Coimisiún na Scrúduithe Stáit
State Examinations Commission

LEAVING CERTIFICATE EXAMINATION, 2004

CHEMISTRY - ORDINARY LEVEL

TUESDAY, 22 JUNE – AFTERNOON 2.00 TO 5.00

400 MARKS

Answer **eight** questions in all

These **must** include at least **two** questions from **Section A**

All questions carry equal marks (50)

Information

Relative atomic masses: H = 1, O = 16, S = 32

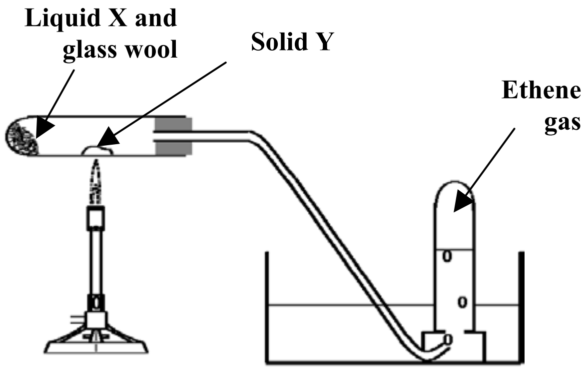
Molar volume at s.t.p. = 22.4 litres

Avogadro constant = 6×10^{23} mol^{-1}

Section A

Answer at least <u>two</u> questions from this section [see page 1 for full instructions].

1. The apparatus shown in the diagram was used to prepare a sample of ethene gas (**C_2H_4**). A little of liquid **X** was poured into a boiling tube and some glass wool was pushed to the end of the boiling tube. Some powdered solid **Y** was heaped about halfway along the tube. A Bunsen flame was used to heat the outside of the boiling tube under **Y**. A number of test tubes of gas were collected.



(*a*) Identify the liquid **X** and the solid **Y**. (8)
What is the colour of solid **Y**? (3)

(*b*) What is the purpose of the glass wool? (6)

(*c*) Why were the first few test tubes of gas collected not used? (6)

(*d*) When heating is stopped at the end of the experiment a suck back of water into the boiling tube is likely to occur. Why might a suck back occur when the heating is stopped, and what action should be taken to avoid this happening? (9)

(*e*) Describe a laboratory test you could carry out on a test tube of ethene to show combustion of the gas. What is observed during this test? What are the products of the combustion reaction? Describe a test to confirm the presence of **one** of these combustion products. (18)

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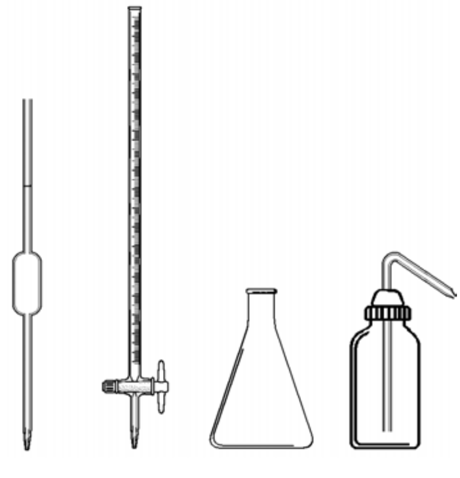
2. A 0.10 M standard solution of sodium carbonate (**Na_2CO_3**) was used to find the concentration of a given hydrochloric acid solution by titration. The pieces of apparatus **A**, **B**, **C** and **D** shown in the diagram were used in the experiment.



(*a*) Name the pieces of apparatus **A**, **B**, and **C**. (11)

(*b*) Describe the correct procedure for rinsing **A** before using it to measure the sodium carbonate solution. (6)

(*c*) Mention **two** precautions which should be taken when using **B**. (9)

(*d*) **D** is a wash bottle containing deionised water. What use should be made of it *during* the titration? (6)

(*e*) Name a suitable indicator for this titration. What colour change was observed in **C** at the end point? (9)

(*f*) The balanced equation for the titration reaction is:

$$\mathbf{Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2}$$

When the hydrochloric acid (**HCl**) solution was titrated a number of times against 25 cm^3 portions of the 0.10 M solution of sodium carbonate (**Na_2CO_3**) an average accurate titre of 20.0 cm^3 was obtained. Calculate the concentration of the hydrochloric acid solution in moles per litre. (9)

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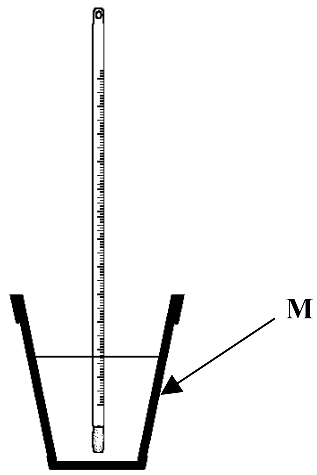
3. The diagram shows an apparatus used to measure the heat of reaction (ΔH) for the reaction between hydrochloric acid (**HCl**) and a solution of sodium hydroxide (**NaOH**).



(*a*) The reaction occurring in this experiment is *exothermic*. Explain the term *exothermic*. (5)

(*b*) Name a suitable material for container **M**. Explain your choice of material. (12)

(*c*) Name a piece of apparatus which could have been used in this experiment to measure out 100 cm^3 of hydrochloric acid solution accurately. (3)

(*d*) State **one** precaution which could have been taken to obtain an accurate value for the final temperature reached when the two solutions were mixed. (6)

(*e*) Both hydrochloric acid and sodium hydroxide solutions are corrosive.
Describe or draw a clear diagram of the hazard-warning symbol that should be used on the labels of bottles to indicate that the contents are corrosive. (6)

(*f*) When 100 cm^3 of 1.0 M hydrochloric acid reacted with excess sodium hydroxide solution, 5.71 kJ of heat were produced.

(*i*) How many moles of hydrochloric acid reacted?
(*ii*) How many kJ of heat would have been produced if one mole of hydrochloric acid (**HCl**) reacted?
(*iii*) Hydrochloric acid reacts with sodium hydroxide according to the equation:

$$\mathbf{HCl + NaOH \rightarrow NaCl + H_2O}$$

What is the heat of reaction (ΔH) for the reaction between hydrochloric acid and sodium hydroxide? (12)

(*g*) The energy content (calorific value) of foods and fuels can be measured in a special piece of apparatus. Name this apparatus. (6)

Section B

[See page 1 for instructions regarding the number of questions to be answered]

4. Answer **eight** of the following items (*a*), (*b*), (*c*), etc. (50)

(*a*) Name the scientist who discovered the nucleus of the atom.

(*b*) State **one** use of the radioisotope ^{60}Co (cobalt-60).

(*c*) What is the trend in the size of atomic radii across a period of the periodic table?

(*d*) State **two** characteristic properties of ionic substances.

(*e*) What is the volume in litres of 6×10^{23} gaseous molecules at standard temperature and pressure?

(*f*) Write the name or formula of the carboxylic acid found in vinegar.

(*g*) The label on a bottle of wine says that the alcohol content is 11% (v/v). How many cm^3 of ethanol per litre does this wine contain?

(*h*) A 100 cm^3 sample of sea water contained 0.022 grams of suspended solids. Calculate the concentration of suspended solids in p.p.m.

(*i*) Write the equilibrium constant expression ($\boldsymbol{K_c}$) for the equilibrium

$$\mathbf{2SO_2 + O_2 \rightleftharpoons 2SO_3}$$

(*j*) Why is chlorine added to domestic water supplies?

(*k*) Answer part **A** or **B**

A State **two** factors used to determine choice of location for a chemical industry.

or

B Use a suitable example to explain the term alloy.

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5. (*a*) The following words are omitted from the passage below:

electronegativity **polar** **pair**

water **non-polar** **boiling points**

Write in your answer book the omitted words corresponding to each of the numbers 1 to 6. (36)

A covalent bond is formed when a ____1____ of electrons is shared between the bonding atoms. When the electrons are shared equally, a ____2____ covalent bond is formed, but when one atom has a greater attraction for the bonding electrons, a ____3____ covalent bond is formed. Most covalent compounds have low ____4____ and do not dissolve very well in ____5____. The nature of chemical bonds can be predicted using ____6____ values.

(*b*) Draw a dot and cross diagram to describe the bonding in methane (**CH_4**). (9)

What is the shape of the methane molecule? (5)

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6. The following compounds are all used as fuels:

methane **butane** **benzene** **ethyne** **hydrogen**

(*a*) Select from the list above one compound in each case which

(*i*) is often formed in refuse dumps and slurry pits, (5)
(*ii*) is used in oxyacetylene torches for cutting and welding, (6)
(*iii*) is used as a fuel for space rockets, (6)
(*iv*) is a component of liquid petroleum gas (LPG), (6)
(*v*) has a high octane number. (6)

(*b*) One of the compounds listed above is described as *aromatic*. Which compound is *aromatic*? Draw a diagram to show the structure of a molecule of this compound. (12)

(*c*) Give **one** disadvantage of hydrogen as a fuel. (3)
State **one** method of manufacturing hydrogen gas on an industrial scale. (6)

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7. Hydrogen peroxide solution decomposes rapidly in the presence of a manganese dioxide catalyst according to the following equation.

$$2H_2O_2 \rightarrow 2H_2O + O_2$$

In an experiment using this reaction, the oxygen gas was collected and its volume measured every minute until the reaction was complete. The data obtained is shown in the table.

Time/minutes	0	1	2	3	4	5	6	7	8
Volume of O_2/cm^3	0.0	7.7	11.7	14.8	17.2	19.0	19.8	20.0	20.0

(*a*) Draw a labelled diagram of the apparatus which could be used to carry out this reaction, collect the oxygen gas, and measure its volume. (11)

(*b*) On graph paper, plot a graph of the volume of oxygen gas produced (y-axis) against time (x-axis). (18)

(*c*) Was the rate of reaction faster after 1 minute or after 4 minutes? Explain your answer, referring to the shape of your graph in doing so. (6)

(*d*) Use the graph to estimate the volume of oxygen gas collected after 2.5 minutes. (9)

(*e*) Use the graph to estimate the time at which the reaction was complete. (6)

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8. Examine the reaction scheme and answer the questions that follow:

$$\underset{\underline{\mathbf{A}}}{\mathbf{CH_2CH_2}} \xrightarrow{\mathbf{X}} \underset{\underline{\mathbf{B}}}{\mathbf{CH_3CH_3}} \xrightarrow{\mathbf{Y}} \underset{\underline{\mathbf{C}}}{\mathbf{CH_3CH_2Cl}}$$

(*a*) Which **one** of the compounds **A**, **B** or **C** is an unsaturated hydrocarbon? (5)

(*b*) Which **one** of the compounds **A**, **B** or **C** has only planar carbon atoms? (6)

(*c*) Name the compounds **A**, **B** and **C**. (18)

(*d*) Classify (*i*) conversion **X** and (*ii*) conversion **Y** as an *addition*, *elimination* or *substitution* reaction. (12)

(*e*) Which **one** of the compounds **A**, **B** or **C** is easily polymerised?
State the name of the polymer formed. (9)

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9. (*a*) What is meant by the term *hard water*? (5)

How may *temporary* hardness be removed from a water sample? (6)

Give the name **and** formula of a compound which causes *permanent* hardness in water (9)

(*b*) Select from the following list the answers to the questions labelled (*i*) to (*v*) below.

eutrophication **bacterial breakdown**

phosphates and nitrates **settlement and screening** **silage effluent**

(*i*) What takes place in the primary treatment of sewage?

(*ii*) What process occurs in the secondary treatment of sewage?

(*iii*) What does tertiary treatment of sewage remove?

(*iv*) Which term describes the enrichment of water with nutrients?

(*v*) Name a pollutant which can cause the enrichment of water with nutrients. (30)

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10. Answer any **two** of the parts (*a*), (*b*) and (*c*). (2 × 25)

(*a*) Define the terms (*i*) *acid*, (*ii*) *base* and (*iii*) *neutralisation*. (13)

Give an everyday example of neutralisation. (6)

Name a household base. (6)

(*b*) Define *relative atomic mass*. (7)

Calculate the relative molecular mass of sulfuric acid (**H_2SO_4**) from the relative atomic masses of its elements. (6)

What is the percentage by mass of sulfur in sulfuric acid? (9)

How many moles of sulfuric acid are contained in 4.9 g of the acid? (3)

(*c*) Protons, neutrons and electrons are located in the atom.
Copy the table below into your answer book and fill in the missing information. (13)

	Relative mass	**Relative charge**	**Location**
Proton	1		
Electron	1/1840		Outside the nucleus
Neutron		0	In the nucleus

Define *atomic number*. (6)

State the arrangement of electrons in the main energy levels in an atom of potassium. (6)

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11. Answer any **two** of the parts (*a*), (*b*) and (*c*). (2 × 25)

(*a*) Define *oxidation* in terms of electron transfer. (7)

When zinc is added to copper sulfate solution the copper is displaced according to the equation:

$$\mathbf{Zn} + \mathbf{CuSO_4} \rightarrow \mathbf{Cu} + \mathbf{ZnSO_4}$$

(*i*) State **one** change observed as the reaction proceeds. (6)

(*ii*) Which substance is oxidised? (6)

(*iii*) Scrap iron can be used to extract copper metal. Which of these two metals is higher up the electrochemical series? (6)

(*b*) Define pH. (7)

Describe how you would use universal indicator paper (pH paper) or solution to measure the pH of a river water sample. (9)

Calculate the pH of a 0.001 M solution of nitric acid (**HNO_3**). (9)

(*c*) Answer part **A** *or* part **B**.

A

Explain the terms (*i*) *feedstock* and (*ii*) *co-products* as used in industrial chemistry. (10)

Explain how batch and continuous processes differ. (9)

Specify **two** ways in which the chemical industry has made a positive contribution to modern life. (6)

or

B

Name the father and son team pictured on the right who were pioneers in the study of X-ray crystallography. (5)

Pioneers in the study of X-ray crystallography

Copy the table into your answer book and fill in the missing information about the binding forces in each crystal. (15)

Type of crystal	**Example**	**Binding Forces**
Ionic	Sodium chloride	
Molecular	Iodine	
Covalent macromolecular	Diamond	

Name the scientist pictured on the right who determined the crystal structures of vitamin B_{12} and penicillin. (5)

The scientist who determined the structures of vitamin B_{12} and penicillin

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