

AN ROINN OIDEACHAIS AGUS EOLAÍOCHTA

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LEAVING CERTIFICATE EXAMINATION, 2002

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# CHEMISTRY - ORDINARY LEVEL

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TUESDAY, 18 JUNE - AFTERNOON 2.00 to 5.00

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**400 MARKS**

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Answer **eight** questions in all

These **must** include at least **two** questions from **Section A**

All questions carry equal marks (50)

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## Information

Relative atomic masses: H = 1, O = 16, Cl = 35.5, Zn = 65

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

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 sample of ethanoic acid (acetic acid) was prepared in the school laboratory as follows. A mixture of ethanol and water was added slowly from a dropping funnel into a cooled solution of sodium dichromate in concentrated sulfuric acid (Diagram 1). The mixture was allowed to warm up slowly and was then refluxed for 30 minutes.

- (a) Why was the ethanol in the dropping funnel mixed with water? (5)
- (b) What should be used to cool the contents of the reaction flask? (6)
- (c) Using a rough sketch, indicate the direction in which the water flowed through the condenser. (6)
- (d) What colour change occurred in the reaction mixture as the ethanol and water were added? (12)
- (e) Why was it important to reflux the mixture? (6)

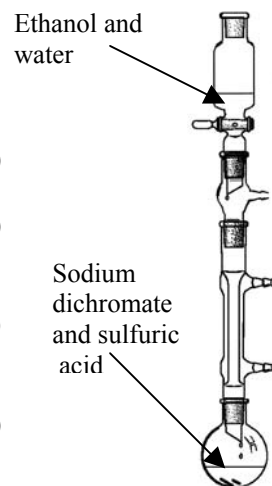


Diagram 1

Following the reflux the reaction mixture was allowed to cool slightly and the apparatus was rearranged to distil the mixture (Diagram 2). A sample of ethanoic acid was isolated by distillation as the fraction which distilled off between 115 °C and 118 °C.

- (f) What gas is given off when sodium carbonate is added to a sample of ethanoic acid? What test could you carry out to identify this gas? (9)
- (g) A dilute solution (5-6% w/v) of ethanoic acid (acetic acid) is used in food preservation and also as a flavouring agent. What is the common name of this solution? (6)

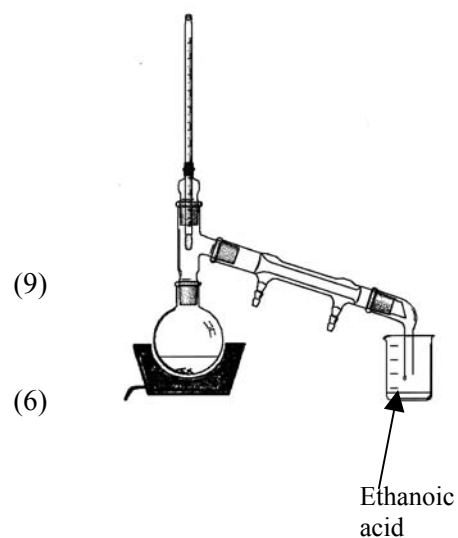
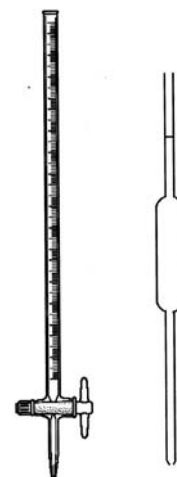


Diagram 2

- 2 The concentration of a solution of hydrochloric acid was measured by titration using a standard 0.10 M solution of sodium hydroxide. The hydrochloric acid solution was titrated against 25 cm<sup>3</sup> portions of the standard sodium hydroxide solution using a suitable indicator. The pieces of equipment shown on the right were used during the experiment.



(a) Name the pieces of equipment **A** and **B**. (8)

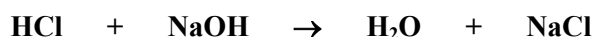
(b) Which piece of equipment was used to measure the 25 cm<sup>3</sup> portions of the sodium hydroxide solution?  
Describe the procedure for washing this piece of equipment and for measuring the 25 cm<sup>3</sup> portions of the sodium hydroxide solution. (12)

(c) Name a suitable indicator for this titration.

What colour change is observed at the end point? (9)

**A B**

A number of accurate titrations were carried out using 25 cm<sup>3</sup> portions of the 0.10 M sodium hydroxide solution. It was found that the mean volume of hydrochloric acid used in these titrations was 20.0 cm<sup>3</sup>. The titration reaction is described by the following equation.



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

(e) How could this experiment be extended to produce a sample of dry sodium chloride (common salt)? (12)

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- 3 Hydrogen peroxide solution decomposes rapidly into water and oxygen gas in the presence of a catalyst. When a catalyst was added to 25 cm<sup>3</sup> of hydrogen peroxide solution, the oxygen gas produced was collected and its volume noted every 2 minutes as shown in the table.

Time/minutes	0	2	4	6	8	10	12	14	16
Volume of O <sub>2</sub> / cm <sup>3</sup>	0	36	54	63	68	71	73	74	74

(a) Name or give the formula of a suitable catalyst for this reaction. (5)

(b) Draw a labelled diagram of a suitable apparatus for carrying out this experiment. (12)

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

(d) What volume of oxygen was produced during the first three minutes of the reaction?  
From this calculate the average rate of oxygen production over the first three minutes of the reaction in cm<sup>3</sup> per minute. (9)

(e) Why did the reaction slow down as time passed? (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 items (a), (b), (c), etc. (50)

(a) Give the number of electrons in each of the main energy levels of a calcium atom.

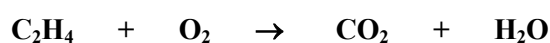
(b) Define *electronegativity*.

(c) What is the shape of the ammonia molecule?

(d) State *Boyle's law*.

(e) Give the name and formula of an aromatic compound.

(f) Balance the chemical equation



(g) The label on a bottle of mineral water indicates that 500 cm<sup>3</sup> of the water contains 120 mg of calcium ions. Express this concentration in parts per million (p.p.m.) of calcium ion.

(h) Define *relative atomic mass*.

(i) Give an example of a useful product of organic synthesis. What use is made of this product?

(j) How many molecules are there in 9 g of water, **H<sub>2</sub>O**?

[Relative atomic masses: H = 1, O = 16; Avogadro constant =  $6 \times 10^{23} \text{ mol}^{-1}$ ]

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

**A** State **two** ways in which chemistry contributes positively to society.

**B** List **two** of the stages in the recycling of poly(phenylethene), [poly(styrene)].

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5 Answer the questions below with reference to the following elements.

**hydrogen    helium    sodium    oxygen**

(a) Which of these elements is the lightest known gas? (5)

(b) Which element is used in yellow/orange street lights? (6)

(c) Which element exists as a monatomic gas? (6)

(d) Which of the elements has atoms with the largest atomic radius? (6)

(e) Which unreactive gas is mixed with oxygen for use by deep-sea divers? (6)

(f) Give the name and formula of an ionic compound formed between any two of these elements. (9)

(g) Draw a dot and cross diagram to show the bonding in a covalent compound formed between two of these elements. Give the name of this compound. (12)

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6 The compounds **A**, **B** and **C** are hydrocarbons.



**A**



**B**



**C**

- (a) Which of these compounds is produced from the decomposition of animal and vegetable waste in dumps? What environmental hazard does this gas present? (8)
- (b) Name each of the compounds **A**, **B** and **C**. (18)
- (c) Which compound is assigned an octane rating of 100?  
What problem arises in a combustion engine if the octane rating of the fuel used is too low? (12)
- (d) In the past, compounds of a heavy metal were added to petrol to increase its octane rating.  
Name this metal. (6)
- (e) Which of the three compounds **A**, **B** or **C**, is a major component of liquid petroleum gas, LPG? (6)
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7 Mass spectrometry (MS), thin layer chromatography (TLC), gas chromatography (GC) and high performance liquid chromatography (HPLC) are all techniques used in chemistry.

- (a) State **one** use that is made of mass spectrometry. (5)
- (b) Describe an experiment to separate a mixture of dyes or indicators using thin layer chromatography.  
State **one** use that is made of this technique in forensic science. (18)
- (c) Give **one** application for  
(i) gas chromatography (GC)  
(ii) high performance liquid chromatography (HPLC). (12)
- (d) All of the three chromatographic separation techniques are based on the same principle.  
What is this principle? (9)
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8 (a) What is *water hardness*? How can permanent hardness be removed from water? (8)

Treatment of a domestic water supply may involve each of the following stages.

**sedimentation**

**flocculation**

**filtration**

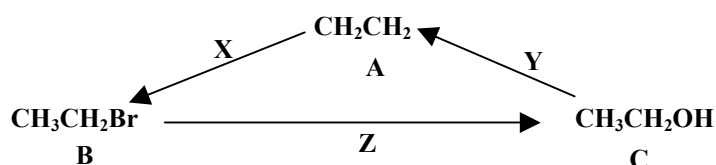
**chlorination**

**fluoridation**

**pH adjustment**

- (b) In the case of any **four** of these stages, explain how the water is treated and state the purpose of each of these four stages. (24)
- (c) Sewage treatment can be divided into three stages, **primary**, **secondary** and **tertiary** treatment.  
Explain what happens in each of these stages. (18)
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9 Answer the questions below with reference to compounds A, B and C in the following reaction scheme.



- Which **one** of the three compounds has only planar carbon atoms in its molecules?  
Draw the structure of this compound. (8)
- Classify the reactions X, Y and Z as *substitution*, *addition* or *elimination* reactions. (18)
- Which of the two compounds, A or C, would you expect to be more soluble in water?  
Give a reason for your answer. (12)
- Which **one** of the three compounds can be polymerised? Give **one** use of that polymer. (12)

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

- Name the female physicist, pictured on the right, who was awarded the 1903 Nobel Prize for Physics for her work on radioactivity and the 1911 Nobel Prize for Chemistry. (4)



She is associated with the discovery of two radioactive elements.  
The name of one of these elements is derived from the name of the country of her birth. Name either element. (3)

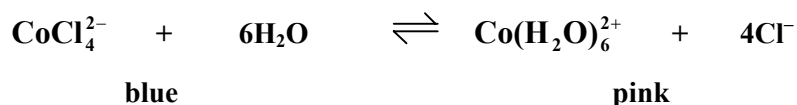
Alpha- ( $\alpha$ -), beta- ( $\beta$ -) and gamma- ( $\gamma$ -) radiations are all associated with radioactivity.

- Place these three types of radiation in order of increasing penetrating power. (6)
  - Which of these three types of radiation was used by Rutherford in his experiment which led to the discovery of the nucleus of the atom? (6)
  - Cobalt-60,  $^{60}\text{Co}$ , is an isotope of cobalt which emits gamma-rays ( $\gamma$ -rays).  
State **one** use made of this type of radiation. (6)
- Define (i) *an acid* according to the Arrhenius theory, (ii) pH. (7)  
Your stomach contains a solution of hydrochloric acid which is about 0.01 M.  
Calculate the approximate pH of this solution. (9)  
What type of compound is usually present in stomach powders used to treat acid indigestion?  
Name or give the formula of **one** such compound. (9)
  - Ethyne (acetylene) is an *unsaturated hydrocarbon*.  
What is meant by the terms (i) *hydrocarbon* and (ii) *unsaturated*? (7)  
(iii) Draw a labelled diagram of the apparatus used to prepare a sample of ethyne (acetylene) gas in the school laboratory. Identify the **two** reagents used. (15)  
(iv) State **one** use of ethyne gas. (3)

(a) State *Le Chatelier's principle*.

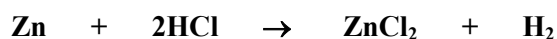
(7)

An equilibrium mixture was set up by adding hydrochloric acid to an aqueous solution of cobalt(II) chloride. The equilibrium is described by the equation



- (i) Use Le Chatelier's principle to explain the change in position of the equilibrium which results from the addition of a small amount of concentrated hydrochloric acid to the equilibrium mixture. (6)
- (ii) Given that the forward reaction is exothermic, how would an increase in temperature affect the position of the equilibrium? What colour change would accompany an increase in temperature? (12)

(b) Zinc reacts with hydrochloric acid to produce zinc chloride and hydrogen gas. The reaction proceeds according to the following equation.



In an experiment 32.5 g of zinc were reacted with hydrochloric acid and the hydrogen gas was collected.

- (i) How many moles of zinc were used? (4)
- (ii) How many moles of hydrochloric acid were needed to react fully with this amount of zinc? (6)
- (iii) What mass of zinc chloride was produced? (6)
- (iv) What volume of hydrogen gas (measured at s.t.p.) was produced? (9)

[Relative atomic masses: Cl = 35.5, Zn = 65; molar volume at s.t.p. = 22.4 litres]

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

**A**

- (i) Name the product of the industry on which you carried out a case study. Where in Ireland is this industry located? (7)
- (ii) Give **one** reason why this is a suitable location for the industry. (6)
- (iii) Is the production process a batch process or a continuous process? Explain your answer. Name **one** of the raw materials used in the production process. (12)

**OR**

**B**

- (i) Name the father-and-son team who received the Nobel Prize for their work in developing the X-ray technique for determining crystal structure. (4)
- (ii) Give an example of a macromolecular crystal. Name the binding force in this crystal. State **one** use of this substance. (12)
- (iii) Give an example of a molecular crystal. Name the binding force in this crystal. (9)