



# Coimisiún na Scrúduithe Stáit State Examinations Commission

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LEAVING CERTIFICATE EXAMINATION, 2008

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**CHEMISTRY – ORDINARY LEVEL**

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THURSDAY, 5 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)

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## Information

Relative atomic masses: H = 1, O = 16, Mg = 24, S = 32, 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].

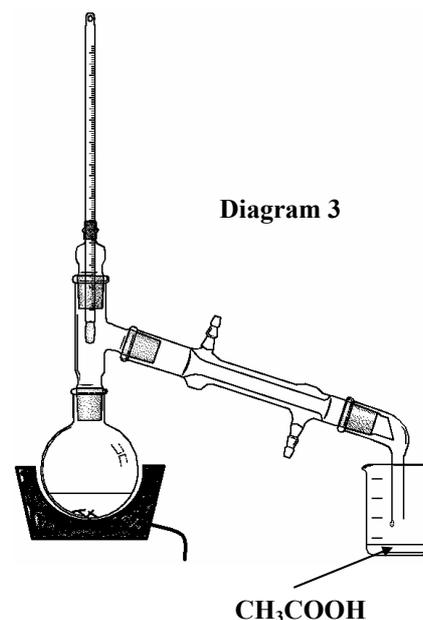
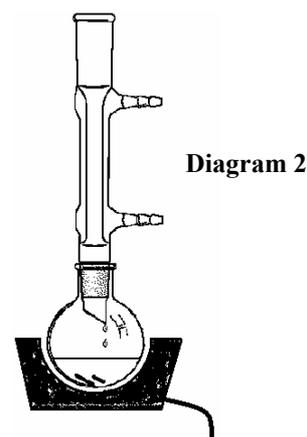
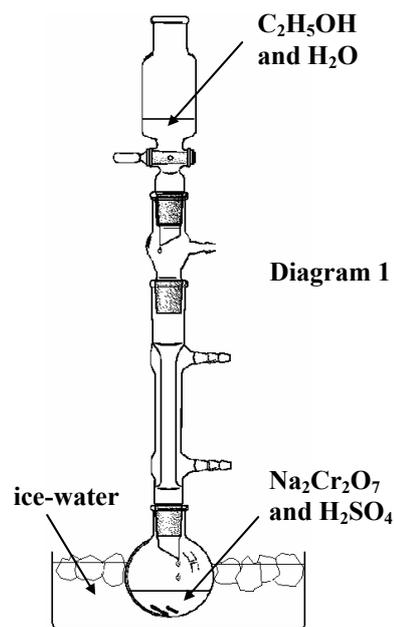
1. A group of students prepared a sample of ethanoic (acetic) acid,  $\text{CH}_3\text{COOH}$ , in the school laboratory as follows.

A solution of ethanol,  $\text{C}_2\text{H}_5\text{OH}$ , in water was added in small portions to an aqueous solution of sodium dichromate(VI),  $\text{Na}_2\text{Cr}_2\text{O}_7$ , and sulfuric acid,  $\text{H}_2\text{SO}_4$ , contained in a flask immersed in ice-water (Diagram 1).

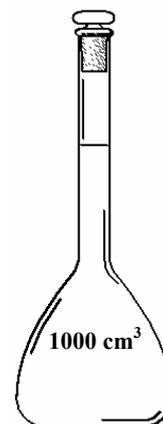
When all of the ethanol solution had been added, the reaction mixture was refluxed for about thirty minutes (Diagram 2).

At the end of the reflux period, the apparatus was rearranged and the ethanoic acid was removed from the reaction mixture by distillation (Diagram 3). The ethanoic acid was collected as a fraction which distilled between  $115^\circ\text{C}$  and  $118^\circ\text{C}$ .

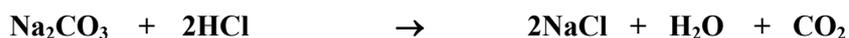
- (a) Make a rough sketch of any one of these arrangements of apparatus in your answer-book and clearly indicate the direction in which the water should flow through the condenser. (8)
- (b) Explain why small pieces of glass or pumice stone were added to the reaction flask at the start of the experiment. (6)
- (c) What was the colour of the solution of sodium dichromate(VI) and sulfuric acid in the reaction flask before any of the solution of ethanol and water was added from the dropping funnel? (6)
- (d) Why was the solution of ethanol and water added in small portions? (6)
- (e) What colour was produced as the ethanol reacted with the sodium dichromate(VI)? (6)
- (f) Why was it important to reflux the reaction mixture? (6)
- (g) Why was a water bath not suitable for heating the flask during the distillation? (6)
- (h) A dilute solution (5-6 % w/v) of ethanoic acid (acetic acid) is used in food preservation and as a flavouring agent. What is the common name of this solution? (6)



2. A standard (0.05 M) solution of sodium carbonate,  $\text{Na}_2\text{CO}_3$ , was made up in the flask shown in the diagram. After making up the solution, it was used to find the concentration of a hydrochloric acid,  $\text{HCl}$ , solution.



- (a) What term is used to describe the type of flask shown in the diagram? (5)
- (b) What is a *standard solution*? (6)
- (c) Outline the steps involved in making up the standard solution of sodium carbonate. (12)
- (d) In the titrations carried out to find the concentration of the hydrochloric acid solution, what piece of equipment is usually used to measure the volume of
- (i) the sodium carbonate solution,
- (ii) the hydrochloric acid solution? (12)
- (e) Name an indicator suitable for a titration involving sodium carbonate and hydrochloric acid solutions. State the colour of the mixture at the end point. (6)
- (f) It was found that  $25.0 \text{ cm}^3$  of the 0.05 M sodium carbonate solution required  $20.0 \text{ cm}^3$  of the hydrochloric acid solution for exact neutralisation. The balanced equation for the titration reaction is:



Calculate the molarity of the hydrochloric acid,  $\text{HCl}$ , solution. (9)

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3. Flame tests can be used to identify the metallic element present in a salt.

- (a) Copy the table below into your answer book and complete it, matching the correct salt from the list on the right with the colour it imparts to a Bunsen flame. (14)

Potassium nitrate ( $\text{KNO}_3$ )
Sodium chloride ( $\text{NaCl}$ )
Copper(II) chloride ( $\text{CuCl}_2$ )

FLAME COLOUR	Orange-yellow	Lilac	Green
SALT			

- (b) Describe how you could carry out a flame test using one of these salts. (18)
- (c) Where, outside the laboratory, would you be likely to see lights containing sodium vapour? (6)
- (d) Some fireworks produce red light in the sky.  
Name a metal whose salts are used in the manufacture of fireworks that produce red light. (6)
- (e) What test could you carry out to confirm the presence of chloride ions in aqueous solution? (6)

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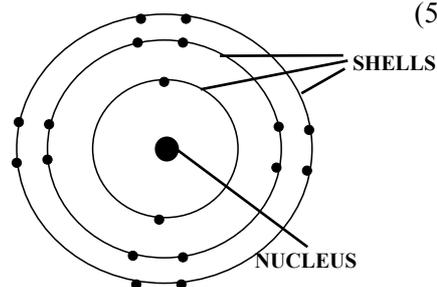
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## Section B

[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) 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 the first group of the periodic table?

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

(e) What is meant by the *octane number* of a fuel?

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



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

(h) Write the equilibrium constant ( $K_c$ ) expression for the equilibrium:



(i) Calculate the percentage by mass of magnesium in magnesium sulfate ( $\text{MgSO}_4$ ).

(j) Identify **one** natural product that is extracted from plant material 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.

5. (a) Atoms are made up of protons, neutrons and electrons.

(i) Copy the following table into your answer book and fill in the missing information. (17)

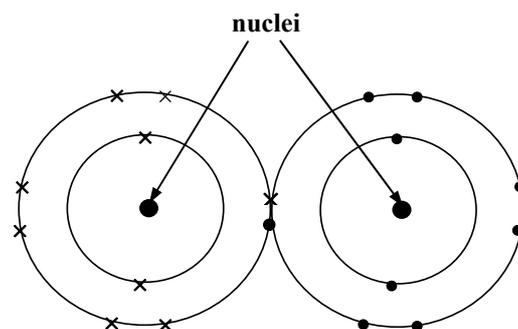
	Relative mass	Relative charge	Location
Proton	1		
Neutron			nucleus
Electron	1/1836	- 1	

(ii) What information about subatomic particles is given by the atomic number of an element? (6)

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

(ii) How are electronegativity values used to predict the type of bonding present in a compound? (6)

(c) The diagram on the right shows the bonding in a fluorine molecule,  $\text{F}_2$ . Dots (•) and crosses (×) represent the electrons.



(i) What type of chemical bond is found between the fluorine atoms in a fluorine molecule? (6)

(ii) Name another type of chemical bond formed by fluorine.

Give an example of a compound in which fluorine forms this type of bond. (9)

6. Hydrogen gas and the hydrocarbons ethyne and butane are all used as fuels.

(a) What are (i) *hydrocarbons*, (ii) *fuels*? (8)

(b) (i) Which of the three fuels, named above, is a major component of liquid petroleum gas (LPG) used as a fuel in patio heaters?

(ii) Which of the three fuels is used as a fuel for space rockets?

(iii) Which of the three fuels has the common name acetylene and is used in high temperature cutting equipment? (15)

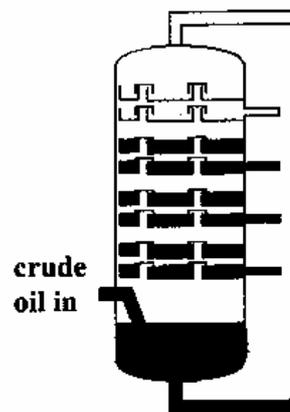
(c) Write structural formulas for the hydrocarbons ethyne and butane. (12)

(d) The diagram on the right shows a fractionating column used in oil refining. Crude oil is separated into fractions that come off through the outlet pipes on the right-hand side of the column.

Name **one** of the fractions obtained by the fractionating process.

State whether this fraction is collected from high up, from the middle or from low down the fractionating column.

State **one** major use of this fraction. (15)



7. (a) In 1884, the Swedish chemist, Arrhenius, pictured on the right, proposed a new theory of acids and bases.

(i) How did Arrhenius define an acid? (5)

(ii) Give **one** example of a commonly used base and state **one** use made of it. (12)

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

(ii) Describe how you could measure the pH of a solution. (9)

The concentration of a solution of hydrochloric acid, **HCl**, is 3.65 grams per litre.

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

(iv) Calculate the pH of the solution. (9)



8. (a) The treatment of water for domestic use may involve each of the following stages.

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

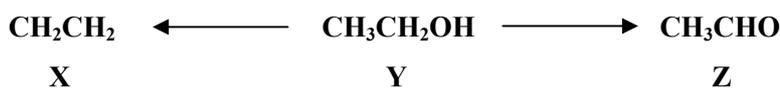
State the purpose of **four** of these stages and describe how the water is treated in each of the four stages you have chosen. (24)

(b) The treatment of domestic and industrial effluent is normally divided into three stages: **primary**, **secondary** and **tertiary**.

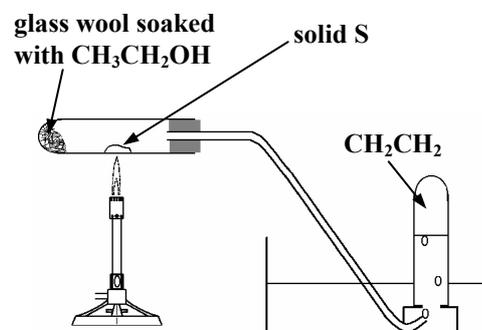
Explain what happens in each of these stages. (18)

(c) Give **two** environmental consequences of discharging untreated sewage into a river. (8)

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



- (a) Which **one** of the compounds X, Y or Z has only planar 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 in concentrations of about 40-55% (v/v) in whiskey,
  - is used to make the plastic poly(ethene) [polythene]? (12)
- (d) An apparatus suitable for the conversion of Y to X in a school laboratory is drawn on the right.
- Give the name or formula of the white solid S.
  - Why should the delivery tube be removed from the trough of water when the heating is stopped?
  - Describe one test you carried out on  $\text{CH}_2\text{CH}_2$ . State the observation you made and the conclusion drawn. (24)



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

- (a) The table shows data obtained when a hydrogen peroxide solution decomposed to form water and oxygen in the presence of a catalyst.

<u>Time</u> seconds	0	10	20	30	40	50	60	70
<u>Volume of oxygen gas produced</u> cm <sup>3</sup>	0	30	53	69	79	85	88	88

- On graph paper, plot the volume of oxygen produced (y-axis) against time (x-axis) (12)
  - Find from the graph the volume of oxygen produced in the first 15 seconds. (6)
  - Use the graph to find the time at which the reaction was finished. (7)
- (b) Mass spectrometry (MS), gas chromatography (GC), high-performance liquid chromatography (HPLC) and thin-layer chromatography (TLC) are all used in analytical chemistry.
- In the case of **each** one of these analytical techniques state **one** important application of the technique. (16)
  - Choose one of these analytical techniques and explain the principle upon which it is based. (9)
- (c) In the Haber process, nitrogen and hydrogen react to produce ammonia ( $\text{NH}_3$ ).



Le Châtelier's principle is applied in deciding the conditions required to give the best yield of the product.

- State *Le Châtelier's principle*. (7)
- What does the symbol  $\rightleftharpoons$  tell us about the reaction? (6)
- Using Le Châtelier's principle, state whether you would use high or low temperature, and also whether you would use high or low pressure, in order to favour the production of ammonia in the Haber process. Give reasons for your choice of conditions. (12)



Henri Le Châtelier

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

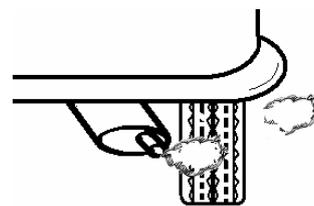
(2 × 25)

- (a) The following names are associated with the development of our knowledge of the elements and atomic structure. Choose a name from this list when answering the questions below.

**Boyle      Curie      Dalton      Mendeleev      Rutherford**

- (i) Who was the Co. Waterford-born scientist who gave us an important gas law and is described as “the father of modern chemistry”?
- (ii) Who was the English schoolteacher who in 1808 described atoms as “small indivisible particles”?
- (iii) Identify the Russian scientist who produced an early version of the periodic table of the elements.
- (iv) Who was the Polish born scientist who received the Nobel Prize in 1911 for isolating the radioactive elements polonium and radium?
- (v) Who is credited with the discovery of the nucleus of the atom? (5 × 5)

- (b) The catalytic converters found in modern cars contain certain metals spread over a fine honeycombed ceramic of very large surface area. Engine exhaust gases react on the surface of the hot solid catalyst to produce less-polluting tailpipe gases.



- (i) Explain the term *catalyst*.  
What term describes the type of catalysis described above? (7)
- (ii) In the catalytic converter nitrogen monoxide (NO) and carbon monoxide (CO) react together to give two gaseous products. Identify these two products. (6)
- (iii) Name **one** of the metals used as a catalyst in the catalytic converter of a car.  
Name an element that poisons the catalysts present in a catalytic converter. (12)

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

**A**

- (i) Name the main product of the chemical industry on which you carried out a case study.  
What use is made of the product you have named? (10)
- (ii) Name the principal raw material used in this industry.  
Give the source of the raw material you have named. (9)
- (iii) Is the process by which the product is made a *batch* or a *continuous* process?  
Explain your answer. (6)

**or**

**B**

In 1964 Dorothy Hodgkin was awarded the Nobel Prize in Chemistry for determining the structures of complex organic molecules.



**Dorothy Hodgkin**

- (i) Identify either the vitamin or the antibiotic whose structures were determined by Hodgkin. (4)
- (ii) What experimental technique did she use to determine these structures? (6)
- (iii) The father and son team who pioneered this technique are pictured on the right. Who are they? (6)
- (iv) Give **two** examples of covalent macromolecular solids. (9)



**Father & Son**

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