Coimisiún na Scrúduithe Stáit
State Examinations Commission

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LEAVING CERTIFICATE EXAMINATION

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CHEMISTRY – ORDINARY LEVEL

_____

3 HOURS DURATION

_____

300 MARKS

_____

Answer any **six** questions.

All questions carry equal marks (50).

_____

The information below should be used in your calculations.

Relative atomic masses (rounded):   H = 1.0, C = 12, O = 16, Ca = 40, Hg = 201

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 superintendent.
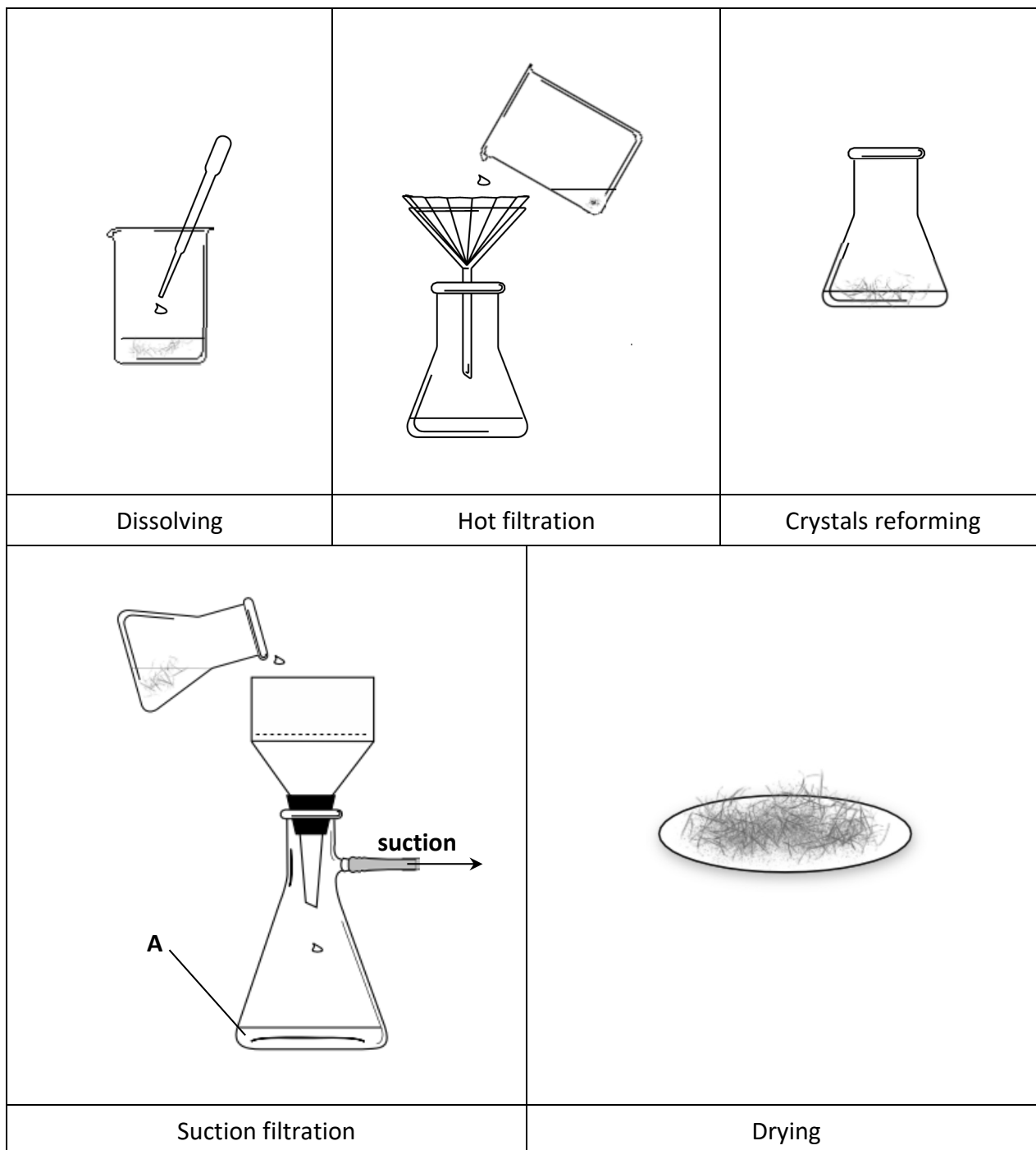
Section A
See page 1 for instructions regarding the number of questions to be answered.

1. Study the diagrams below showing the stages of the recrystallisation of benzoic acid and answer the questions on the next page.

Dissolving	Hot filtration	Crystals reforming

suction	
A	
Suction filtration	Drying

(*a*) The following words are omitted from the paragraph below.

cooling   soluble   insoluble   boiling   warm

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

Recrystallisation is a technique often used to purify solids. The impure solid is

dissolved in the minimum amount of __**1**__ solvent. This solution is filtered while

still hot through a fluted filter paper that traps __**2**__ impurities. After __**3**__ pure

crystals of the solid form. Suction filtration is then used to collect the crystals.

The __**4**__ impurities are located at **A**. The suction helps dry the crystals and they

can be completely dried in a __**5**__ oven.   (25)

(*b*) Suggest a suitable solvent to recrystallise benzoic acid.   (6)

(*c*) With the aid of a labelled diagram describe how you could measure the melting
point of a sample of benzoic acid crystals.   (12)

(*d*) State one way that the melting point of impure crystals differs from the melting
point of a pure sample of the same substance.   (7)

2. A student used a pipette to measure 25.0 cm³ portions of a *standard solution* of sodium hydroxide (**NaOH**) into a conical flask to find by titration the concentration of a given solution of hydrochloric acid (**HCl**).

(*a*) What is meant by a standard solution? (5)

(*b*) Mention one precaution that should be taken when using a pipette. (6)

(*c*) What piece of equipment should be used to measure the hydrochloric acid solution during the titration?

Briefly describe the procedure for rinsing this piece of equipment before use in the titration. (15)

(*d*) Name a suitable indicator for this titration.

What colour change is observed at the end point? (12)

The titration reaction is described by the equation:

$$HCl \;+\; NaOH \;\rightarrow\; NaCl \;+\; H_2O$$
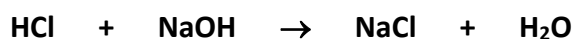
(*e*) After two accurate titrations it was found that 25.0 cm³ of 0.10 M sodium hydroxide solution was neutralised by 22.5 cm³ of the hydrochloric acid solution.

Calculate the concentration of the hydrochloric acid solution in moles per litre. (12)

3. A student was asked to measure the amount of dissolved solids in a sample of seawater. The teacher advised the student to filter the seawater first. Some of the pieces of equipment used are drawn on the right.

A

(*a*)   Name the pieces of equipment **A**, **B** and **C**.   (11)

(*b*)   Why was it advisable to filter the water first?   (6)

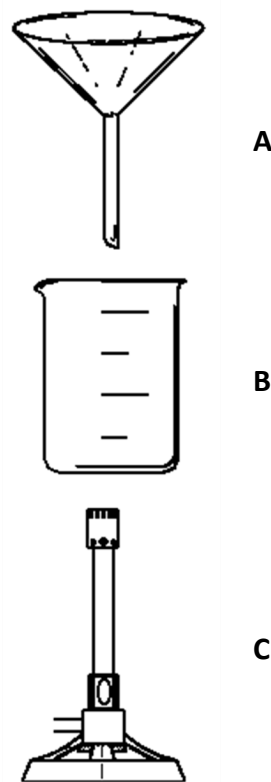(*c*)   Describe how you would filter the seawater.   (9)

B

(*d*)   Describe how the student should have carried out the rest of the experiment.   (15)

(*e*)   At the end of the experiment, the student found that 250 cm^3 of filtered seawater contained 3.5 g of dissolved solids.

Calculate the concentration of dissolved solids

(*i*)   in grams per litre,

(*ii*)   in p.p.m. (mg l^{-1}).   (9)

C

Section B
See page 1 for instructions regarding the number of questions to be answered.

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

    (*a*)   Give an example of (*i*) a household acid, (*ii*) a household base.

    (*b*)   Give one major use of ethyne.

    (*c*)   Write the chemical formula of calcium chloride.

    (*d*)   Name the piece of equipment used to measure the energy value of a fuel or of a food.

    (*e*)   Which of the radioisotopes, ^{241}**Am** or ^{14}**C** or ^{60}**Co**, is used in cancer treatment?

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

    (*g*)   Which process in the treatment of drinking water is carried out to prevent tooth decay?

    (*h*)   Calculate the percentage by mass of oxygen in calcium carbonate (**CaCO$_3$**).

    (*i*)   Name the scientist pictured on the right who received a Nobel prize for the discovery of the elements polonium and radium.

    (*j*)   The electronegativities of hydrogen and chlorine are 2.20 and 3.16 respectively.
    Use these values to predict whether the bond in hydrogen chloride (**HCl**) is *ionic*, *polar covalent* or *pure covalent*.

    (*k*)   What is the shape of a water molecule?

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

    A   In the chemical industry what is meant by the term *feedstock*?

    or

    B   List **two** stages in the recycling of polystyrene.

**5.** (*a*) What is an element?

Outline John Dalton's atomic theory of 1808. (14)

(*b*) In the periodic table of the elements, the vertical columns or groups contain elements of similar chemical behaviour. Group 1 is sometimes referred to as *the alkali metals*, and it contains lithium, sodium and potassium.

(*i*) State the number of protons, neutrons and electrons in an atom of lithium, $^{7}_{3}\text{Li}$. (9)

(*ii*) What is the arrangement of electrons in the main energy levels of a potassium atom? (6)

(*iii*) What would you observe if a small piece of sodium was dropped into a trough of cold water?
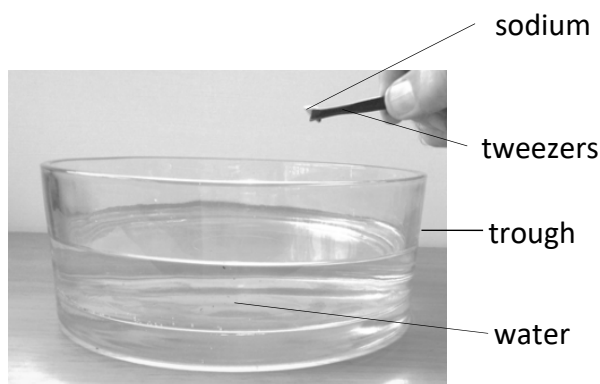
What would be observed if the liquid in the trough at the end of the reaction was tested with litmus? (12)

(*iv*) Which alkali metal is sometimes used in street lighting?

What colour light is produced? (9)

6. (*a*) Methane (**CH₄**) is the most abundant *hydrocarbon* found in natural gas. Methane is also produced in coal mines and in refuse dumps.

   (*i*)   What is meant by the term hydrocarbon?

   (*ii*) What hazard is created when methane accumulates in coal mines?

   (*iii*) In what way does the release of methane into the atmosphere affect the environment?

   (*iv*) Name the homologous series to which methane belongs.   (23)

(*b*) Explain why methylpropane is a structural isomer of butane.   (6)

(*c*) Benzene (**C₆H₆**) and methylbenzene (**C₆H₅CH₃**) are examples of aromatic compounds. Aromatic compounds are found in many consumer products.

   (*i*)   Draw the structural formula of benzene.

   (*ii*) Would you expect methylbenzene to be more soluble in water or in cyclohexane? Give a reason for your answer.

   (*iii*) Why is benzene no longer considered suitable for use as a solvent in the school laboratory?   (21)

7. (*a*) (*i*) What is meant by *hardness* in water?   (8)

Temporary hardness causes the formation of limescale in kettles and pipes.

To test a sample of limescale to show that it contains carbonate salts, the apparatus drawn on the right was used. An acid was added to a sample of limescale in tube **A** and the gas released was bubbled through a liquid **X** in tube **B** as shown.

limescale and acid
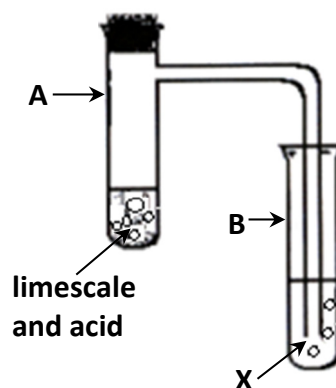
   (*ii*) Suggest a suitable acid for this test.   (6)

   (*iii*) Identify the gas that was released in the reaction in tube **A**.

   What liquid should be placed in tube **B**?

   What is observed when the gas released from the reaction in tube **A** passes through the liquid in tube **B**?   (18)

(*b*) Define pH.

Calculate the pH of a 0.05 M solution of sulfuric acid (**H₂SO₄**).   (18)

8. Examine the reaction scheme below and answer the questions that follow.

$$C_2H_4 \underset{Z}{\overset{X}{\rightleftharpoons}} CH_3CH_2OH \overset{Y}{\longrightarrow} CH_3COOH$$

A **B** **C**
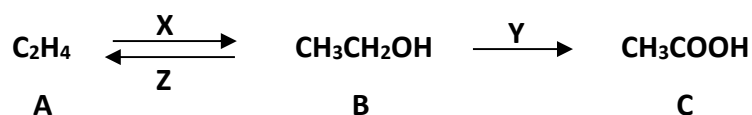
(*a*)   Which one of these compounds contains **only** tetrahedrally bonded carbon atoms
in its molecules?   (5)

(*b*)   Name the compounds **A** and **C**.   (12)

(*c*)   Classify each one of the conversions **X** and **Y** as an *addition*, a *substitution*
or an *oxidation* reaction.   (12)

(*d*)   Name the substance required to bring about conversion **Z**.   (6)

(*e*)   Which one of these compounds can be used as a motor fuel instead of petrol?   (6)

(*f*)   Which one of these compounds polymerises to give a widely used plastic?
Name this plastic.   (9)

9. Oxygen gas is produced by the decomposition of hydrogen peroxide, using manganese dioxide as a catalyst. When the catalyst was added to 20 cm³ of hydrogen peroxide solution, the volume of the oxygen gas collected at room temperature was recorded every 30 seconds. The data are given in the table.

Time (seconds)	0	30	60	90	120	150	180	210
Volume O$_2$ (cm³)	0	40	70	90	100	104	105	105

(*a*) What is a *catalyst*?   (8)

(*b*) Plot a graph (on graph paper) of the volume of oxygen (*y*-axis)
against time (*x*-axis).   (15)

(*c*) From the graph find

(*i*)   the volume of oxygen produced in the first 75 seconds, measured at room temperature,

(*ii*)   how long it took for 60 cm³ of oxygen to be collected,

(*iii*) the average rate of reaction over the first 45 seconds
(in cm³ of **O$_2$** at room temperature per second).   (15)

(*d*) Most modern cars have a catalytic converter fitted to their exhaust systems.

Name **two** metals used as catalysts in a catalytic converter.

Give an example of a reaction that occurs in a catalytic converter.   (12)

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

(*a*)   State one characteristic property of ionic substances.

Use dot and cross diagrams to illustrate the ionic bonding in sodium chloride (**NaCl**).

Describe a test to confirm the presence of chloride ions in aqueous solution.

Where in the home would you use sodium chloride?   (25)

(*b*)   Define (*i*) atomic mass number, (*ii*) relative atomic mass (A_r).

What is the relative molecular mass (M_r) of glucose ($C_6H_{12}O_6$)?

What is the empirical formula for glucose?

Another organic compound **B** has the same empirical formula as glucose but its relative molecular mass is 60.

What is the molecular formula of **B**?   (25)

(*c*)   (*i*)   State *Le Châtelier's principle*.

(*ii*)   Write the equilibrium constant expression K_c for the following system:

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

(*iii*)   What information is given by the symbol $\rightleftharpoons$?

(*iv*)   In the equilibrium system described by the equation in part (*ii*) above, what would be the effect of increasing the pressure (by compressing the gases) on the amount of ammonia (NH_3) formed at equilibrium?

Explain your answer.   (25)

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

(*a*)   The following words and terms are omitted from the passage below.

GC   alcohol   drugs   stationary   rates

separation   mobile

Write in your answer book the omitted word or term corresponding to each
number (**1** to **7**).

Chromatography is a ___**1**___ technique.
A ___**2**___ phase moves over a ___**3**___ phase carrying the components
of the mixture at different ___**4**___.
Gas chromatography, commonly known as ___**5**___, is used in ___**6**___ testing
of athletes.
It is also used to measure the amount of ___**7**___ in blood.   (25)

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

When zinc powder is added to a solution of copper(II) sulfate, the blue solution
becomes colourless and a brownish precipitate is formed.

The reaction is described by the equation:

$$Cu^{2+}_{(aq)} \quad + \quad Zn_{(s)} \quad \rightarrow \quad Cu_{(s)} \quad + \quad Zn^{2+}_{(aq)}$$
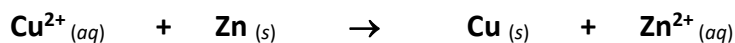
Identify which species
(*ii*)   is oxidised,
(*iii*)   is reduced.

Identify which species is responsible for
(*iv*)   the blue colour of the solution at the start,
(*v*)   the brownish precipitate at the end.   (25)

(c)   Oxygen gas was isolated as an element in 1774 by Joseph Priestley. He focussed sunlight on solid mercuric oxide (**HgO**) in a glass tube and collected the colourless gas released. The second product of the reaction was mercury, a metal that is in the liquid state at room temperature.
The balanced equation for this endothermic reaction is:

$$\textbf{2HgO}_{(s)} \rightarrow \textbf{2Hg}_{(l)} + \textbf{O}_2{}_{(g)}$$

Priestley observed that a candle flame burned taller and brighter and a mouse was more active inside bell-jars filled with this gas than when the bell-jars were filled with air.

air   oxygen
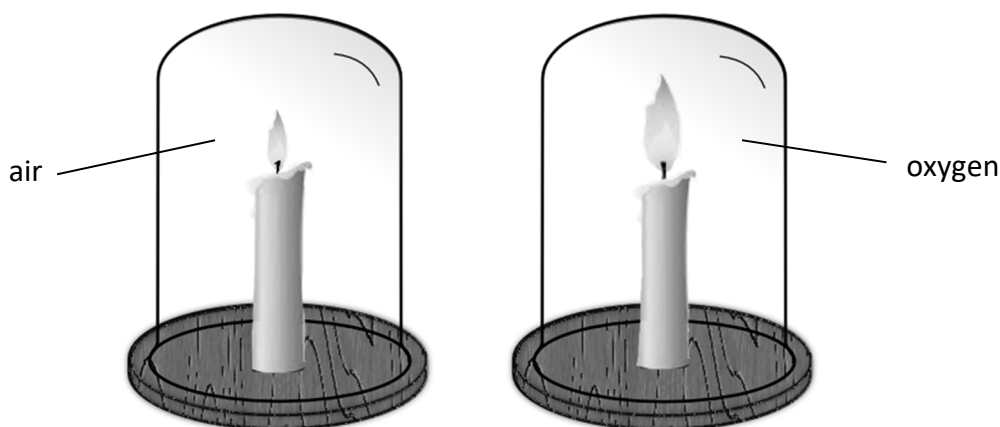
(*i*)   The two oxygen atoms in an **O₂** molecule are bonded covalently.
What is a covalent bond?

(*ii*)   What is an endothermic reaction?

(*iii*) What mass of mercury metal was produced when 0.4 moles of **HgO** were decomposed using sunlight?

(*iv*)   How many moles of oxygen gas would Priestley have obtained for his bell-jar experiments by decomposing 0.4 moles of **HgO**?
What volume would this oxygen have occupied, measured at s.t.p?   (25)

This question continues on the next page.

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

A

State **two** ways in which industrial chemistry has made a positive contribution to modern society.

Give **two** differences between a *batch* and a *continuous* process.

Glass and stainless steel are often used in the manufacture of reaction vessels in industry. Give one chemical property of these materials which makes them suitable for this purpose.
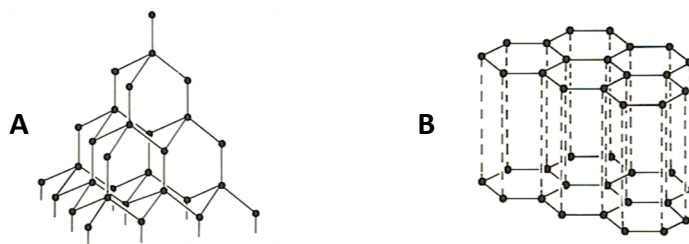
Answer any one of the following.

(*i*)   Give one major use for ammonia.

(*ii*)   Write a chemical equation for the oxidation of nitrogen monoxide in air.

(*iii*)   Write the chemical formula for magnesium oxide.   (25)

or

B

The diagram below shows two crystalline forms of carbon, **A** and **B**.

(*i*)   Name **A**.

What type of bond holds the carbon atoms together in crystal **A**?

(*ii*)   Name **B**.

Give one use of this form of carbon.

(*iii*)   What experimental technique is used to determine crystal structures?   (25)

There is no examination material on this page.

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Leaving Certificate – Ordinary Level

Chemistry

3 Hours Duration