



Coimisiún na Scrúduithe Stáit
State Examinations Commission

LEAVING CERTIFICATE EXAMINATION, 2005

CHEMISTRY - ORDINARY LEVEL

TUESDAY, 21 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, Cl = 35.5

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

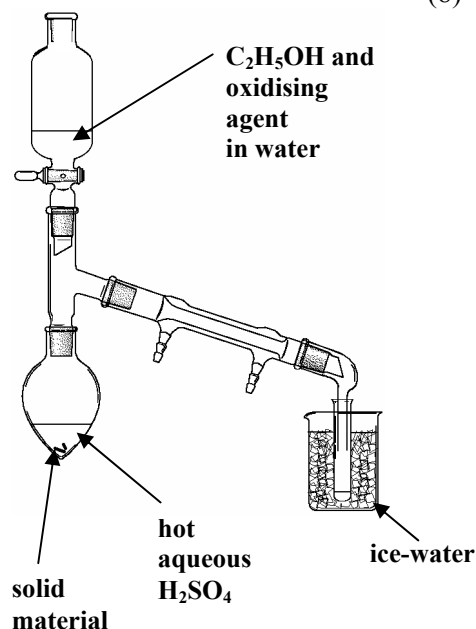
Avogadro constant = $6 \times 10^{23} \text{ mol}^{-1}$

Section A

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

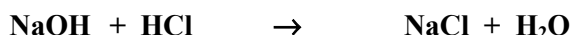
1. A group of students prepared ethanal (CH_3CHO) by slowly adding a mixture of ethanol ($\text{C}_2\text{H}_5\text{OH}$) and an oxidising agent in water, to hot aqueous sulfuric acid. The apparatus drawn below was used.

- (a) At the start of the experiment a few pieces of a solid material were placed in the reaction flask along with the sulfuric acid. Identify this solid and state its purpose. (8)
- (b) Identify a suitable oxidising agent for this preparation. (6)
- (c) What is the colour of the mixture in the dropping funnel at the start? (6)
- (d) What is the colour of the mixture in the reaction flask as the reaction proceeds? (6)
- (e) Why is it important to distill off the ethanal as it is produced? (6)
- (f) Why is it not necessary to keep heating the reaction flask during the addition? (6)
- (g) Why is the receiving vessel cooled in ice-water? (6)
- (h) What colour is the solid produced when a mixture containing a few drops of Fehling's solutions (No 1 and No 2) and ethanal is heated? (6)



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

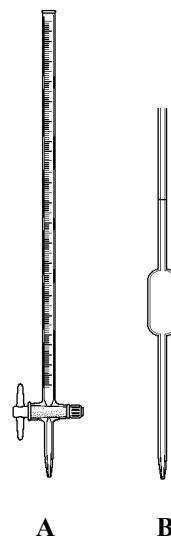
- (a) Name the pieces of equipment **A** and **B**. (8)
- (b) Which of the two solutions is normally placed in the piece of equipment labelled **A**?
Describe the correct procedure for rinsing and filling **A**. (12)
- (c) Name a suitable indicator for this titration.
What colour change was observed at the end point? (9)
- (d) The balanced equation for the titration reaction is:



When the hydrochloric acid (HCl) solution was titrated a number of times against 25 cm³ portions of the 0.10 M solution of sodium hydroxide (NaOH), an average accurate titre of 22.6 cm³ was obtained.

Calculate the concentration of the hydrochloric acid solution in moles per litre. (9)

- (e) Describe how this experiment could be used to prepare a pure sample of sodium chloride (common salt). (12)



3. Hydrogen peroxide solution decomposes rapidly in the presence of a suitable catalyst according to the following equation.



In an experiment using this reaction, the oxygen gas was collected and its volume measured every two minutes until the reaction was complete. The data obtained is shown in the table.

| Time/minutes | 0 | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 |
|---|-----|----|----|----|----|----|----|-----|-----|
| Volume of O ₂ /cm ³ | 0.0 | 31 | 55 | 74 | 87 | 95 | 99 | 100 | 100 |

- (a) What is a *catalyst*? Name a suitable catalyst for this reaction. (8)
- (b) Draw a labelled diagram of an apparatus which could be used to carry out this reaction, collect the oxygen gas, and measure its volume. (12)
- (c) On graph paper, plot a graph of the volume of oxygen gas produced (*y*-axis) against time (*x*-axis). (18)
- (d) Why does the rate of oxygen production decrease as time passes? (6)
- (e) Use the graph to estimate the volume of oxygen gas collected during the first 3 minutes. (6)
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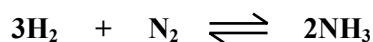
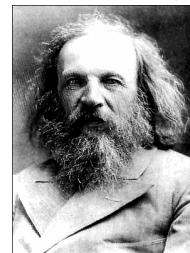
Section B

[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 Russian scientist pictured on the right who proposed an early version of the periodic table in 1867.
- (b) Describe the nature (composition) of an alpha-particle (α -particle).
- (c) Define *electronegativity*.
- (d) Name the piece of equipment used to measure the calorific value of foods and fuels.
- (e) Give the name or formula of the acid which is the cause of the sting of nettles.
- (f) A 500 cm³ bottle of mineral water contains 0.480 g of dissolved solids. Calculate the concentration of dissolved solids in p.p.m.
- (g) Write the arrangement of the electrons in the main energy levels of a calcium atom.
- (h) The label on a bottle of whiskey says that the alcohol content is 40% (v/v). How many cm³ of ethanol are there in 30 cm³ of the whiskey?
- (i) Write the equilibrium constant (K_c) expression for the equilibrium:



- (j) Define *reduction* in terms of electron transfer.
- (k) Answer part **A** or **B**
- A** What is the chemical formula for ozone? State **one** beneficial effect of the ozone layer.
- or*
- B** State **two** general chemical properties of transition metals.
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5. Each of the following were important contributors to what we know about atomic structure, the elements or radioactivity.

Bohr Becquerel Curie Dalton The Greeks Moseley Thomson Rutherford

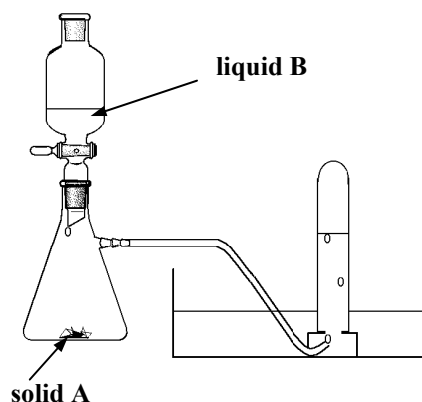
Select from the list above one answer to each of the following.

- (a) Who proposed the early theory that matter consists of the four elements: earth, air, fire and water? (7)
- (b) Who described atoms as small indivisible particles? (7)
- (c) Who identified electrons as sub-atomic particles? (6)
- (d) Who is credited with the discovery of the nucleus of the atom? (6)
- (e) Who proposed a model for the atom in which the electrons circulated around the nucleus in fixed energy levels or orbits? (6)
- (f) Who discovered that uranium salts emitted radiation? (6)
- (g) Who received a Nobel Prize for the isolation of the elements polonium and radium? (6)
- (h) Whose determination of the charge on the nucleus of atoms allowed the systematic arrangement of the elements in the modern periodic table? (6)
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6. (a) Alkynes form a *homologous series* of which ethyne (C_2H_2) is the first member.
- (i) What is a *homologous series*? (5)
- (ii) Draw the structure of the ethyne molecule. (6)
- (iii) In a chemical reaction, three molecules of ethyne can combine to form an aromatic molecule of formula C_6H_6 . Give the name *or* structure of this molecule. (6)

(b) The diagram on the right shows an apparatus which could be used for the preparation of ethyne gas.

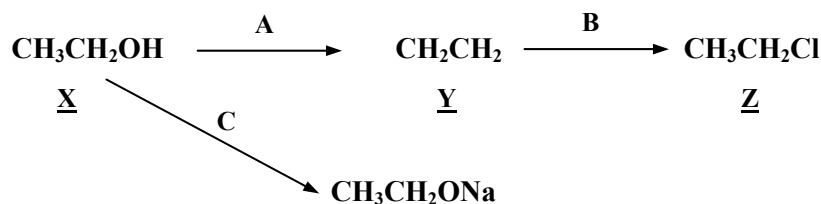
- (i) Identify the solid **A** and the liquid **B** used in the preparation. (12)
- (ii) Describe what you would observe when a sample of ethyne gas is burned in air. (6)
- (iii) Describe a test you could carry out on a sample of ethyne gas to show that the gas is unsaturated. (9)
- (iv) Give **one** major use of ethyne gas. (6)



7. (a) What is meant by (i) an *ionic bond*, (ii) a *covalent bond*? (8)
- (b) Describe using dot and cross diagrams the bond formation in (i) water (H_2O), (ii) sodium chloride ($NaCl$). (18)
- (c) What is the shape of the water molecule? (6)
- (d) What colour would a sample of sodium chloride impart to a Bunsen flame? (6)
- (e) The diagram shows a thin stream of water flowing from a suitable piece of equipment. What would be observed if a charged rod was held close to the stream of water? (12)
What property of water does this experiment demonstrate?



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



- (a) Which **one** of the compounds X, Y or Z is an unsaturated hydrocarbon? (5)
- (b) Name the compound Y. (6)
- (c) Classify (i) conversion **A**, (ii) conversion **B**, as an *addition*, an *elimination* or a *substitution* reaction. (12)
- (d) Draw a clearly labelled diagram of the apparatus used to carry out conversion **A** in a school laboratory. Identify the compound used to bring about this conversion. (15)
- (e) What reagent is used to bring about (i) conversion **B**, (ii) conversion **C**? (12)

9. (a) The following words all refer to stages in water treatment. These words are omitted from the passage below:

chlorination **filtration** **flocculation**
pH adjustment **fluoridation** **sedimentation**

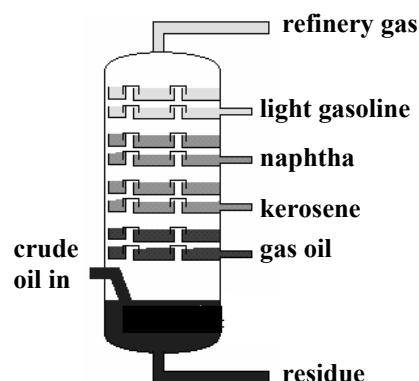
Write in your answer book the omitted words corresponding to each of the numbers 1 to 6. (36)

Aluminium sulfate and/or a polyelectrolyte is added to water to help suspended solids clump together in a process called 1. Following this addition the suspended solids are allowed settle to the bottom of 2 tanks. Bacteria in the water are destroyed by 3. Lime or acid is added to carry out 4. In Ireland 5 of water is carried out in urban supplies to help prevent tooth decay. The water is passed through beds of sand and gravel to remove any remaining suspended solids in a process called 6.

- (b) Identify **two** substances removed by the tertiary treatment of sewage effluent. State **one** damaging environmental effect of these substances. (14)

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

- (a) The diagram shows a fractionation tower of an oil refinery. The main fractions produced are named.



- (i) Which fraction is used as tar or bitumen in surfacing roads? (7)
- (ii) Identify the fraction which is rich in propane and butane, and which is used as a fuel for outdoor (space) heaters? (6)
- (iii) Which fraction is used as an aircraft fuel? (6)
- (iv) Which fraction is a heavy fuel oil used in furnaces? (6)

- (b) (i) Define *pH*. (7)

The concentration of a solution of hydrochloric acid (**HCl**) is given as 3.65 grams per litre.

- (ii) What is the concentration of the solution in moles per litre? (9)
- (iii) Calculate the *pH* of the solution. (9)

- (c) It is possible to estimate the *free chlorine* in swimming pool water or bleach using a colorimeter or a comparator.

- (i) Describe how you could measure the free chlorine in either swimming pool water or bleach using one of these methods. (18)
- (ii) Outline briefly the principles on which the technique you have described in (i) is based. (7)

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

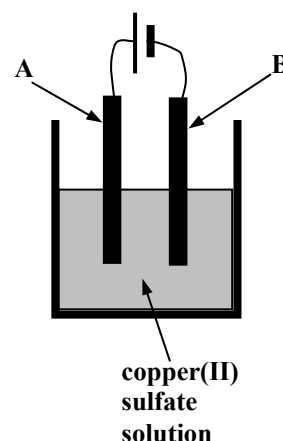
(2 × 25)

(a) Paper chromatography, thin-layer chromatography and column chromatography are all separation techniques.

- (i) Describe with the aid of a diagram an experiment to separate a mixture of indicators using **one** of these techniques. (15)
- (ii) What material is the stationary phase in the experiment you have described? (5)
- (iii) Give **one** example of the use of thin-layer chromatography in forensic science. (5)

(b) The diagram shows an arrangement for the electrolysis of copper(II) sulfate solution using copper electrodes.

- (i) Write the chemical formula for copper(II) sulfate. What colour is the copper(II) sulfate solution? (7)
- (ii) State **one** change which happens to the electrode labelled **A** during the experiment. (6)
- (iii) If you wished to electroplate a metal object with copper, which of the electrodes, **A** or **B**, should be replaced by the object? (6)
- (iv) If you wished to purify a sample of copper, which of the electrodes, **A** or **B**, should you replace with the piece of impure copper? (6)



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

A

Air serves as a major source of both nitrogen gas and oxygen gas.

- (i) How is oxygen gas produced commercially from air? (4)
- (ii) State **one** commercial use of oxygen and **one** commercial use of nitrogen. (6)
- (iii) What is meant by *nitrogen fixation*? Why is it important? (9)
- (iv) Give **one** way in which nitrogen is fixed in nature. (6)

or

B

- (i) Name the English scientist pictured on the right who isolated the elements sodium and potassium in the early 1800s. (4)
- (ii) Both sodium and potassium *corrode* easily. What is meant by *corrosion*? (6)



English scientist who isolated sodium and potassium in the early 1800s

The corrosion of iron can be prevented by *galvanising*.

- (iii) How is a piece of iron galvanised? (6)
- (iv) How does this prevent the iron from corroding? (6)
- (v) State **one** method, other than galvanising, which helps prevent iron from corroding. (3)

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