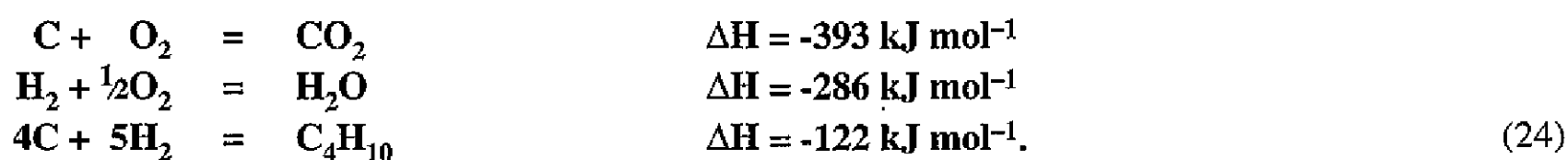
- (i) Describe how this experiment may be carried out. (15)
- (ii) What is the value of the heat of neutralisation of hydrochloric acid found in this experiment? (9)
- (iii) Mention one significant precaution which should be taken to ensure the accuracy of this experiment. (6)

- (b) Define the *heat of combustion* of a substance. (6)

Butane (C_4H_{10}) is used as a fuel and the equation for its combustion is:



Calculate the heat of combustion of butane from the following data:



6. Read the sentences below and answer the items which follow.

“The release of an acidic gas into the atmosphere is the major cause of acid rain. Amongst the causes of water pollution are untreated sewage and fertilisers. To ensure that water is fit for human consumption, it is purified in a number of stages”.

- (a) Name such an acidic gas and give a major source. (12)
- (b) Describe the (i) primary, (ii) secondary treatment of sewage. Why is tertiary treatment carried out? (18)
- (c) Give an effect of the presence of too much fertiliser in water. (6)
- (d) Describe, briefly, what happens at each of the stages involved in the purification of water for domestic use. (18)
- (e) A student filtered 500 cm³ of water and found that the mass of the filter paper increased by 0.154 g. On evaporation of the filtered water to dryness, it was found that the container had increased in mass by 0.135 g. Calculate (i) the total suspended solids and (ii) the total dissolved solids, in the water. Express each answer in mg litre⁻¹ (dm⁻³) or ppm. (12)

7. Fig. 2 shows apparatus used to study the rate of reaction between marble chips (calcium carbonate) and dilute hydrochloric acid.

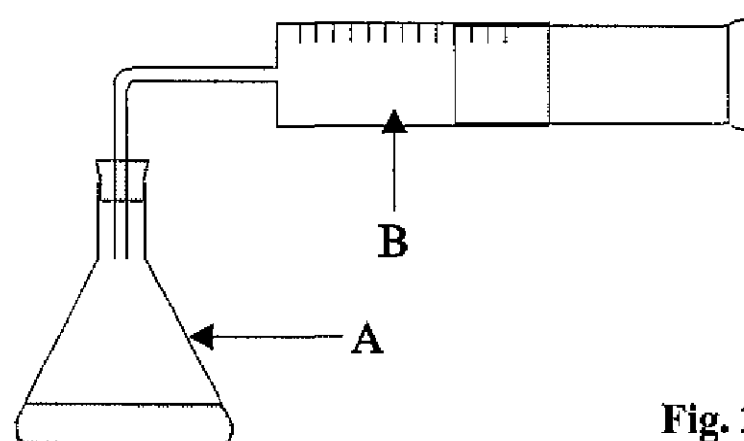


Fig. 2

- (a) Name the piece of apparatus labelled A and the gas labelled B. Is heat necessary for this reaction to take place? (15)
- (b) The following readings were taken during the experiment.

Time/min	0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5
Vol. of gas/cm ³	0	15.1	38.9	70.1	94.2	108.1	115.4	118.6	120.0	120.0

Plot a graph with the volume of gas collected (y-axis) against time. (15)

- (c) What happens to the rate as the reaction proceeds? How does the shape of the graph show this? (6)
- (d) On the same graph sketch a curve you might expect if the reaction was carried out at a higher temperature. (6)
- (e) State two ways (excluding the use of heat) by which the rate of this reaction may be increased. (12)
- (f) Describe, using a diagram, a different method/apparatus which could be used to follow the rate of this reaction. (12)

8. (a) Copy the Table below into your answer book and complete it.

Compound	Homologous Series	Functional Group	Structural Formula
ethyne			H—C≡C—H
ethanol		—OH	
ethanal			
ethanoic acid	carboxylic acid		

(27)

- (b) Describe, with the aid of a sketch, the laboratory preparation of ethyne and the test which you would use to show that the compound was unsaturated. (15)
- (c) Describe a chemical test which would distinguish between ethanal and propanone in the laboratory. (9)
- (d) Which compound, named in the table, might be used as a motor fuel? (6)
- (e) Which of the four compounds named in the table would you expect to find:
- in beer, wine and spirits?
 - in vinegar?
 - in use with oxygen to produce a hot flame suitable for cutting steel? (9)

9. (a) The diagram Fig. 3 shows a Blast Furnace.

- What are the two materials which, together with iron ore e.g. Fe_2O_3 , are added to the furnace at A? (12)
- At which point is the molten iron removed? (6)
- Give a chemical equation for the reduction of iron ore and name the reducing agent. (12)

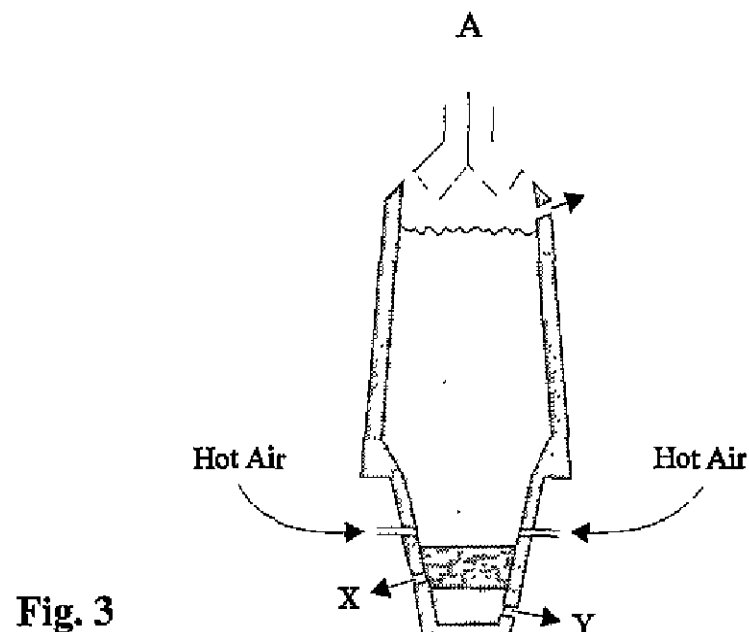


Fig. 3

- (b) There are three Stages in the Contact Process for the manufacture of sulphuric acid. Stage III involves absorption in 98% sulphuric acid.
- Name the raw materials which are used in Stage I to produce sulphur dioxide. (6)
 - The equation for the reaction occurring in Stage II is:

$$2\text{SO}_{2(g)} + \text{O}_{2(g)} \rightleftharpoons 2\text{SO}_{3(g)} \quad \Delta H = -196 \text{ kJ mol}^{-1}.$$
Name the catalyst used in Stage II.
Explain the meaning of: 1. The expression $\Delta H = -196 \text{ kJ mol}^{-1}$. 2. The symbol \rightleftharpoons . (15)
- (c) One use of sulphuric acid is the manufacture of fertilisers. One such fertiliser is ammonium sulphate.
- Write the equation for the formation of ammonium sulphate. (6)
 - What is the percentage of nitrogen in ammonium sulphate? (6)
 - A fertiliser is labelled as 7:16:17. Explain the label. (3)

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

(a) State what you would see during each of the following procedures:

- (i) Carbon dioxide is bubbled into limewater.
- (ii) A solution of silver nitrate is added to a solution of sodium chloride.
- (iii) Magnesium is added to dilute sulphuric acid.
- (iv) Ethyne gas is ignited.
- (v) Potassium chloride is placed on a platinum or nichrome wire and introduced into a bunsen flame.
- (vi) An iron nail is placed in an aqueous solution of copper(II) sulphate.
- (vii) A solution containing magnesium ions is added to a solution with carbonate ions.
- (viii) A few drops of a soap solution are added to hard water and shaken.
- (ix) A freshly prepared solution of iron(II) sulphate is added to a solution of sodium nitrate in a test tube and well mixed. Concentrated sulphuric acid is then poured down the inside wall of the test tube.
- (x) Filter paper, dipped in acidified potassium manganate(VII), is placed in a test tube of sulphur dioxide gas.
- (xi) The pressure of the mixture N_2O_4 (colourless) \rightleftharpoons 2NO_2 (brown) is increased. (11 x 3)

(b) The table below gives information on three electrolysis experiments.

	SUBSTANCE ELECTROLYSED	ELECTRODES	CATHODE PRODUCT	CATHODE EQUATION
1.	dil. sulphuric acid	inert	hydrogen	$\text{H}^+ + \text{e}^- \rightarrow \frac{1}{2}\text{H}_2$
2.	lead bromide (molten)	inert	A	B
3.	copper sulphate (aq.)	copper	C	D

(i) Write down the information which might be shown in the boxes A, B, C and D. (18)

(ii) If 224 cm³ of hydrogen gas were collected at STP during the electrolysis of dilute sulphuric acid:

1. What mass of the hydrogen gas was produced? 2. What mass of water was formed on combustion, according to the equation: $2\text{H}_2 + \text{O}_2 = 2\text{H}_2\text{O}$? (15)

(c) Write down the missing words, formulae or numbers in the following passage:

Oxidation is defined as _____ (1) _____ of electron(s), or as _____ (2) _____ in oxidation number. In the equation $\text{Na} + \frac{1}{2}\text{Cl}_2 = \text{NaCl}$, the oxidation numbers of the elements are _____ (3) _____ for Na and _____ (4) _____ for Cl. The oxidation numbers of the product ions are _____ (5) _____ for sodium and _____ (6) _____ for chloride. Thus, in this reaction _____ (7) _____ is oxidised and _____ (8) _____ is reduced.

Oxides are classified as basic, acidic, amphoteric and neutral. Sodium oxide is an example of basic oxide, _____ (9) _____ is an acidic oxide, _____ (10) _____ is an amphoteric oxide and _____ (11) _____ is a neutral oxide. (11x3)

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