Coimisiún na Scrúduithe Stáit
State Examinations Commission

LEAVING CERTIFICATE EXAMINATION, 2010

CHEMISTRY – ORDINARY LEVEL

TUESDAY, 22 JUNE – AFTERNOON 2.00 TO 5.00

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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, C = 12, O = 16, Na = 23, Cu = 63.5

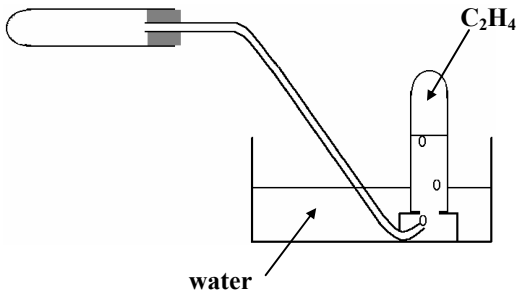
Molar volume at s.t.p. = 22.4 litres

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

Section A

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

1. A group of students prepared ethene, C_2H_4, in the school laboratory using the apparatus shown in the diagram. The ethene was obtained using an organic liquid **X** and a solid reagent **Y** and heat. The heat was supplied by a Bunsen burner. The ethene was collected in test tubes over water as shown.



(*a*) Give the name *<u>and</u>* formula of organic liquid **X**. (8)

(*b*) Identify solid **Y** *<u>and</u>* describe its appearance. (6)

(*c*) Copy the diagram into your answer-book and complete it by indicating the correct positions of

(*i*) the liquid **X**,

(*ii*) the solid **Y**,

(*iii*) the Bunsen burner.

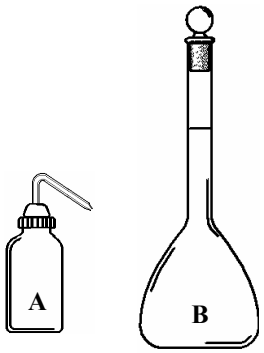
How was the liquid **X** kept in its proper position in the horizontal test tube? (15)

(*d*) What precaution should have been taken when the Bunsen burner was turned off at the end of the experiment? What could have happened if this precaution was not taken? (12)

(*e*) A colour change was observed when a few drops of acidified potassium manganate(VII), $KMnO_4$, were shaken in a stoppered test tube of ethene gas.

What colour change was observed?
What information does this test result give about ethene? (9)

2. Hydrochloric acid, **HCl**, is not a *primary standard*.
A solution of hydrochloric acid, **HCl**, was standardised by titration with a 0.05 M solution of sodium carbonate, $\mathbf{Na_2CO_3}$.



The sodium carbonate solution was made up by weighing out 5.3 g of anhydrous sodium carbonate on a clock glass, dissolving it in deionised water in a beaker, and then diluting the solution to exactly 1 litre in flask **B**.

It was found by titration that 25.0 cm^3 of the sodium carbonate solution needed exactly 27.5 cm^3 of the hydrochloric acid solution for neutralisation.

The equation for the reaction involved in the titration is

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

(*a*) Name the pieces of apparatus **A** and **B**. (8)

(*b*) Explain the terms (*i*) *standard solution*, (*ii*) *primary standard*, in volumetric analysis. (9)

(*c*) What is meant by describing the sodium carbonate used as *anhydrous*?
Give **one** property of anhydrous sodium carbonate that makes it suitable for use as a primary standard. (6)

(*d*) The piece of equipment **A** has a number of uses both when making up the sodium carbonate solution and also when carrying out the titration. Describe any **two** of these uses. (12)

(*e*) Show clearly that a solution containing 5.3 g of anhydrous sodium carbonate, $\mathbf{Na_2CO_3}$, in 1 litre is a 0.05 M solution. (6)

(*f*) Find the molarity of the hydrochloric acid solution correct to two decimal places. (9)

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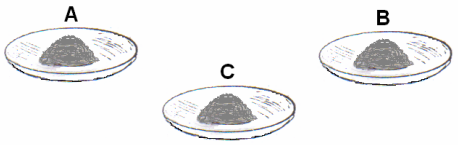
3. A student was given a sample of each of the three different salts listed in the table below on clock glasses **A**, **B** and **C** as shown in the diagram. The student was asked



(*i*) to identify the salts by means of flame tests,

(*ii*) to confirm the identity of the anion in each salt by testing with appropriate reagents.

The student presented the results in a table as shown below.

Salt	Flame colour	Anion test reagents	Observation in anion test
Lithium chloride (**LiCl**)			
Sodium nitrate ($\mathbf{NaNO_3}$)			
Potassium sulfate ($\mathbf{K_2SO_4}$)			

(*a*) Give a full description of the procedure involved in carrying out a flame test.
In the case of each of the three salts state the flame colour observed. (18)

(*b*) Which anion test, for chloride ($\mathbf{Cl^-}$), for nitrate ($\mathbf{NO_3^-}$), or for sulfate ($\mathbf{SO_4^{2-}}$), involves:

(*i*) the careful addition of concentrated sulfuric acid down the side of a test-tube containing a sample of salt mixed with saturated iron(II) sulfate solution,

(*ii*) the addition of silver nitrate solution to a solution of the salt,

(*iii*) the addition of a barium chloride solution to a solution of the salt?

State the observation made that clearly confirmed the anion in each of these tests. (32)

Section B

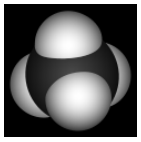
[See page 1 for instructions regarding the number of questions to be answered.]

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

(*a*) Name the scientist, pictured on the right, who discovered the atomic nucleus.

(*b*) State **two** differences between Mendeleev's periodic table and the modern periodic table.

(*c*) Define *covalent bond*.



(*d*) Give **one** use of thin layer chromatography (TLC).

(*e*) What is the shape of the methane molecule, a model of which is shown on the right?

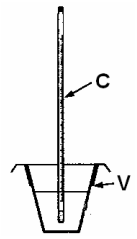
(*f*) What would you observe when ethanal reacts with warm Fehling's reagent?

(*g*) Distinguish between temporary and permanent hardness of water.

(*h*) The picture on the right shows the French scientist, Jacques Charles.
Name the two properties of gases that are related mathematically
in the gas law that bears his name.

(*i*) Write the equilibrium constant (K_c) expression for the following reaction.

$$CH_4 + H_2O \rightleftharpoons CO + 3H_2$$



(*j*) The apparatus shown on the right is used to measure the heat of reaction
when hydrochloric acid (**HCl**) and sodium hydroxide (**NaOH**) solution
react. Name the piece of equipment **C**.
What material would you choose for vessel **V** so as to minimise heat loss?

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

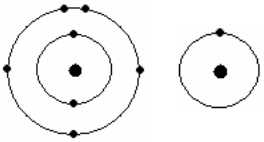
A List **two** factors that would influence the location of a chemical factory.

B Explain the term *alloy*. Give an example of an alloy.

5. The English scientist, pictured on the right, introduced his atomic theory
in the early 1800s. He stated that all matter is made up of tiny,
indivisible particles called atoms. He also stated that the atoms
of a particular element are all the same, especially in regard to mass.

(*a*) Name the English scientist. (5)
Explain by reference to a named element why he was incorrect in stating that
all the atoms of a particular element have the same mass.
What term is used for atoms of the same element that have different atomic masses? (12)

(*b*) Diagrams of nitrogen and hydrogen atoms are shown
on the right. Nitrogen and hydrogen combine to form ammonia.
State the valency (*i*) of nitrogen, (*ii*) of hydrogen, in ammonia.
Explain how these valencies arise by reference to the noble gases. (12)



(*c*) Use dot and cross diagrams to describe the bonding in the ammonia
molecule. What is the shape of the ammonia molecule? (12)

(*d*) Define *electronegativity*.
Use electronegativity values to predict the type of bond formed between nitrogen and hydrogen. (9)

6. The alkanes are a group of *hydrocarbons* that are commonly used as fuels. The simplest of the alkanes is methane. Another alkane of molecular formula $\mathbf{C_8H_{18}}$ has several *structural isomers*. One of these isomers, 2,2,4-trimethylpentane, has an application in connection with the octane number of a fuel.

(*a*) What are (*i*) *hydrocarbons*, (*ii*) *isomers*? (11)

(*b*) State **two** important sources of hydrocarbon fuels. (6)

(*c*) Mention **two** situations in which there may be a hazardous build-up of methane gas.
Why are the levels of methane in the lower atmosphere a cause of environmental concern? (15)

(*d*) What do you understand by the *octane number* of a fuel?
What is the significance of the compound 2,2,4-trimethylpentane in relation to octane numbers?
Draw the structural formula of 2,2,4-trimethylpentane. (18)

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7. Answer the questions below with reference to the organic compounds listed.

$\mathbf{C_2H_2}$ $\mathbf{CH_2CH_2}$ $\mathbf{CH_3CH_2OH}$ $\mathbf{CH_3COOH}$

(*a*) Which **one** of the four compounds (*i*) has only tetrahedral carbon atoms, (*ii*) has one tetrahedral atom and one planar carbon atom, in its molecules? (8)

(*b*) Give the systematic (IUPAC) names for (*i*) $\mathbf{C_2H_2}$, (*ii*) $\mathbf{CH_3COOH}$. (6)

(*c*) Which one of the four compounds
(*i*) is found in large quantities in wines and spirits,
(*ii*) gives the sharp taste to vinegar,
(*iii*) is used to synthesise the plastic PVC? (9)

(*d*) Describe the appearance of the flame produced when a sample of $\mathbf{C_2H_2}$ is burned in air.
Write a balanced equation for the complete combustion of $\mathbf{C_2H_2}$ in oxygen. (9)

(*e*) What type of chemical reaction is involved
(*i*) in the conversion of $\mathbf{CH_2CH_2}$ to $\mathbf{CH_3CH_2OH}$,
(*ii*) in the conversion of $\mathbf{CH_3CH_2OH}$ to $\mathbf{CH_3COOH}$?
For each conversion, indicate a suitable reagent or reagents for the conversion. (18)

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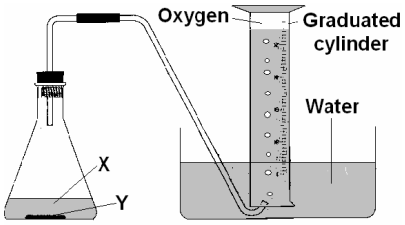
8. The volume of oxygen liberated from liquid **X** in the presence of catalyst **Y** was measured at two-minute intervals using the apparatus shown in the diagram. The results are shown in the table below.



Time (min)	0	2	4	6	8	10	12	14	16
Vol. (cm^3)	0	27	41	48	52	54	55	55	55

(*a*) Define *catalyst*. (5)

(*b*) Give (*i*) the name *or* formula of liquid **X**, (*ii*) the name *or* formula of catalyst **Y**. (12)

(*c*) When carrying out the experiment how would you decide that no further volume readings need be taken? (6)

(*d*) Plot, on graph paper, a graph of volume (*y*-axis) *versus* time (*x*-axis).
From the graph estimate the volume of gas liberated after 3 minutes. (18)

(*e*) Explain why the rate of the reaction decreases with time. (3)

(*f*) Using the same volume and concentration of liquid **X** and the same mass of catalyst **Y** as in the above experiment, suggest **one** way of increasing the rate of the reaction. (6)

9. (*a*) Define pH. (5)

In the treatment of water for drinking it may be necessary to adjust the pH.
Name a substance that is added to the water (*i*) if the pH is too high, (*ii*) if the pH is too low. (6)
What harm could result if the pH of a drinking water supply was too low? (6)

Flocculation and *fluoridation* are the terms used for two other processes involved in the treatment of water for drinking. In the case of **one** of these processes, explain *how* and *why* it is carried out. (12)

(*b*) The following words/phrases, which all relate to sewage treatment, are omitted from the passage below.

biological oxidation **eutrophication** **nitrates & phosphates** **solids**

Write in your answer book the omitted word/phrase corresponding to each number (1 to 4).

The primary stage of sewage treatment involves the removal of ____**1**____ . The remaining liquid waste undergoes ____**2**____ during the secondary stage. The levels of ____**3**____ are lowered during the tertiary stage to help prevent ____**4**____ . (21)

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

(*a*) A mass of 6.35 g of pure copper was reacted with an excess of warm concentrated sulfuric acid to produce copper(II) sulfate, water and sulfur dioxide according to the following equation:

$$\mathbf{Cu + 2H_2SO_4 \rightarrow CuSO_4 + 2H_2O + SO_2}$$

(*i*) How many moles of copper were used? How many moles of sulfuric acid were used up? (7)

(*ii*) What mass of water was produced in the reaction? (6)

(*iii*) What volume of sulfur dioxide (at s.t.p.) was produced in the reaction?
How many molecules did this volume contain? (12)

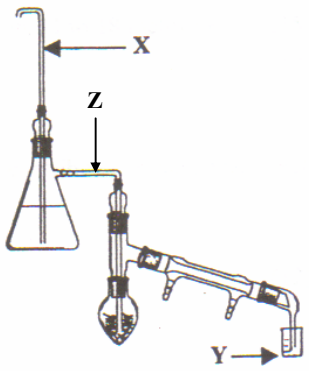
(*b*) The concentration of *free chlorine* in swimming pool water or bleach can be estimated using a colorimeter or a comparator.

(*i*) What is meant by *free chlorine*? What is its function in swimming pools? (7)

(*ii*) Why is it important to regularly monitor the level of *free chlorine* in swimming pools? (6)

(*iii*) Outline how you would carry out the estimation of *free chlorine* using a colorimeter or a comparator. (12)

(*c*) The diagram on the right shows the arrangement of apparatus for steam distillation.



(*i*) What substance did you extract at school using steam distillation? From what was this substance extracted? (7)

(*ii*) What is the function of the tube labelled **X**? (6)

(*iii*) A cloudy mixture made up of the extracted substance and another substance is collected at **Y**. Name the other substance. Name the substance that travels along the tube labelled **Z**. (12)

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

(*a*) Benzene and benzoic acid are *aromatic* compounds. Benzoic acid is purified by dissolving it in a suitable hot solvent, filtering the solution, and then allowing the solution to cool.

(*i*) What is meant by the term *aromatic* in organic chemistry? (4)

(*ii*) Give the name and structural formula of another aromatic compound. (9)

(*iii*) Name the method by which benzoic acid was purified.
Is this method used for purifying solids, liquids or gases? (9)

(*iv*) What health hazard is associated with the use of benzene? (3)

(*b*) The terms below are all encountered in the study of chemistry.

alpha particle **diffusion** **Arrhenius base** **reducing agent**

molecule **empirical formula**

In your answer book, match each term with its description (**A**, **B**, **C**, **D**, **E** or **F**) in the table below. (25)

A	*Produces hydroxyl (**OH**$^-$) ions in aqueous solution.*
B	*Loses electrons in a chemical reaction.*
C	*Shows the simplest ratio of atoms in a molecule.*
D	*The smallest part of a substance that can exist independently.*
E	*Is emitted by some radioactive elements and has a relative atomic mass of 4.*
F	*Spreading and mixing of substances due to random motion of their particles.*

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

A

By clear examples or otherwise, distinguish between the following pairs of terms used in industrial chemistry.

(*i*) *Main product* and *co-product*. (6)

(*ii*) *Fixed costs* and *variable costs*. (6)

(*iii*) *Batch process* and *continuous process*. (6)

State **two** ways in which chemistry benefits society. (7)

B

Low density poly(ethene), LDPE, is a polymer.
It was discovered in 1933 by chemists working for ICI.

(*i*) Explain the term *polymer*. (7)

(*ii*) Give **one** use of LDPE. (3)

(*iii*) What type of polymer is LDPE? (3)

(*iv*) Plastics are collected for recycling.
Apart from collection, list **three** of the stages in the recycling of a plastic. (9)

(*v*) Give **one** benefit of the recycling of plastics. (3)

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