Coimisiún na Scrúduithe Stáit
State Examinations Commission

LEAVING CERTIFICATE EXAMINATION, 2013

CHEMISTRY – ORDINARY LEVEL

TUESDAY, 18 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)

The information below should be used in your calculations.

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

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

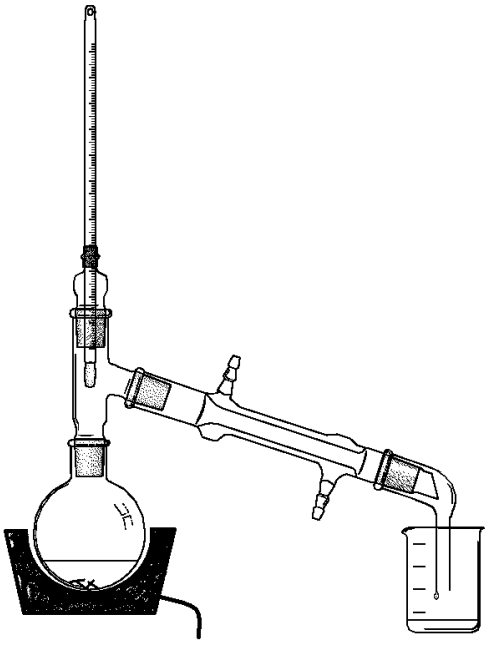
Avogadro constant = 6.0×10^{23} mol^{-1}

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

1. A sample of soap was prepared in the school laboratory by the reaction between two substances, **X** and **Y**. Suitable amounts of these substances, and a material to ensure smooth boiling, were placed in a flask together with some ethanol, and the mixture was refluxed for about 30 minutes. The apparatus was then rearranged for distillation as shown in the diagram below. At the end of the distillation process, a small amount of hot water was added to the flask to help wash the contents into a beaker containing brine. The soap appeared as a precipitate which was then separated from the brine. Finally the soap was washed with ice-cold water.



(*a*) What substances could have been used for **X** and **Y**? (8)

(*b*) Copy the distillation diagram into your answer book and label it fully. (12)

(*c*) What material could have been added to the flask to ensure smooth boiling? (6)

(*d*) What substance was removed from the reaction mixture by distillation? (6)

(*e*) What is brine?
How was the precipitate of soap removed from the brine? (9)

(*f*) Why was it necessary to wash the soap before it was used?
Why should warm water *not* have been used to wash it? (9)

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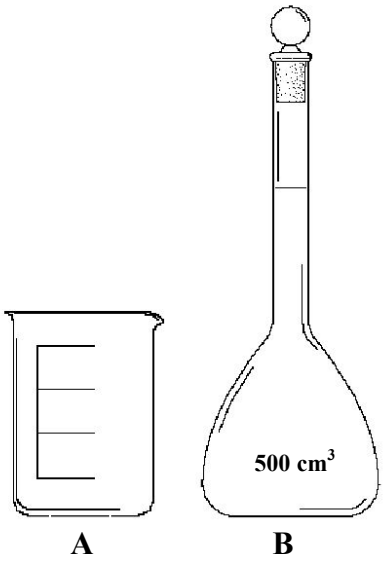
2. A group of students prepared 500 cm^3 of a 0.05 M standard solution of sodium carbonate, using anhydrous sodium carbonate (Na_2CO_3) which is a primary standard. The required mass of the carbonate was weighed accurately on a clock glass. It was then dissolved in deionised water in beaker **A**. The solution was transferred to flask **B** and made up accurately to the 500 cm^3 mark with deionised water.



(*a*) Explain the underlined term. (5)

(*b*) Give **one** property of anhydrous sodium carbonate that allows it to be used as a primary standard. (6)

(*c*) Name the type of flask labelled **B** in the diagram. (6)

(*d*) How would you have ensured that all of the solution in the beaker was transferred to flask **B**? (9)

(*e*) Outline the procedure for bringing the solution in **B** accurately to the 500 cm^3 mark. What further step should be taken before the solution is ready for use? (12)

(*f*) It was found by titration that exactly 17.85 cm^3 of a hydrochloric acid (**HCl**) solution neutralised 25.0 cm^3 of this 0.05 M sodium carbonate solution. The equation for the titration reaction is:

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

Find, correct to two decimal places, the concentration of the hydrochloric acid solution

(*i*) in moles per litre,

(*ii*) in grams per litre. (12)

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3. (*a*)


sodium nitrate


potassium chloride

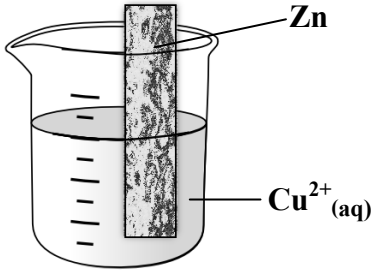

copper(II) sulfate

Samples of three salts are provided on clock glasses as shown above.

Describe how you would carry out flame tests on the salts.

In the case of each salt, state the colour you would expect it to give to a Bunsen flame. (20)

(*b*) A zinc rod was left standing in a blue solution containing copper(II) ions (Cu^{2+}) for about 30 minutes using the apparatus shown on the right.



(*i*) What would you have observed as a result of the reaction that took place? (6)

(*ii*) Explain the reaction in terms of electron transfer. (6)

(*c*) How would you confirm

(*i*) the presence of chloride ions in an aqueous solution of potassium chloride,

(*ii*) the presence of nitrate ions in an aqueous solution of sodium nitrate? (18)

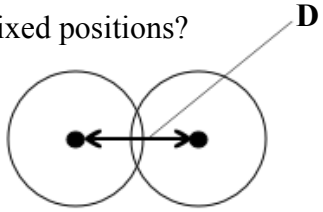
Section B

[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*) In which of the three states of matter do the particles vibrate about fixed positions?

(*b*) In the diagram on the right, **D** is the distance between the centres of two identical atoms joined by a single covalent bond. What term is used for *half* this distance?

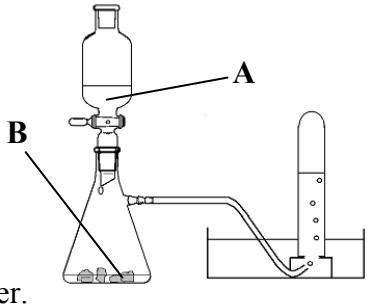


(*c*) What is an *endothermic* reaction?

(*d*) The molecular formula of ethanoic acid is $\mathbf{C_2H_4O_2}$. Write its empirical formula.

(*e*) What organic reaction type occurs when methane and chlorine are mixed in the presence of ultraviolet light?

(*f*) The arrangement for the preparation of ethyne gas is shown in the diagram on the right. Identify liquid **A** and solid **B**.



(*g*) State the shape of (*i*) the hydrogen chloride molecule (**HCl**), (*ii*) the water molecule ($\mathbf{H_2O}$).

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

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

$$\mathbf{N_2} + \mathbf{3H_2} \rightleftharpoons \mathbf{2NH_3}$$

(*j*) When a drop of soluble blue ink was added to water in a beaker, the ink spread out until the water was uniformly coloured.

What term is used for the spreading out of the ink?

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

A State one method by which nitrogen is fixed in nature.

or

B Name a metal which is extracted by an electrochemical method.

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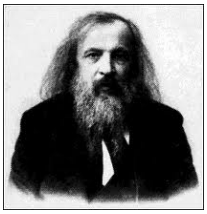
5. (*a*) Distinguish between *mass number* and *relative atomic mass* of an element. (11)

You will notice, from the values given on page 79 of the *formulae and tables booklet*, that the relative atomic mass of an element is rarely a whole number.

Give the reason for this. (6)

(*b*) In developing his periodic table in the 1860s, the Russian scientist, pictured on the right, arranged the elements in order of increasing relative atomic mass (atomic weight).



(*i*) Who was the Russian scientist?

(*ii*) What is the order used in arranging the elements in the modern periodic table? (9)

(*c*) Carbon–14 is a radioactive isotope of carbon. It is a beta-particle (β-particle) emitter and has a half-life of about 5700 years.

(*i*) Explain the underlined term.

(*ii*) What is a beta-particle?

(*iii*) Explain what is meant by the *half-life* of a radioactive isotope.

(*iv*) Give **one** use of carbon–14. (18)

(*d*) Draw a diagram showing the arrangement of electrons in an atom of carbon–14.

Use dots (•) *or* crosses (×) to represent the electrons. (6)

6. Alkanes and alkenes are homologous series of hydrocarbons.

(*a*) Name **two** major sources of hydrocarbons. (8)

(*b*) A drum of LPG is shown on the right. It contains an alkane of formula $\mathbf{C_3H_8}$.

(*i*) What do the letters LPG stand for?

(*ii*) Give the IUPAC name for $\mathbf{C_3H_8}$.

(*iii*) Compounds are added to LPG and to natural gas to make them safer to use. What are these compounds?

How do they make the use of LPG and natural gas safer?

(*iv*) Give **one** common use of LPG. (21)

(*c*) The compound $\mathbf{C_3H_6}$ is another hydrocarbon.

Name this compound.

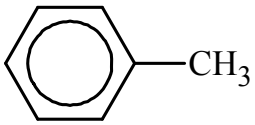
Draw its structural formula. (9)

(*d*) The hydrocarbon shown on the right is aromatic.

Name this hydrocarbon.

Would you expect its octane number to be high or low?

Give a reason for your answer. (12)



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7. (*a*) Define (*i*) acid, (*ii*) base, according to the theory of Arrhenius, who is pictured on the right. (8)

Explain the term *neutralisation*. (6)

Give the name *and* formula of the strong acid which is a constituent of gastric juice in the stomach. (6)

(*b*) Describe how you would measure the concentration (*i*) of suspended solids, (*ii*) of dissolved solids, in a water sample. (18)

(*c*) A 100 cm^3 sample of river water was found to contain 0.015 g of suspended solids and 0.17 g of dissolved solids. Express **both** of these concentrations

(*i*) in grams per litre,

(*ii*) in parts per million (ppm). (12)

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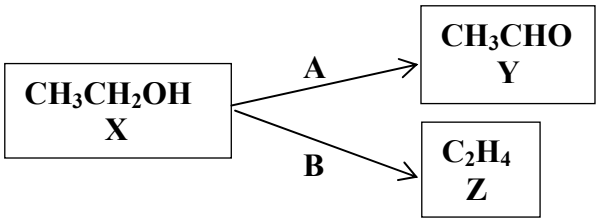
8. Answer the questions below with reference to the compounds **X**, **Y** and **Z** in the following reaction scheme.



(*a*) Name **X**, **Y** and **Z**. (11)

(*b*) Which **one** of the compounds, **X**, **Y** *or* **Z**, contains only one planar carbon atom?

Draw the *full* structural formula of this compound and indicate clearly the carbon atom that is in planar geometry. (12)

(*c*) What type of reaction is involved in conversion **A**?

Describe how you would test product **Y** with Fehling's reagent. (12)

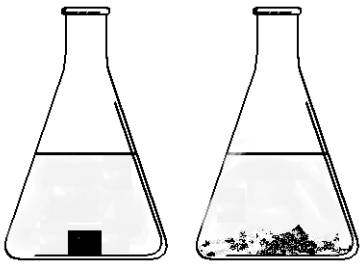
(*d*) Draw a clearly labelled diagram to show how you would obtain a sample of compound **Z** from compound **X** by reaction **B** in a school laboratory. (15)

9. (*a*) Define (*i*) *rate of reaction*, (*ii*) *catalyst*. (11)

(*b*) Give the name *or* formula of the catalyst used in the production of oxygen ($\mathbf{O_2}$) from hydrogen peroxide ($\mathbf{H_2O_2}$). (6)

(*c*) What is the term used for the catalysts produced by living cells?
Give **one** example. (9)

(*d*) The flasks, **A** and **B**, shown on the right contain equal volumes of 1 M hydrogen peroxide solution at room temperature. Flask **A** contains a solid block of catalyst of known mass. Flask **B** contains the same mass of the same catalyst in powdered form.



A **B**

(*i*) What difference would you expect to see in the rate of oxygen production between the two flasks?
What is the reason for this difference?

(*ii*) How would you expect an increase in temperature to affect the rate of the reaction in flask **A**? (15)

(*e*) Name **two** catalysts found in the catalytic converter of a car.
Give **one** way in which the use of a catalytic converter benefits the environment. (9)

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

(*a*) Define *electronegativity*. (7)

Explain why electronegativity values (*i*) increase across a period, (*ii*) decrease down a group, in the periodic table. (9)

Use electronegativity values (*formulae and tables booklet*, page 81) to predict the bonding – ionic, covalent or polar – in the following substances: hydrogen chloride (**HCl**), sodium chloride (**NaCl**) and hydrogen ($\mathbf{H_2}$). (9)

(*b*) A mass of 8.4 g of pure sodium hydrogencarbonate was completely converted to sodium carbonate, water and carbon dioxide by the action of heat. The equation for the reaction is:

$$\mathbf{2NaHCO_3 \rightarrow Na_2CO_3 + H_2O + CO_2}$$

(*i*) How many moles of sodium hydrogencarbonate ($\mathbf{NaHCO_3}$) were used up? (7)

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

(*iii*) What volume of carbon dioxide was produced at standard temperature and pressure?
How many molecules of carbon dioxide did this volume contain? (12)

(*c*) Gas chromatography (GC), thin-layer chromatography (TLC) and high-performance liquid chromatography (HPLC) are techniques used in analytical chemistry.

(*i*) State the principle on which all chromatographic techniques are based. (7)

(*ii*) Which of these three techniques is routinely used in blood-alcohol testing? (6)

(*iii*) Describe an experiment you carried out in the school laboratory to separate a mixture of indicators using thin-layer, paper or column chromatography. (12)

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

(*a*) The following names are omitted from the passage below, which outlines the history of the development of our knowledge about atoms.

Thomson **Rutherford** **Dalton** **Moseley** **Bohr**

Write in your answer book the name corresponding to each number, **1** to **5**. (25)

In ancient Greece, Leucippus and his pupil, Democritus, said that matter is made up of atoms. About two centuries ago **1** described atoms as tiny, indivisible particles. Almost a century later, **2** discovered the electron. A few years after that **3** carried out the experiment, involving the scattering of alpha particles by gold foil, that resulted in the discovery of the nucleus. Later **4** developed a theory restricting electrons in atoms to energy levels. In the early 1900s **5** discovered that the atoms of each element have a characteristic positive nuclear charge now called the atomic number.

(*b*) State the purpose of adding each of the following in the purification of water for drinking:

(*i*) a flocculating agent e.g. aluminium sulfate,

(*ii*) a basic substance e.g. lime,

(*iii*) an acidic substance e.g. sulfuric acid,

(*iv*) chlorine,

(*v*) a fluorine-containing compound e.g. hexafluorosilicic acid. (15)

Name the material used in filtering the water during the purification process. (3)

It is important to be aware that there are EU limits for various chemical species (e.g. nitrates) in water.

Suggest **two** ways in which nitrates could get into a water source. (7)

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

A

Oxygen ($\mathbf{O_2}$) and ozone ($\mathbf{O_3}$) are forms of the same element. Because of concern about damage to the Earth's ozone layer by CFCs, these compounds have been banned and have been replaced by other substances e.g. HCFCs.

(*i*) Give a brief outline of the extraction of oxygen ($\mathbf{O_2}$) from air. (10)

(*ii*) What do the letters CFC and HCFC represent?
Give **one** common use that was made of CFCs before they were banned. (9)

(*iii*) What is the importance of the ozone layer? (6)

or

B

Iron and copper are examples of transition elements. Iron is above copper in the electrochemical series.

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

(*ii*) Give **two** general properties of transition elements. (6)

(*iii*) Which of the two elements, iron or copper, would you expect to corrode more readily?
Give a reason for your answer. (6)

(*iv*) Mention **two** common methods used to protect metals from corrosion. (6)

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