Coimisiún na Scrúduithe Stáit
State Examinations Commission

LEAVING CERTIFICATE EXAMINATION, 2006

CHEMISTRY - ORDINARY LEVEL

TUESDAY, 20 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, C = 12, O = 16, Na = 23, Mg = 24, S = 32

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

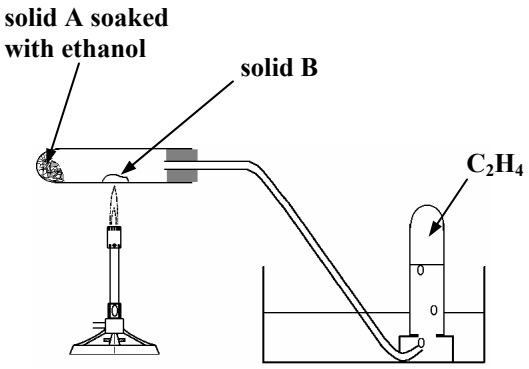
Avogadro constant = 6×10^{23} mol^{-1}

Section A

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

1. Ethene ($\mathbf{C_2H_4}$) and ethyne ($\mathbf{C_2H_2}$) are *unsaturated* hydrocarbons. They can both be easily prepared in a school laboratory.

(*a*) The diagram on the right shows an apparatus which could be used for the preparation of ethene gas ($\mathbf{C_2H_4}$).



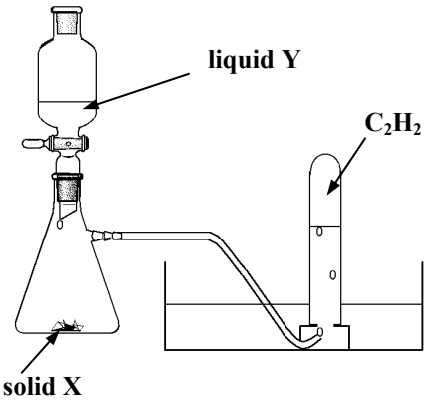
(*i*) Identify solid **A** which is used to keep the ethanol at the end of the test tube. (5)

(*ii*) Give the name <u>or</u> formula of solid **B** which is heated using the Bunsen burner. (6)

(*iii*) What precaution should be taken when heating is stopped? Why is this necessary? (6)

(*iv*) Give **one** major use of ethene gas. (3)

(*b*) The diagram on the right shows an apparatus which could be used for the preparation of ethyne gas ($\mathbf{C_2H_2}$).



(*i*) Identify solid **X** and liquid **Y**, the reagents used in the preparation. (12)

(*ii*) Describe what you would observe when a sample of ethyne gas is burned in air. (6)

(*iii*) Give **one** major use of ethyne gas. (3)

(*c*) Describe a test you could carry out on either of the two gases to show that it is *unsaturated*. What would you observe during the test? (9)

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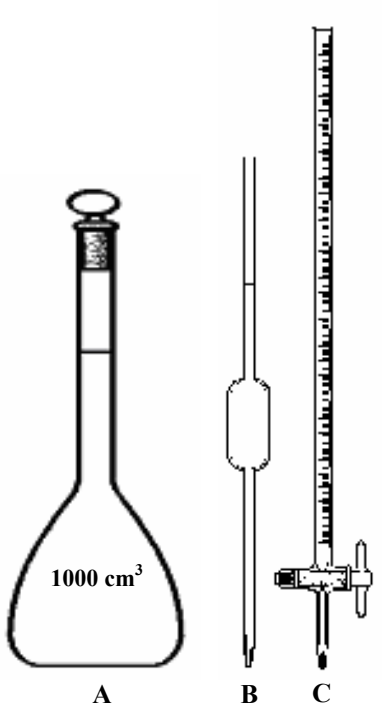
2. A 0.06 M *standard solution* of sodium carbonate was made up by weighing out ***X*** grams of anhydrous sodium carbonate (Na_2CO_3), dissolving it in deionised water, and making the solution carefully up to the mark in a suitable 1 litre flask. This solution was then used to find, by titration, the 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? (9)

(*c*) What is meant by a *standard solution*? (6)

(*d*) Calculate the mass (***X*** g) of sodium carbonate (Na_2CO_3) required to make 1 litre of a 0.06 M solution. (6)

(*e*) Name the pieces of equipment **B** and **C** used in the titration. (6)

(*f*) Name a suitable indicator for this titration and state the colour change at the end point. (6)

(*g*) What should be done with the conical flask and its contents *during the titration* in order to ensure an accurate result? (3)

(*h*) A number of accurate titrations were carried out. It was found that, on average, 25.0 cm^3 of the 0.06 M sodium carbonate (Na_2CO_3) solution was neutralised by 30.0 cm^3 of the hydrochloric acid (**HCl**) solution. Calculate the concentration of the hydrochloric acid solution in moles per litre. (9)
The balanced equation for the titration reaction is:

$$Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$$

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3. A student was given a bucket of sea water for analysis. The student was asked to find out the concentrations of suspended and dissolved solids in the sea water. The student was also asked to carry out tests to show that the sea water contained sodium ions and chloride ions.

(*a*) To measure the amount of suspended solids present, the student filtered 500 cm^3 of the sea water through a weighed clean dry filter paper. The student then washed the filter paper through with a little distilled water, dried it, and reweighed the filter paper. The filter paper had increased in mass by 0.44 g.

(*i*) Why did the student wash the filter paper with distilled water after filtering the sea water? (8)

(*ii*) Express the concentration of suspended solids in p.p.m. (6)

(*b*) Describe how the student could have then measured the concentration of dissolved solids in the sea water. (12)

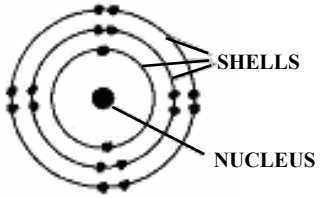
(*c*) Describe how the student could have carried out a flame test to show that a sodium salt was present in the dissolved solids collected. What flame colour would indicate the presence of sodium ions? (18)

(*d*) How could the student have tested the sea water to show that chloride ions were present? (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*) The diagram on the right shows the arrangement of electrons in main energy levels (shells) for an atom of a particular element. Identify the element.

(*b*) What is an *endothermic reaction*?

(*c*) What is the trend in the size of atomic radii going down any group of the periodic table?

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

(e) Methylbenzene (toluene) is an aromatic compound of molecular formula $\mathbf{C_7H_8}$. Give its structural formula. State **one** common use of methylbenzene.

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

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

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

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

(*i*) Calculate the percentage by mass of magnesium in magnesium sulfate ($\mathbf{MgSO_4}$).

(*j*) Identify **one** natural product that is extracted by steam distillation.

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

A State **two** ways in which safety can be promoted at a chemical plant.

or

B Give any **two** characteristic properties of metals.

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

(*b*) The two best-known isotopes of carbon are carbon-12 and carbon-14.

(*i*) What term is used in chemistry for the numbers (e.g. 12 and 14 in the case of carbon above) used to identify particular isotopes of an element? (6)

(*ii*) Name the subatomic particle that is responsible for the difference between carbon-12 and carbon-14. How many of these particles are found in an atom of carbon-14? (6)

(*iii*) Carbon-14 is radioactive and is an emitter of β-particles (beta-particles). Explain what a β-particle is. Give **one** use of carbon-14. (12)

(*c*) Define *electronegativity*. (6)

Use electronegativity values (Mathematics Tables, page 46) to predict the type of bond (ionic, polar covalent or non-polar) likely to be formed between each of the following pairs of elements.

(*i*) carbon and sulfur, (*ii*) potassium and fluorine, (*iii*) hydrogen and chlorine. (9)

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6. (*a*) Hydrocarbons are widely used as fuels.

(*i*) What are *hydrocarbons*? Give **one** major source of hydrocarbons. (8)

(*ii*) Increasing levels of methane ($\mathbf{CH_4}$) in the lower atmosphere are a concern to environmentalists at present. Explain why this is so. (6)

(*b*) Liquid petroleum gas (LPG) is used as a fuel in patio heaters. A major component of LPG includes hydrocarbons of molecular formula $\mathbf{C_4H_{10}}$. Draw the structure and give the systematic (IUPAC) name of each of the **two** structural isomers of $\mathbf{C_4H_{10}}$. (12)

(*c*) Words or phrases are omitted from the passage below.

Write in your answer book suitable words or phrases corresponding to the numbers **1** to **4**.

To purify a sample of benzoic acid, the impure crystals were dissolved in the **1** of hot water. The hot solution was filtered to remove the **2** impurities. The filtrate was allowed to cool and, when crystals had formed, they were removed from the solution by filtration, leaving the **3** impurities behind. This method of purification of a solid is known as **4**. (24)

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7. (*a*) In 1884, the Swedish chemist, pictured on the right, proposed a new theory of acids and bases. He defined an acid as a substance which produces hydrogen ions ($\mathbf{H^+}$) by dissociation when dissolved in water.

(*i*) Identify the Swedish chemist. (5)

(*ii*) Define *base* according to the theory proposed by this chemist. (6)

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

(*iv*) What do you understand by the term neutralisation? Give **one** everyday example. (9)

(*b*) (*i*) Define pH. (6)

The concentration of a solution of sodium hydroxide (**NaOH**) is as 4.0 grams per litre.

(*ii*) What is the concentration of the solution in moles per litre? (9)

(*iii*) Calculate the pH of the solution. (9)

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

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

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

(*b*) Give the names of the compounds **X**, **Y** and **Z**. (9)

(*c*) Which of the three compounds **X**, **Y** or **Z** is found

(*i*) in concentrations of about 6 – 15% (v/v) in wine,

(*ii*) in concentrations of about 6% (v/v) in vinegar? (12)

(*d*) Both conversions (**X** to **Y** and **Y** to **Z**) are of the same reaction type.

(*i*) What term is used to describe this type of reaction?

(*ii*) What reagents could be used to bring about both of these conversions? (18)

(*e*) What observation is made when a sample of compound **Y** is heated with Fehling's reagent? (6)

9. (*a*) The treatment of drinking water for an urban supply consists of a number of stages. In the case of **any three** of the stages in the treatment process, state the treatment involved and why it is carried out. (20)

(*b*) The following words all relate to sewage treatment. These words are omitted from the passage below:

eutrophication **nitrates** **biological** **sedimentation** **solid**

Write in your answer book the omitted words corresponding to each of the numbers 1 to 5. (30)

In primary treatment, sewage is passed through grids and over grit channels to remove dense **1** material. The sewage is then transferred to **2** tanks where suspended solids are allowed settle to the bottom. In secondary treatment the sewage is broken down by **3** digestion. Tertiary treatment removes phosphates and **4**. These nutrients can cause **5** if their concentrations build up in lakes and rivers.

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

(*a*) (*i*) Describe using a dot and cross diagram the bonding in a molecule of ammonia (**NH_3**). (10)

(*ii*) What is the shape of the ammonia molecule? (6)

(*iii*) Would you expect ammonia gas to be soluble or insoluble in water? Give a reason for your answer. (9)

(*b*) Mass spectrometry (MS), gas chromatography (GC), high-performance liquid chromatography (HPLC) and thin-layer chromatography (TLC) are all used in analytical chemistry.

(*i*) Give **one** application of mass spectrometry. (4)

(*ii*) Give an application of thin-layer chromatography (TLC) in forensic science. (6)

(*iii*) Give an application of high-performance liquid chromatography (HPLC) in the food industry. (6)

(*iv*) State the principle on which all chromatographic techniques are based. (9)

(*c*) Catalysts are used in many important chemical processes. They are used, for example, in the catalytic converters in modern cars.

(*i*) Explain the term *catalyst*. (4)

(*ii*) Name **two** of the metals that form the catalyst in the catalytic converter of a car. What is the advantage of using a catalytic converter? (12)

(*iii*) Name an element that poisons the catalyst present in a catalytic converter. (3)

(*iv*) Nitrogen monoxide (**NO**) and carbon monoxide (**CO**) react together in the catalytic converters of modern cars to give two gaseous products. Give the names or formulas of these products. (6)

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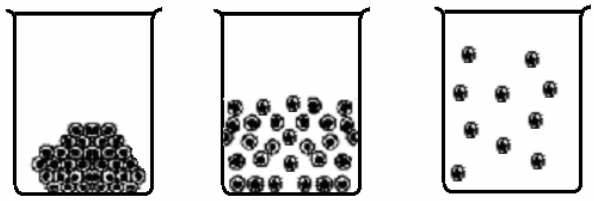
11. Answer any **two** of the parts (*a*), (*b*) and (*c*). (2 × 25)

(*a*) The diagrams illustrate the arrangement of particles in the three states of matter.



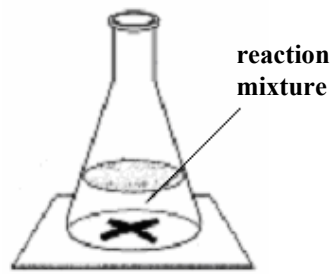
(*i*) Outline briefly the differences between the three states in terms of the movement of their particles. (9)

(*ii*) What do you understand by *diffusion*? (6)

(*iii*) Describe a simple experiment to demonstrate diffusion. (10)

(*b*) Define *rate of reaction*. (7)

The effect of concentration on reaction rate can be studied using the reaction between sodium thiosulfate solution and hydrochloric acid. The apparatus shown in the diagram may be used. As the reaction proceeds, the reaction mixture becomes cloudy and, after a certain time, the cross becomes invisible when viewed through the solution. The equation for the reaction is



$$Na_2S_2O_3 + 2HCl \rightarrow 2NaCl + H_2O + SO_2 + S$$

(*i*) Which product of the reaction causes the reaction mixture to become cloudy? (6)

(*ii*) If a higher concentration of sodium thiosulfate solution were used in the reaction, would the time taken for the cross to become invisible be greater, less or unchanged? Explain your answer. (6)

(*iii*) If the conical flask were surrounded by ice-water, would the time taken for the cross to become invisible be greater, less or unchanged? Explain your answer. (6)

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

A

(*i*) Explain the term *feedstock* in industrial chemistry. (7)

In planning to set up a chemical factory, finding a suitable location and the minimisation of costs, both fixed and variable, are very important considerations.

(*ii*) State any **two** factors that would influence the choice of location for the factory. (6)

(*iii*) Explain the difference between fixed costs and variable costs by giving **one** example in each case. (6)

(*iv*) Name **two** important products of the Irish chemical industry. (6)

or

B

Poly(phenylethene), also known as polystyrene, is a widely-used addition polymer.

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

(*ii*) Give any **two** common uses of poly(phenylethene). (6)

(*iii*) State any **two** of the procedures involved in the recycling of poly(phenylethene) (6)

(*iv*) Name **one** other addition polymer. (6)

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