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LEAVING CERTIFICATE EXAMINATION, 2000

CHEMISTRY — ORDINARY LEVEL

TUESDAY, 20 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, Ca = 40.

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

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

(*c*) In flame tests, what colour light do sodium salts give to a Bunsen flame?

(*d*) Give the name or formula of a tetrahedral molecule.

(*e*) What is the percentage calcium in calcium carbonate, $\mathbf{CaCO_3}$?

(*f*) What force hold molecules of water together in a crystal of ice?

(*g*) Write the equilibrium constant expression for: $\mathbf{N_2 + 3H_2 \rightleftharpoons 2NH_3}$

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

(*i*) What is the oxidation number of sulphur in $\mathbf{H_2SO_4}$?

(*j*) What is meant by *catalytic cracking*?

(*k*) Arrange the following elements in order of *increasing* activity in the electrochemical series:

Fe Cu Mg

(*l*) State *Hess's law.*

(*m*) Give the name or formula of an *amphoteric oxide.*

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

(*o*) Complete and balance the equation:

$$\mathbf{Zn + HCl \rightarrow}$$

(70)

2. A student prepared a standard 0.05 mol litre^{-1} (mol dm^{-3}) solution of sodium carbonate, Na_2CO_3, as follows:

5.3 g of anhydrous sodium carbonate was dissolved in deionised water in a small beaker. This solution was transferred to a 1000 cm^3 (1 dm^3) volumetric flask and the solution made up to the mark with deionised water.

(*a*) How would you make sure that all the sodium carbonate solution from the small beaker was transferred into the volumetric flask? (6)

(*b*) What part of the meniscus should be level with the mark on the volumetric flask when you are making the solution up to 1000 cm^3 in a volumetric flask? (6)

(*c*) How would you make sure that the solution in the volumetric flask was mixed properly? (6)

The sodium carbonate solution was measured in 25 cm^3 portions and titrated with a hydrochloric acid solution. Three titrations were carried out and the volumes of hydrochloric acid solution used were:

Titration	1	2	3
Volume/cm^3	27.7	27.45	27.55

(*d*) What piece of equipment would you use to measure the 25 cm^3 portions of sodium carbonate solution? State <u>one</u> precaution you would take when using this piece of equipment. (9)

(*e*) What piece of equipment would you use to measure the hydrochloric acid solution used during the titration? What is the procedure for washing and filling this piece of equipment before starting the titration? (15)

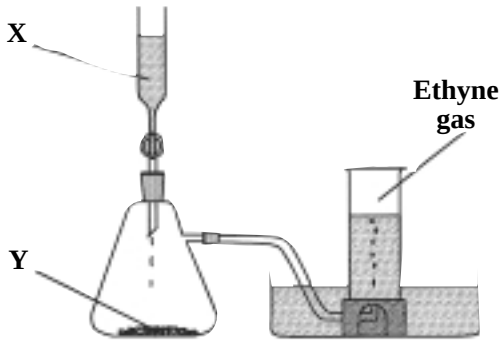
(*f*) Name an indicator that you could use for this titration.
What colour change would be seen at the end point of the titration? (9)

(*g*) The titration reaction is: $\mathbf{Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2}$

What mean titration figure should you use in calculating the concentration of the hydrochloric acid solution in the experiment described above?
The concentration of the sodium carbonate solution was 0.05 mol litre^{-1} (mol dm^{-3}).
Calculate the concentration of the hydrochloric acid solution in mol litre^{-1} (mol dm^{-3}). (15)

3. To prepare ethyne, C_2H_2, the apparatus shown can be used. The liquid **X** is dropped onto the solid **Y**. The ethyne gas is collected in gas jars.

(*a*) Name <u>or</u> give the formula of the liquid **X** and the solid **Y**.
Describe the appearance of the solid **Y**. (12)



(*b*) What do you see when the liquid **X** is added to the solid **Y**? (6)

(*c*) Why should you not use the first few jars of gas collected? (6)

(*d*) Describe what you would see when a jar of ethyne gas is burned. (6)

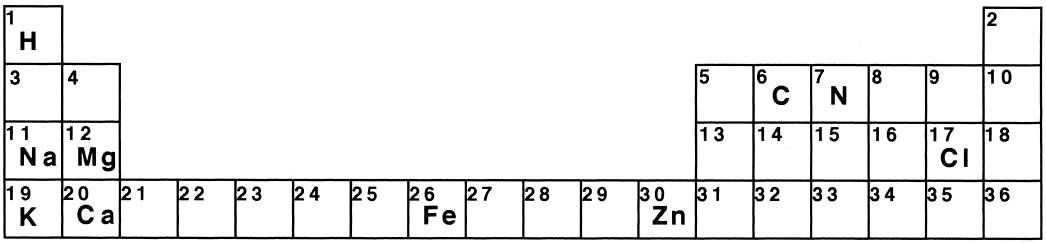
(*e*) What do you see when a few drops of a bromine solution are added to a jar of ethyne gas? What does this tell you about ethyne? (12)

(*f*) Draw the structure of the ethyne molecule.
To what family of organic compounds does ethyne belong? (12)

(*g*) Three molecules of ethyne can be combined to produce a molecule of benzene.
Draw the structure of a benzene molecule. (6)

(*h*) The common name for ethyne gas is acetylene.
Give <u>one</u> large scale use of ethyne or acetylene gas. (6)

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



(*a*) What name is given to the Group I elements? Name <u>two</u> elements from this group. (9)

(*b*) Name <u>and</u> give the electronic configuration of an atom of each of the following: (i) **Ca**, (ii) **Fe**. (18)

(*c*) Describe with the aid of a diagram the bonding in the simplest compound formed involving elements **nitrogen** and **hydrogen**. What is the shape of a molecule of this compound? (15)

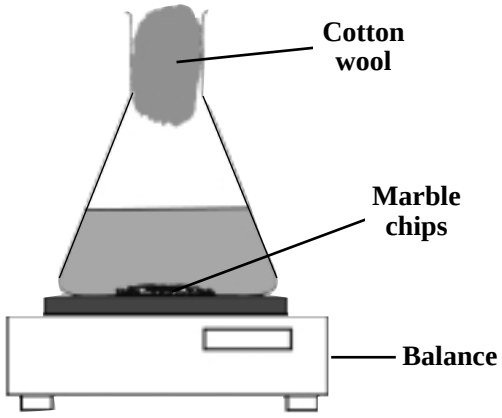
(*d*) Which <u>two</u> of the indicated elements are the major components of steel? (6)

(*e*) Iron is often galvanised to prevent *corrosion.*
What simple word is used to describe the corrosion of iron?
Which of the listed elements is used to galvanise iron? (6)

(*f*) What is the name <u>and</u> the formula for the compound formed between **magnesium** and **chlorine**?
Is this compound ionic or covalent? (12)

5. In an experiment a student added 25 cm^3 of dilute hydrochloric acid to an excess of marble chips, $CaCO_3$, using the apparatus shown in the diagram.

The mass of the flask and contents were measured at three minute intervals. From the readings on the balance the mass of carbon dioxide produced was calculated.



The following table of data was recorded.

Time/minutes	0	3	6	9	12	15	18	21
Mass of flask and contents /g	160.66	160.44	160.33	160.28	160.25	160.23	160.22	160.22
Mass of CO_2 / g	0.0	0.22	0.33	0.38	0.41	0.43	0.44	0.44

(*a*) Plot a graph of the mass of CO_2 (y-axis) against time. (18)

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

(*c*) Using the graph find the time taken for one quarter of the hydrochloric acid to be used up. (6)

(*d*) Using the graph find the mass of carbon dioxide produced after four minutes. From this calculate the average rate of production of carbon dioxide (in g/minute) over the first four minutes. (12)

(*e*) Why does the rate of reaction decrease as the reaction proceeds? (6)

(*f*) What effect would each of the following have on the rate of the reaction:

(i) warming the hydrochloric acid before adding it to the marble chips

(ii) adding the same mass of larger marble chips

(iii) using hydrochloric acid of greater concentration? (18)

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

Define heat of combustion. (6)

The combustion of ethene can be represented by the equation:

$$C_2H_{4(g)} + 3O_{2(g)} \rightarrow 2CO_{2(g)} + 2H_2O_{(l)}$$

Use the data below to show that the heat of combustion of ethene, C_2H_4, is -1412 kJ mol^{-1}.

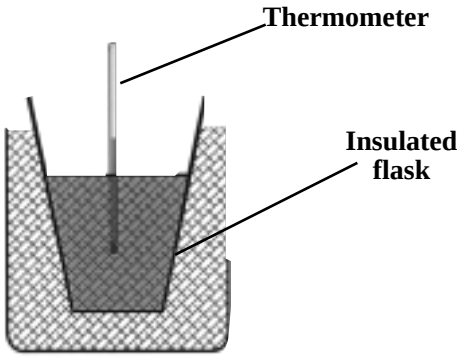
$$C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)} \qquad \Delta H = -394 \text{ kJ mol}^{-1}$$
$$H_{2(g)} + \tfrac{1}{2}O_{2(g)} \rightarrow H_2O_{(l)} \qquad \Delta H = -286 \text{ kJ mol}^{-1}$$
$$2C_{(s)} + 2H_{2(g)} \rightarrow C_2H_{4(g)} \qquad \Delta H = 52 \text{ kJ mol}^{-1}$$

(21)

Use the heat of combustion of ethene (-1412 kJ mol^{-1}) to calculate the kilogram calorific value of ethene (relative molecular mass = 28). (6)

(*b*) Define heat of neutralisation. (6)

In an experiment to find the heat of neutralisation of hydrochloric acid a student mixed 100 cm^3 of 1 M hydrochloric acid and an excess of potassium hydroxide solution in an insulated flask as shown in the diagram.



Why was it important to insulate the flask? (6)

From the results of the experiment the student calculated that 5.7 kJ of heat energy was given out in the reaction.

(i) How many moles of hydrochloric acid were neutralised in the reaction?

(ii) Calculate the heat of neutralisation of hydrochloric acid. (12)

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

C_2H_5OH	CH_3CHO	CH_3COOH	CH_3COCH_3
A	**B**	**C**	**D**

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

(*b*) Name the family of organic compounds to which compound **B** belongs. (6)

(*c*) The same reagents can be used in the school laboratory to convert compound **A** to compound **B** and to convert compound **A** to compound **C**. Name or give the formula of these reagents. (12)

(*d*) What is seen when you test an aqueous solution of compound **C** with litmus solution?
What information does this give you about compound **C**? (9)

(*e*) When you add compound **C** to a solution of sodium carbonate a gas is produced.
What test could you use to show that the gas produced is carbon dioxide? (6)

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

(*g*) Describe a test you could carry out to distinguish between compound **B** and compound **D**.
State clearly the observations you make in the test. (15)

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8. (*a*) The following substances are used in large scale industrial processes:

coke **hydrogen** **iron ore** **limestone** **nitrogen** **sulphur**

Which of these substances are used in the industrial production of

(i) ammonia

(ii) sulphuric acid

(iii) iron? (30)

Which of the substances, ammonia, sulphuric acid and iron are made using the

(i) Blast Furnace

(ii) Haber Process

(iii) Contact Process? (18)

(*b*) The diagram shows the arrangement of apparatus used for the purification of copper by electrolysis.

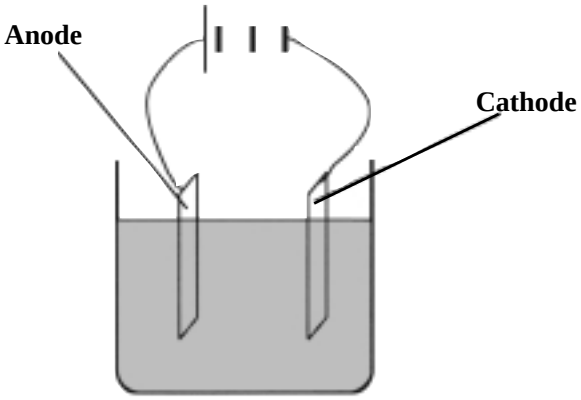
(i) Which electrode is made of impure copper?

(ii) What substance makes up the other electrode?

(iii) What is the name <u>or</u> formula of the electrolyte used?

(iv) Write an equation for the reaction occurring at the cathode.
Give <u>one</u> major use of pure copper.

(v) Name a valuable metal present as an impurity in the impure copper. (18)



9. (*a*) Match the following words to the statements (i) to (vi).

chlorination **deionisation** **filtration** **flocculation** **fluoridation** **hard**

(i) Water which does not easily form a lather with soap. (3)

(ii) The removal of small particles suspended in water using aluminium salts. (6)

(iii) The killing of harmful bacteria in water. (6)

(iv) A treatment carried out on water to help prevent tooth decay. (6)

(v) Passing water through a bed of sand to remove any suspended solids. (6)

(vi) Removal of all salts from water. (6)

(*b*) Sewage treatment involves three stages **primary**, **secondary** and **tertiary** treatment. Identify the stage where:

(i) bacteria are used to break down the sewage

(ii) solid material is removed by screening and settling

(iii) phosphates and nitrates are removed. (18)

Failure to remove phosphates and nitrates from sewage can lead to *eutrophication.*

What is meant by eutrophication?

Give <u>two</u> of the effects of eutrophication on a river or lake. (15)

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

(*a*) Define (i) an acid, (ii) pH. (12)

How would you test a solution to measure its pH? (9)

The concentration of a sulphuric acid (H_2SO_4) solution is 0.01 M.

(i) What is the concentration of H^+ ions in this solution in mol litre^{-1} (mol dm^{-3})? (6)

(ii) Calculate the pH of the solution. (6)

(*b*) **Avogadro**, **Dobereiner**, **Mendeleef** and **Newlands** are of historical importance in chemistry.

(i) Which of these proposed the *law of triads*? (6)

(ii) Who proposed the law of octaves? State this law. (12)

(iii) In Mendeleef's periodic table the elements were arranged in order of increasing atomic weights. In what order are elements arranged in the modern Periodic Table? (6)

(iv) Which of these scientists has a gas law named after him? State that law. (9)

(*c*) A sample of 22 g of propane gas was burned in excess oxygen.

The carbon dioxide and water produced was collected.

Propane burns according to the equation:

$$\mathbf{C_3H_{8(g)} + 5O_{2(g)} \rightarrow 3CO_{2(g)} + 4H_2O_{(l)}}$$

(i) How many moles of propane gas were burned? (6)

(ii) How many moles of oxygen were needed for complete combustion of the propane? (6)

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

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

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

ionic **electrostatic** **macromolecular** **covalent molecular** **covalent**

high **low** **van der Waals** **soft** **hard**

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

Sodium chloride is an example of an _____1_____ crystal. The forces that hold the crystal together are _____ 2_____ forces. Sodium chloride has a _____3_____ melting point. Diamond and graphite are both _____4_____crystals. The carbon atoms in diamond are held together by _____5_____ bonds and diamonds are very _____6_____. The carbon atoms in graphite are arranged in layers and each layer is attracted to the next by _____7_____ forces. Graphite is a _____8_____substance. Iodine and solid carbon dioxide are examples of _____9_____ crystals. The molecules are held in place in these crystals by _____10_____ forces. Solid carbon dioxide has a _____11_____ melting point. (11 x 3)