Coimisiún na Scrúduithe Stáit
State Examinations Commission

LEAVING CERTIFICATE EXAMINATION, 2007

CHEMISTRY - ORDINARY LEVEL

TUESDAY, 19 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

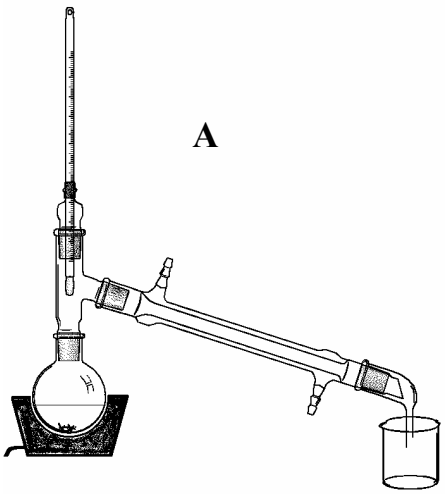
Molar volume at s.t.p. = 22.4 litres

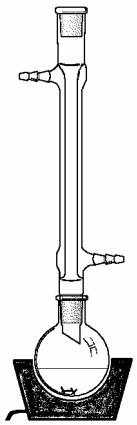
Avogadro constant = 6×10^{23} mol^{-1}

Section A

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

1. A group of students prepared a sample of soap in a school laboratory. A mixture of about 4 g of fat, 2 g of sodium hydroxide and 25 cm^3 of ethanol was refluxed for about 30 minutes. The apparatus was then rearranged and the reaction flask heated to remove the ethanol by distillation. Then the residue in the distillation flask was dissolved in a little boiling water and the mixture poured onto brine (saturated sodium chloride solution). The solid soap separated and it was collected by filtration. The soap was washed with a little ice-cold water. Some of the arrangements of apparatus used are drawn on the right.





(*a*) Which of the arrangements of apparatus (**A** or **B**) was used for (*i*) the reflux, (*ii*) the distillation stage of the preparation? (8)

(*b*) Draw a rough sketch of either arrangement of apparatus in your answer-book and clearly indicate which part of the condenser should be connected to the cold water tap. (6)

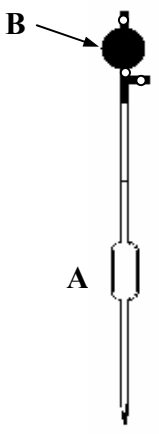
(*c*) Why was ethanol added to the fat and the sodium hydroxide? What else should have been added to the reaction flask before heating was commenced? (12)

(*d*) Why was only a small amount of boiling water used to dissolve the residue remaining in the distillation flask after the distillation? (6)

(*e*) When the soap was collected by filtration it was washed with a little ice-cold water.
Why was it important to wash the soap? (6)

(*f*) A small amount of the soap produced in this experiment was added to test tubes containing different water samples and the mixtures were shaken.
What would you expect to observe if the water used was
(*i*) deionised,
(*ii*) from a hard water region? (12)

2. A 0.10 M standard solution of hydrochloric acid (**HCl**) was used to find the concentration of a sodium hydroxide (**NaOH**) solution by titration. The piece of equipment **A** shown in the diagram was used in the experiment.



(*a*) Name the piece of equipment **A**. (5)

(*b*) (*i*) Which of the two solutions is usually measured using the piece of equipment labelled **A**?

(*ii*) Name the piece of equipment used to measure the second solution used in the titration. (12)

(*c*) (*i*) Describe the correct procedure for rinsing and filling **A**.

(*ii*) Why is it preferable to use a filler (labelled **B** in the diagram) rather than your mouth when filling **A**?

(*iii*) State **one** precaution you would take when transferring the liquid measured in **A** to the titration flask to ensure that the correct volume was transferred. (15)

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

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

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

When the 0.10 M hydrochloric acid solution was titrated a number of times against 25.0 cm^3 portions of the sodium hydroxide solution an average accurate titre of 27.5 cm^3 was obtained.
Calculate the concentration of the sodium hydroxide solution in moles per litre. (9)

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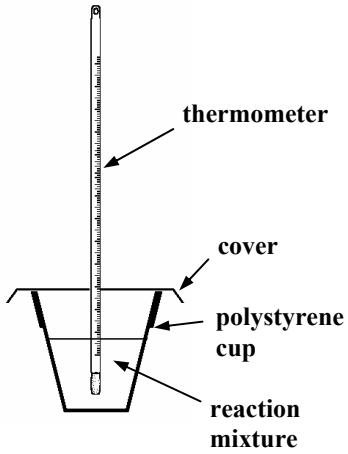
3. The apparatus drawn was used in a student experiment to measure the heat of reaction (**ΔH**) for the reaction between 1.0 M hydrochloric acid (**HCl)** solution and 1.0 M sodium hydroxide (**NaOH**) solution. When 50 cm^3 of the hydrochloric acid solution was added to 50 cm^3 of the sodium hydroxide solution in the polystyrene cup it was found that 2.8 kJ of heat energy was produced by the reaction. The equation for the reaction is:



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

(*a*) What is meant by *heat of reaction*? (5)

(*b*) How do the temperature measurements taken during the experiment provide evidence that the reaction between **HCl** and **NaOH** is exothermic? (6)

(*c*) What is the advantage of using a cup made from polystyrene? (6)

(*d*) How would you have obtained a reasonably accurate value for the change in temperature? (9)

(*e*) Calculate (*i*) the number of moles of hydrochloric acid (**HCl**) in 50 cm^3 of 1.0 M hydrochloric acid,

(*ii*) the heat in kJ which would be produced if a solution containing 1 mole of hydrochloric acid reacted fully with sodium hydroxide,

(*iii*) the heat of reaction (**Δ*H***) for the reaction. (18)

(*f*) What term is used for the reaction between an acid and a base resulting in the production of a salt and water? (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*) State the shape of the water molecule.

(*b*) What is the mass of 11.2 litres of methane ($\mathbf{CH_4}$) gas at s.t.p.?

(*c*) Give **one** industrial source of hydrogen gas.

(*d*) Name the piece of equipment used to measure the calorific values of foods.

(*e*) Write the equilibrium constant ($\boldsymbol{K_c}$) expression for the following reaction:

$$\mathbf{N_{2\,(g)} + 3H_{2\,(g)} \rightleftharpoons 2NH_{3\,(g)}}$$

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

(*g*) A 500 cm^3 sample of mineral water has a sodium content of 0.028 g.
Express the concentration of sodium in parts per million (ppm).

(*h*) How would you test for the presence of sulfate ions in aqueous solution?

(*i*) Define *oxidation* in terms of electron transfer.

(*j*) What *type* of organic reaction is involved in the preparation of ethene from ethanol, represented by the following equation?

$$\mathbf{C_2H_5OH \rightarrow C_2H_4 + H_2O}$$

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

A Give **one** industrial use of nitrogen gas that is based on its lack of chemical reactivity.

or

B Name the process used to recycle scrap iron to produce steel.

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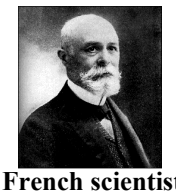
5. (*a*) How many (*i*) protons, (*ii*) neutrons, are there in an atom of potassium-39?
(*iii*) How are the electrons arranged in shells in this atom?
(*iv*) What is the valency of potassium? (15)
[See Mathematics tables p. 44.]

Litvinenko

(*b*) In November 2006, a former Soviet agent, Alexander Litvinenko, died in London. The cause of his death was identified as radiation poisoning due to polonium-210.

(*i*) Name the French scientist who discovered radioactivity in 1896. (5)



French scientist

(*ii*) Name the Polish born scientist who received the Nobel prize in 1911 for the isolation of the radioactive elements polonium and radium. (6)

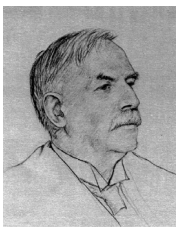
(*iii*) Polonium-210 decays with a half-life of 138 days by emitting alpha particles. What is meant by the term *half-life*? What are *alpha particles*? (12)

Isolated polonium

(*c*) The scientist shown in the bottom picture discovered the nucleus of the atom by bombarding thin sheets of a particular element with alpha particles from a radioactive source.

(*i*) Name this scientist. (6)

(*ii*) Name the element he bombarded with alpha particles. (6)



Discovered nucleus

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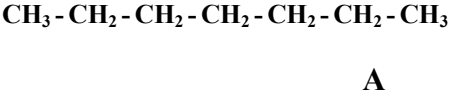
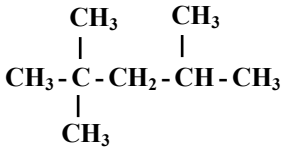
6. The engines in many modern cars perform well using petrol with an octane number of 95.



A

(*a*) What do you understand by *octane number*? (8)

(*b*) The structures of the two compounds (**A** and **B**) on which octane numbers are based are shown on the right. Name the **two** compounds. (12)



B

(*c*) One of these two compounds is assigned an octane number of 100, and the other an octane number of 0. Which compound is assigned the higher octane number? (6)

(*d*) Suggest **one** conversion that could be carried out in an oil refinery on the compound of zero octane number in order to produce a compound of higher octane number. (6)

(*e*) The molecular formula for benzene is $\mathbf{C_6H_6}$. Draw the structure of the molecule. Would you expect the octane number of benzene to be high or low? Give a reason for your answer. (12)

(*f*) What effects would be noticed when driving a car if the octane number of the petrol used were too low? (6)

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7. The bond between the chlorine atoms in a chlorine molecule ($\mathbf{Cl_2}$) is a pure (non-polar) covalent bond, whereas the bond between the chlorine atom and the hydrogen atom in the hydrogen chloride molecule (**HCl**) is a polar covalent bond. The bond between chlorine and sodium in sodium chloride (**NaCl**) is an ionic bond.

(*a*) Define (*i*) *covalent bond*, (*ii*) *ionic bond*. (8)

(*b*) Draw dot and cross diagrams showing the formation of the bonds in (*i*) $\mathbf{Cl_2}$, (*ii*) **HCl**, (*iii*) **NaCl**. (18)

(*c*) What is meant by a *polar bond*? Explain why the bond in the **HCl** molecule is polar. (9)

(*d*) Which of the substances, chlorine or sodium chloride, would you expect to be more soluble in water? Give a reason for your answer. (9)

(*e*) Hydrogen chloride dissolves readily in water to give a solution which is found in gastric juice in the stomach, and which is also commonly used in the school laboratory. Name the solution. (6)

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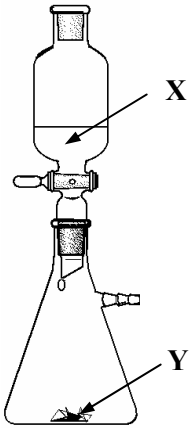
8. Answer the questions below with reference to the compounds **A**, **B** and **C**.

$\mathbf{C_2H_2}$	$\mathbf{C_2H_4}$	$\mathbf{C_2H_5Cl}$
A	**B**	**C**

(*a*) Which one of the three compounds is not a hydrocarbon? (5)

(*b*) Give the systematic (IUPAC) names of **A**, **B**, and **C**. (9)

(*c*) Compound **A** can be prepared in the school laboratory by dropping liquid **X** onto solid **Y** using the apparatus shown in the diagram.



(*i*) Identify **X** *and* **Y**.

(*ii*) Explain, by means of a diagram, how **A** may be collected.

(*iii*) Describe how would you show that **A** is unsaturated? (24)

(*d*) Compound **B** can be easily converted to compound **C**. Identify the reagent used to bring about this conversion and state the type of reaction involved. (12)

9. When a hydrogen peroxide ($\mathbf{H_2O_2}$) solution was decomposed in the presence of a suitable catalyst, the oxygen gas produced was collected and its volume measured every three minutes until the reaction was complete. The data obtained is shown in the table.

Time/minutes	0	3	6	9	12	15	18	21
Volume of O_2/cm^3	0.0	30	45	53	57	59	60	60

(*a*) Give the name or formula of a suitable catalyst for this reaction. (5)

(*b*) Write a balanced equation for the decomposition of hydrogen peroxide ($\mathbf{H_2O_2}$) to form oxygen gas ($\mathbf{O_2}$) and water ($\mathbf{H_2O}$). (6)

(*c*) Draw a labelled diagram of an apparatus that could be used to carry out this reaction, to collect the oxygen gas, and to measure its volume. (12)

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

(*e*) Use your graph to estimate the volume of oxygen gas collected during the first 4.5 minutes. (6)

(*f*) When this reaction was repeated at a higher temperature it was found that the oxygen gas was produced more quickly. Why does this happen? (3)

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

(*a*) (*i*) Define pH. (7)

(*ii*) Give **two** ways of measuring the pH of a solution. (6)

(*iii*) An aqueous solution has a pH of 7.5 at 25 ^{o}C. Is the solution acidic, basic or neutral? (3)

(*iv*) Calculate the pH of a 0.01 M solution of sodium hydroxide. (9)

(*b*) (*i*) What is *chromatography*? (7)

(*ii*) Describe, with the aid of a diagram, how you would separate the indicators in a mixture of indicators using paper chromatography, thin-layer chromatography or column chromatography. (12)

(*iii*) Which of the three types of chromatography in (*ii*) above is used in the separation of dyes taken from fibres in forensic work? (6)

(*c*) The following procedures are involved in the treatment of water for domestic use.

flocculation **filtration** **pH adjustment** **fluoridation**

(*i*) What is meant by flocculation? What substance is added to the water to bring it about? (7)

(*ii*) Outline briefly how the filtration of the water is carried out. What is removed from the water by this procedure? (9)

(*iii*) If the pH of the water were found to be too low, what substance could be added in order to raise it? (3)

(*iv*) How is fluoridation of the water brought about? What is the purpose of fluoridation? (6)

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

(*a*) The following names are associated with the development of our knowledge of elements. Write in your answer-book the omitted name corresponding to each number 1 to 5.

Mendeleev **Dalton** **The Greeks** **Bohr** **Davy**

In ancient times **1** suggested that everything that exists was formed from the four elements: earth, air, fire and water. In the early 1800s **2** suggested that atoms were tiny indivisible particles. By the use of electrolysis **3** isolated elements such as sodium and potassium. By arranging the elements in order of increasing relative atomic mass (atomic weight) and by placing similar elements in groups **4** produced a systematic arrangement (an early periodic table) of the elements known to him. From looking at atomic spectra **5** came up with the theory that electrons moved around the nucleus of an atom in fixed energy levels (orbits). (5 × 5)

(*b*) The treatment of sewage can be broken into three stages: **primary**, **secondary** and **tertiary**.

(*i*) Which stage involves the biological breakdown of organic matter present in the sewage? (6)

(*ii*) Which stage involves the screening and settling of the sewage to remove large particles? (6)

(*iii*) Which stage involves the reduction of the levels of nitrates and phosphates? (6)

(*iv*) Why is it important to reduce the levels of nitrates and phosphates in sewage effluent? (7)

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

A

A number of gases present in the lower atmosphere are responsible for the greenhouse effect. This effect is generally beneficial, but it has been increasing in recent times, and this increased greenhouse effect is believed to be responsible for various kinds of damage to the environment.

(*i*) What is the *greenhouse effect*? (7)

(*ii*) Name **two** of the gases responsible for causing the greenhouse effect. (6)

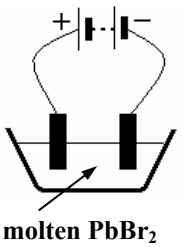
(*iii*) Why is the greenhouse effect largely beneficial? (6)

(*iv*) Give **two** kinds of environmental damage that may result from the increased greenhouse effect. (6)

or

B

The diagram shows the electrolysis of molten lead bromide (**$PbBr_2$**) using inert electrodes.



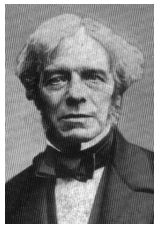
molten $PbBr_2$

(*i*) Suggest a suitable material for the electrodes. (7)

(*ii*) Identify the product formed at the cathode and also the product formed at the anode. (6)

(*iii*) Why should this electrolysis be carried out in a fume cupboard? (6)

(*iv*) Name the pictured English chemist who coined the terms *electrode, electrolysis*, *anode* and *cathode* in 1832. (6)



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