Coimisiún na Scrúduithe Stáit
State Examinations Commission

LEAVING CERTIFICATE EXAMINATION, 2011

CHEMISTRY – ORDINARY LEVEL

TUESDAY, 21 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).

The information below should be used in your calculations.

Relative atomic masses: H = 1, C = 12, N = 14, O = 16, Na = 23, Al = 27, Cl = 35.5

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

Avogadro constant = 6.0×10^{23} mol^{-1}

The use of the Formulae and Tables booklet approved for use in the State Examinations is permitted. A copy may be obtained from the examination superintendent.

Section A

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

1. The two arrangements of apparatus shown in Figures **A** and **B** are widely used in organic chemistry.

(*a*) Examine Figure **A** and answer the following questions.

(*i*) Name the separation technique carried out using this arrangement of apparatus.

(*ii*) Identify an organic experiment from your course where this arrangement of apparatus was used.

What substance was collected at **X** when this experiment was carried out? (14)

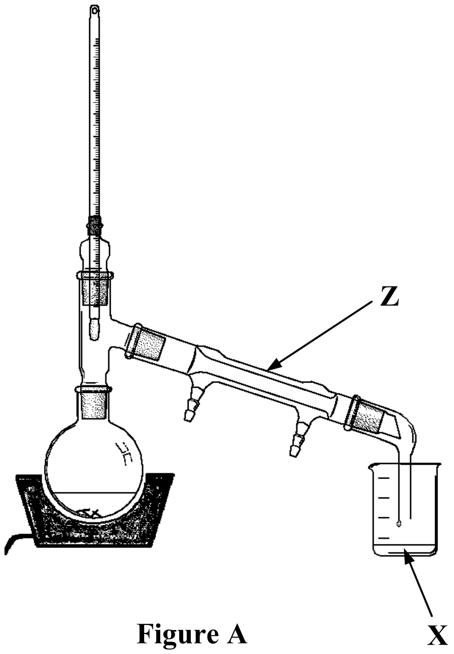


Figure A

(*b*) Examine Figure **B** and answer the following questions.

(*i*) Name the process carried out using this arrangement of apparatus.

(*ii*) Identify an organic experiment from your course where this arrangement of apparatus was used.

(*iii*) What was the purpose of carrying out this process?

Explain what happens to the liquid in the round-bottomed flask during this process. (21)

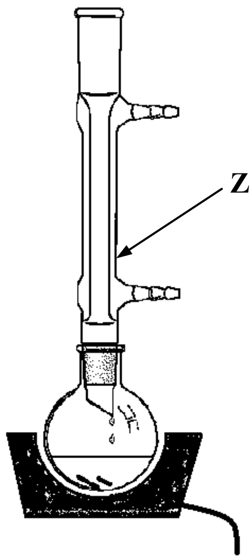


Figure B

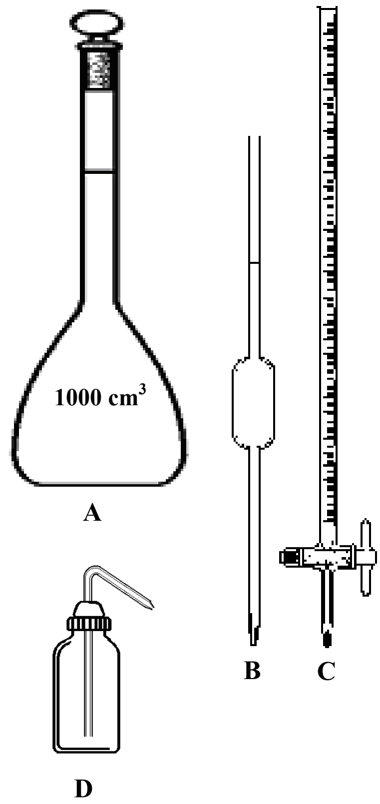
(*c*) Name the common part labelled **Z** in each arrangement of apparatus.

Make a rough sketch of either arrangement of apparatus in your answer-book and clearly indicate which part of **Z** should be connected to the water supply from a cold tap.

How does this part of the apparatus work? (9)

(*d*) Explain why small pieces of glass or pumice stone were added to the round-bottomed flask at the start of each of the processes shown. (6)

2. A 0.05 M *standard solution* of sodium carbonate was made up by weighing out ***x*** grams of anhydrous sodium carbonate (**Na_2CO_3**), dissolving it in deionised water, and making the solution carefully up to the mark in a suitable 1 litre flask. This solution was then used to find, by titration, the concentration of a given hydrochloric acid (**HCl**) solution. Some of the pieces of equipment used are shown on the right.



(*a*) Name the piece of equipment **A** used to make up 1 litre of the **Na_2CO_3** solution. (5)

(*b*) What should be done with **A** and its contents immediately after bringing the solution up to the 1 litre mark with deionised water? Why is this important? (6)

(*c*) Calculate the mass (***x*** grams) of sodium carbonate (**Na_2CO_3**) required to make 1 litre of a 0.05 M solution. (6)

(*d*) Name the pieces of equipment **B** and **C** used in the titrations. (6)

(*e*) What use would be made of the piece of equipment labelled **D** during the titrations? (6)

(*f*) Name a suitable indicator for this titration. State the colour change at the end point. (9)

(*g*) Why is it helpful to place the titration flask on a white tile during the titrations? (3)

(*h*) A number of accurate titrations were carried out. The balanced equation for the titration reaction is:

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

It was found that, on average, 25.0 cm^3 of the 0.05 M sodium carbonate (**Na_2CO_3**) solution were neutralised by 22.7 cm^3 of the hydrochloric acid (**HCl**) solution.

Calculate the concentration of the hydrochloric acid solution in moles per litre. (9)

---

3. A student investigated the rate of decomposition of hydrogen peroxide (**H_2O_2**) using a suitable catalyst. The oxygen produced was collected and its volume measured.

(*a*) Give the name <u>and</u> formula of a suitable catalyst for this reaction. (8)

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

The table shows the data obtained in the investigation.

Time **minutes**	0	2	4	6	8	10	12	13
Volume of oxygen gas produced **cm^3**	0	40	60	70	75	77	78	78

(*c*) (*i*) On graph paper, plot the volume of oxygen produced (*y*-axis) against time (*x*-axis). (15)

(*ii*) From your graph find the volume of oxygen produced in the first 3 minutes. (6)

(*iii*) Use your graph to find the time at which the reaction was finished. (3)

(*d*) Why does the rate of oxygen evolution slow down as time passes? (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*) How did John Dalton describe atoms?

(*b*) Name the piece of equipment used to measure the calorific values of foods and fuels.

(*c*) What is an *exothermic reaction*?

(*d*) Name a process carried out in oil refineries to increase the octane number of fuels.

(e) Why is the use of benzene (C_6H_6) not permitted in the school laboratory?

(*f*) The Irish scientist, pictured on the right, described the relationship between the volume occupied by a fixed mass of gas and its pressure at constant temperature. He is often described as "the father of chemistry". What is his name?

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

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

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

(*i*) Calculate the percentage by mass of nitrogen in ammonium nitrate (NH_4NO_3).

(*j*) Name **two** of the metals that form the catalyst in the catalytic converter of a car.

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

A Give **one** major use that was made of chlorofluorocarbons (CFCs) before they were banned for general use.

or

B Name the non-metallic element generally found in steel at concentrations of less than 1.7%.

5. (*a*) Define (*i*) *atomic number*, (*ii*) *mass number*. (11)

(*b*) Name the English scientist, pictured on the right, who identified electrons as negatively charged subatomic particles in the 1890s. (6)

(*c*) Neils Bohr described a theory of atomic structure that involved the electrons occupying shells, orbits or fixed energy levels. What is the maximum number of electrons that can occupy the second shell (main energy level)? (3)

(*d*) Draw a diagram showing the arrangement of electrons in an oxygen atom. Use dots (•) or crosses (×) to represent the electrons. (6)

(*e*) Define *electronegativity*. (6)

(*f*) Use electronegativity values to predict the type of bonding that occurs in a water molecule. (6)

(*g*) Draw a dot and cross diagram to show the bonding in a water molecule. (9)
State the shape of a water molecule. (3)

6. Hydrogen ($\mathbf{H_2}$), methane ($\mathbf{CH_4}$), ethyne ($\mathbf{C_2H_2}$) and butane ($\mathbf{C_4H_{10}}$) are all combustible.

(*a*) Which of these gases forms the principal component of (*i*) natural gas, (*ii*) bottled gas used to fuel patio heaters, (*iii*) a fuel used in high temperature cutting equipment? (11)

(*b*) Why are mercaptans added to both natural gas and liquid petroleum gas? (3)

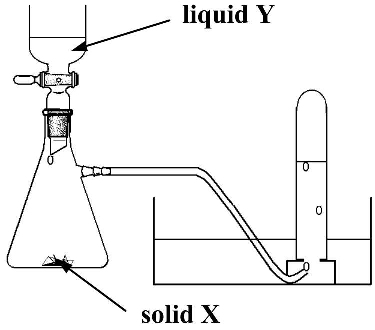
Oil refineries distil crude oil to produce several fractions ranging from gases to solids. These include kerosene and a residue fraction (bitumen).

(*c*) Give a major use of

(*i*) kerosene,

(*ii*) the residue fraction (bitumen). (6)

(*d*) The diagram on the right shows an arrangement of apparatus suitable for the preparation of ethyne gas in a school laboratory.



(*i*) Identify a solid **X** and a liquid **Y** suitable for this preparation. (12)

(*ii*) Describe what you would see if a sample of ethyne gas was burned in air. Write a balanced equation for the complete combustion of ethyne in oxygen. (12)

(*e*) Give **one** advantage of using hydrogen as a fuel. (6)

---

7. (*a*) Define (*i*) *an acid*, (*ii*) *a base*, according to the Arrhenius theory. (8)

(*b*) Give **one** example of a common household acid and **one** example of a common household base. (6)

(*c*) Explain the term *neutralisation*. Give **one** everyday example. (12)

(*d*) Define pH. (6)

Calculate the pH of (*i*) 0.1 M hydrochloric acid (**HCl**), (*ii*) 0.1 M sulfuric acid ($\mathbf{H_2SO_4}$). (12)

(*e*) Give **one** limitation of the pH scale. (6)

---

8. Answer the questions below with reference to compounds **W**, **X**, **Y** and **Z** in the following reaction scheme.

$$\underset{\mathbf{W}}{\mathbf{CH_2CH_2}} \longrightarrow \underset{\mathbf{X}}{\mathbf{CH_3CH_2OH}} \longrightarrow \underset{\mathbf{Y}}{\mathbf{CH_3CHO}} \longrightarrow \underset{\mathbf{Z}}{\mathbf{CH_3COOH}}$$

(*a*) Which **one** of the compounds **W**, **X**, **Y** or **Z** has only tetrahedral carbon atoms? (5)

(*b*) Give the names of the compounds **W**, **X**, **Y** and **Z**. (12)

(*c*) What word describes

(*i*) the conversion of **W** to **X**, (*ii*) the conversion of **Y** to **Z**? (12)

(*d*) Describe a test to show that **W** is an unsaturated compound. (6)

(*e*) Give **one** household use of compound **Z**. (6)

(*f*) Which of the compounds can be polymerised to form a widely used plastic? Give the name of this plastic. (9)

9. (*a*) The treatment of drinking water for an urban supply consists of a number of stages. The main stages are listed below.

chlorination **filtration** **flocculation** **fluoridation**

pH adjustment **sedimentation**

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

Harmful bacteria are killed by ____**1**____ .

Large beds of sand are used in the ____**2**____ stage.

If the water is too acidic, lime is added in the ____**3**____ stage.

The ____**4**____ of the water is done to help prevent tooth decay.

The ____**5**____ stage involves the addition of chemicals that encourage finely suspended material to clump together and sink. Large ____**6**____ tanks are used in this stage.

(*b*) Sewage treatment is often broken up into three stages: **primary**, **secondary** and **tertiary**. Describe the processes carried out in any **two** of these stages and the effects these processes have on the material being treated. (14)

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

(*a*) A flame test can be used to identify the metal present in a salt.

Describe how you would carry out a flame test on a sample of a salt. (16)

What colour would you expect each of the following salts to give in a flame test:
(*i*) sodium chloride, (*ii*) potassium nitrate? (9)

(*b*) (*i*) Give an application of thin-layer chromatography (TLC) in forensic science. (4)

(*ii*) Describe a simple experiment you carried out to demonstrate the use of paper, thin layer or column chromatography. (15)

(*iii*) State the principle on which all chromatographic techniques are based. (6)

(*c*) Define (*i*) *oxidation*, (*ii*) *reduction*, in terms of electron transfer. (7)

The equation below describes the reaction between magnesium and chlorine to form magnesium chloride.

$$\mathbf{Mg + Cl_2 \longrightarrow MgCl_2}$$

(*iii*) Indicate which substance is oxidised and which substance is reduced in this reaction. Justify your answer. (9)

(*iv*) Describe a test for the chloride ion in aqueous solution. (9)

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

(*a*) What is *radioactivity*? (7)

(*i*) Name the **three** types of radiation associated with radioactive substances.
Which is the most penetrating of these radiations? (12)

(*ii*) Marie Curie, pictured on the right, was the recipient of two Nobel prizes.
One Nobel prize related to the isolation of two radioactive elements.
One of these elements was named in honour of the country of her birth.
Name **both** radioactive elements. (6)

(*b*) When a piece of aluminium of mass 2.7 g was dissolved in excess hydrochloric acid the following reaction occurred.

$$2Al + 6HCl \longrightarrow 2AlCl_3 + 3H_2$$

(*i*) How many moles of aluminium reacted? (9)

(*ii*) How many moles of hydrochloric acid were used up in the reaction? (4)

(*iii*) What mass of aluminium chloride was formed? (12)

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

A

Over 100 years ago the Swedish chemist, Arrhenius, pictured on the right, predicted that carbon dioxide produced by the combustion of fossil fuels would cause environmental damage.

(*i*) Explain the *greenhouse effect*.
State **two** possible consequences of an increased greenhouse effect. (10)

(*ii*) Both methane and water vapour have a far greater greenhouse effect than carbon dioxide. State **one** reason in each case why methane and water vapour are increasing in concentration in the atmosphere. (9)

(*iii*) Carbon dioxide is produced in large quantities by the combustion of fossil fuels.
Give the name and formula of **one** other oxide, produced in the burning of fossil fuels, that gives rise to acid rain. (6)

or

B

Name the English scientist, pictured on the right, who isolated the elements sodium and potassium in the early 1800s.

(*i*) What technique did he use to isolate sodium and potassium? (7)

(*ii*) Iron can be isolated from its ores in a blast furnace.
Explain why sodium cannot be extracted in a similar way. (6)

(*iii*) How is iron galvanised?
How does galvanising protect iron from corrosion? (12)

Blank Page