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LEAVING CERTIFICATE EXAMINATION, 2001

CHEMISTRY — ORDINARY LEVEL

TUESDAY, 19 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: H = 1, C = 12, O = 16, S = 32, Cl = 35.5, Ca = 40, Zn = 65.

Molar volume at STP = 22.4 litres (dm^3).

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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 $\mathbf{1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^4}$?

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

(*c*) Who proposed the *law of triads*?

(*d*) State *Avogadro's law*.

(*e*) What is the percentage carbon in carbon dioxide, $\mathbf{CO_2}$?

(*f*) What force holds the molecules together in a crystal of iodine?

(*g*) Write the equilibrium constant expression for:

$$\mathbf{CH_4 + H_2O \rightleftharpoons CO + 3H_2}$$

(*h*) Name or give the formula for a compound that causes permanent hardness in water.

(*i*) What is the oxidation number of manganese in $\mathbf{KMnO_4}$?

(*j*) A solution contains 0.25 g of solute in 500 cm^3 of solution.
Express this concentration in parts per million (p.p.m.).

(*k*) Which **two** of the following metals are extracted from their compounds by electrolysis?

Fe Cu Mg Na Zn

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

(*m*) Name a family of organic compounds which react with Fehling's reagent to give a brick-red precipitate.

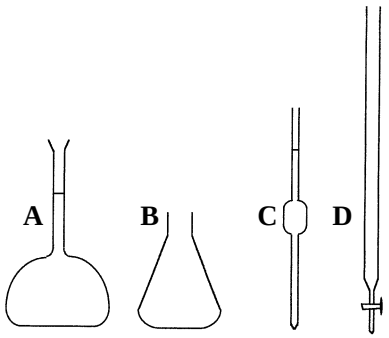
(*n*) How would you confirm the presence of chloride ions in aqueous solution?

(*o*) What mass of calcium oxide is produced when 200 g of calcium carbonate decomposes according to the equation:

$$\mathbf{CaCO_3 \rightarrow CaO + CO_2}$$

(70)

2. The pieces of equipment shown are used when making up a standard solution of sodium carbonate and when finding the concentration of a sulphuric acid solution.



(*a*) Name the pieces of apparatus **A**, **B**, **C** and **D**. (12)

(*b*) Which piece of equipment is used to
(i) make up a standard solution of sodium carbonate?
(ii) measure the volume of the sulphuric acid used in the titration?
(iii) measure the volume of sodium carbonate solution used in the titration? (9)

(*c*) Which of the pieces of equipment should be washed before use with
(i) deionised water followed by a little of the solution it is to contain?
(ii) deionised water only? Why is it not correct to wash this piece of apparatus with the solution it is to contain? (12)

(*d*) Name a suitable indicator for this titration. What is the colour change at the end-point? (9)

The sodium carbonate solution was measured in 25.0 cm^3 volumes and titrated with the sulphuric acid solution. Three titrations were carried out and the volumes of sulphuric acid solution used were:

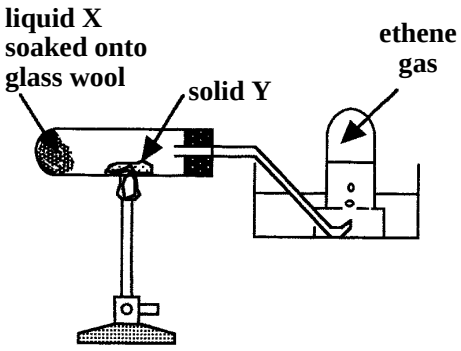
Titration	1	2	3
Volume/cm^3	20.30	20.05	19.95

The titration reaction is: $\mathbf{Na_2CO_3 + H_2SO_4 \rightarrow Na_2SO_4 + H_2O + CO_2}$

(*e*) State **one** precaution which should be taken during the titration to ensure accuracy in the result. (6)

(*f*) What mean titration figure should you use in calculating the concentration of the sulphuric acid solution in the experiment described above?
Given that the concentration of the sodium carbonate solution was 0.05 mol $litre^{-1}$ (mol dm^{-3}), calculate the concentration of the sulphuric acid solution in mol $litre^{-1}$ (mol dm^{-3}) and in grams per litre (g dm^{-3}). (18)

3. To prepare ethene, C_2H_4, the apparatus shown can be used. The liquid **X** is vapourised and passed over the solid **Y**. The ethene gas is collected in test tubes as shown.



(*a*) Name or give the formula of the liquid **X** and the solid **Y**.
What is the colour of the solid **Y**. (9)

(*b*) Why should you not use the first few test tubes of gas collected? (6)

(*c*) Why should you remove the delivery tube from the trough of water when the heating is stopped? (6)

(*d*) What term is used to describe the type of reaction occurring here, where the liquid **X** is being converted to ethene? (6)

(*e*) What are the products of the combustion of ethene?
Describe a test for **one** of these products. (9)

(*f*) What do you see when a few drops of a bromine solution are added to a test tube of ethene gas? What does this tell you about the structure of ethene? (12)

(*g*) Draw the structure of the ethene molecule. To what family of organic compounds does ethene belong? (9)

(*h*) Ethene can be polymerised to produce poly(ethene). Draw two repeating units of this polymer. State **one** use of poly(ethene). (9)

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4. Answer the following items with reference to the elements indicated in the section of the Periodic Table shown below.

1 **H**																	2 **He**
3	4											5	6	7 **N**	8	9	10
11 **Na**	12											13	14	15	16	17 **Cl**	18
19	20	21	22	23	24 **Cr**	25	26	27	28	29	30	31	32	33	34	35	36

(*a*) Name the metal stored under oil.
What gas is evolved when a piece of this metal is reacted with water? (9)

(*b*) Name the metallic element which forms coloured compounds and has variable valency.
Write the electronic configuration of this element. (12)

(*c*) Name the least reactive of the elements shown.
What is the name given to the group of elements to which this element belongs? (12)

(*d*) Which non-metal makes up nearly 80% of the earth's atmosphere?
Describe the bonding in the simplest compounds formed between this element and hydrogen. (12)

(*e*) Which of these elements are gases at room temperature and atmospheric pressure? (12)

(*f*) Give the name and formula of an ionic compound formed between any two of these elements. (9)

5. In an experiment to measure the rate at which hydrogen gas was produced a student reacted a piece of magnesium ribbon with an excess of dilute hydrochloric acid.

The volume of hydrogen gas produced was measured every two minutes and the data collected is given in the table.

Time/minutes	0	2	4	6	8	10	12	14	16
Volume of hydrogen gas / cm^3	0	14	22	26	28	29	30	30	30

(*a*) Draw a labelled diagram of a suitable apparatus for this experiment. (12)

(*b*) Plot a graph of the volume of hydrogen (y-axis) against time. (18)

(*c*) Use the graph to find out
(i) at what time the reaction was finished?
(ii) the time taken for half of the magnesium ribbon to be used up.
(iii) the time it took for 18 cm^3 of hydrogen gas to be produced? (18)

(*d*) Why did the reaction slow down as time passed? (6)

(*e*) What would be the effect, if any, of each of the following on the rate at which hydrogen gas was produced in this experiment:
(i) warming the hydrochloric acid before the magnesium ribbon was added?
(ii) using the same mass of powdered magnesium? (12)

6. (*a*) What is meant by (i) an exothermic reaction (ii) an endothermic reaction? (9)

Define the heat of formation of a substance. (6)

The formation of ethyne can be represented by the equation:

$$\mathbf{2C_{(s)} + H_{2(g)} \rightarrow C_2H_{2(g)}}$$

Use the data below to show that the heat of formation of ethyne, C_2H_2, is 225 kJ mol^{-1}.

$$\begin{array}{llll} \mathbf{C_2H_{2(g)} + 2^1/_2O_{2(g)} \rightarrow 2CO_{2(g)} + H_2O_{(l)}} & & & \mathbf{\Delta H = -1299\ kJ\ mol^{-1}} \\ \mathbf{C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)}} & & & \mathbf{\Delta H = -394\ kJ\ mol^{-1}} \\ \mathbf{H_{2(g)} + {}^1/_2O_{2(g)} \rightarrow H_2O_{(l)}} & & & \mathbf{\Delta H = -286\ kJ\ mol^{-1}} \end{array}$$ (18)

Use the heat of combustion of ethyne (-1299 kJ mol^{-1}) supplied in the data above to calculate the kilogram calorific value of ethyne (relative molecular mass = 26). (6)

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

Describe an experiment you could carry out in the school laboratory to measure the heat of combustion of a liquid such as methanol.
What are the main sources of error in the experimental procedure you have described? (21)

7. (*a*) Define (i) an acid, (ii) a base, (iii) a conjugate pair, (iv) pH. (18)

The concentration of a sodium hydroxide (NaOH) solution is 0.05 M.
(i) What is the concentration of OH^- ions in this solution? (6)
(ii) Calculate the pH of the solution. (9)
(The ionic product for water $K_w = 1 \times 10^{-14}$ at 25 °C)

(*b*) Match one of the following compounds with one of the types of oxide listed below:

CO **CO_2** **MgO** **H_2O**

(i) an acidic oxide
(ii) a basic oxide
(iii) an amphoteric oxide
(iv) a neutral oxide (24)

What is *acid rain?* State **two** effects of acid rain. (9)

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8. The formulae of four organic compounds are given below:

CH_3CH_3	CH_3CH_2Cl	CH_3CH_2OH	CH_3COOH
A	**B**	**C**	**D**

(*a*) Name the compounds **A**, **B**, **C** and **D**. (12)

(*b*) Name the family of organic compounds to which compound **A** belongs. Give the name and formula of another member of this family of compounds. (12)

(*c*) How can **A** be converted to **B**? (12)

(*d*) How can **B** be converted to **C**? (6)

(*e*) What reagents can be used in the school laboratory to convert **C** to **D**?
What word is used to describe this type of reaction? (18)

(*f*) Name the family of organic compounds to which **D** belongs. (6)

9. (*a*) What is a catalyst?
(6)

The following catalysts are used in large scale industrial processes:

rhodium-platinum gauze (Rh/Pt) **activated iron oxide (Fe_2O_3)** **vanadium pentoxide (V_2O_5)**

Which one of these catalysts is used in the industrial production of:

(i) ammonia from hydrogen and nitrogen?
(ii) nitric acid from ammonia?
(iii) sulphuric acid from sulphur?

Write a balanced equation for **one** of these chemically catalysed reactions. (24)

(*b*) In the Haber process ammonia is made from nitrogen and hydrogen.
What is the main source of (i) nitrogen (ii) hydrogen in the Haber process? (12)

The Haber process is important as an industrial method of *nitrogen fixation*.
What is meant by nitrogen fixation? How does it occur in nature? (9)

(*c*) Ammonia reacts with nitric acid to produce ammonium nitrate.
Write an equation for this reaction. (6)

(*d*) The brown ring test is used as a test for nitrate ions in solution.
What reagents are used in the brown ring test and what is seen when a solution containing nitrate ions is tested? (9)

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

(*a*) Define (i) energy level (ii) orbital (12)

Name the scientist who first put forward the idea of energy levels in his atomic theory. (6)
Flame tests can be used to identify the metal present in different salts.
In the case of **any three** of the following metals state the colour observed in flame tests:
lithium sodium potassium magnesium calcium copper (15)

(*b*) Iron is made from its ore in a Blast Furnace.

(i) What three materials are added at the top of a Blast Furnace? (18)

(ii) What is the name and formula of the gas which reduces the iron oxide to iron? Write an equation for this reduction. (12)

(iii) What non-metallic element is an essential part of steel? (3)

(*c*) A sample of 32.5 g of zinc was reacted with excess hydrochloric acid.

Zinc reacts with hydrochloric acid according to the equation:

$$\mathbf{Zn_{(s)} + 2HCl_{(aq)} \rightarrow H_{2(g)} + ZnCl_{2(aq)}}$$

(i) How many moles of zinc were used? (6)

(ii) How many moles of hydrochloric acid were needed to react fully with this quantity of zinc? (6)

(iii) How many moles of hydrogen were produced? What volume would this quantity of hydrogen occupy at STP? [Molar volume at STP = 22.4 litres (dm^3)] (9)

(iv) What mass of zinc chloride was produced in the reaction? (12)

(*d*) The following names or words are omitted from the passage below:

chlorination deionisation eutrophication filtration flocculation fluoridation
hard primary secondary soft tertiary

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

The addition of aluminium salts to water in a water works to speed up settling is called **_____1_____** .
Harmful bacteria in drinking water are killed by **_____2_____**. As part of a programme designed to combat dental decay **_____3_____** of drinking water is carried out. The process of passing drinking water through sand beds is called **_____4_____** .
Water which contains large quantities of calcium salts dissolved in it is **_____5_____** but it can be made **_____6_____** by **_____7_____**.
In sewage treatment **_____8_____** treatment involves screening and settling. Phosphates and nitrates are removed in **_____9_____** treatment. The sewage is broken down biologically during **_____10_____** treatment. If large quantities of nitrates and phosphates seep into rivers and lakes **_____11_____** can occur.
(11 x 3)

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