



# Coimisiún na Scrúduithe Stáit State Examinations Commission

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LEAVING CERTIFICATE EXAMINATION, 2016

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## CHEMISTRY – ORDINARY LEVEL

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TUESDAY, 21 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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**The information below should be used in your calculations.**

Relative atomic masses (rounded):            H = 1.0, O = 16, Na = 23, Fe = 56

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

Avogadro constant =  $6.0 \times 10^{23} \text{ mol}^{-1}$

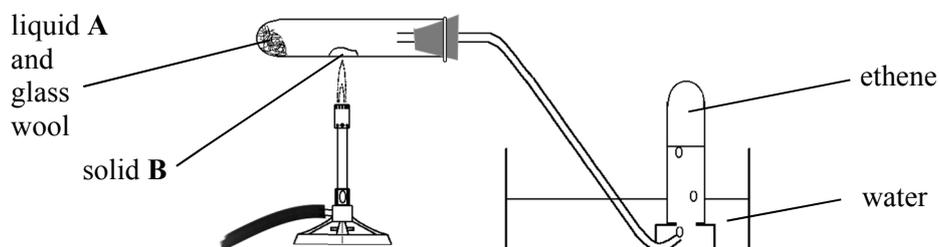
**The use of the *Formulae and Tables* booklet approved for use in the State Examinations is permitted. A copy may be obtained from the examination superintendent.**

## Section A

Answer at least two questions from this section. See page 1 for full instructions.

1. Ethene and ethyne are both unsaturated, gaseous, flammable hydrocarbons.

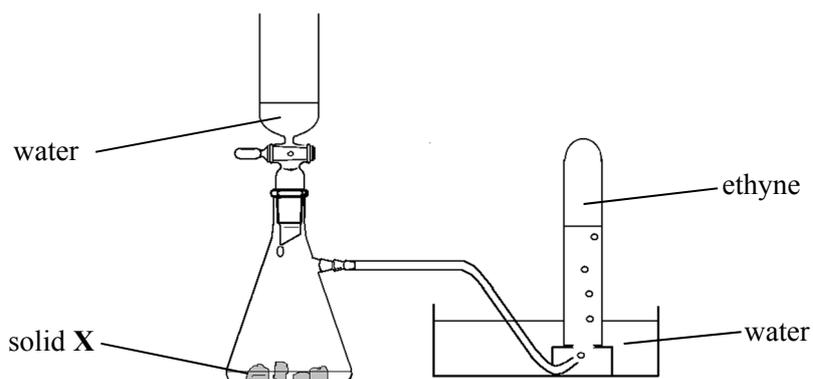
(a) The diagram shows the preparation and collection of ethene ( $C_2H_4$ ).



- Identify liquid A held by glass wool at the end of the horizontal test tube.
- Give the name or formula of the white solid B.
- State one precaution that should be taken while carrying out this preparation.
- Describe how ethene could be tested for unsaturation.
- Write a balanced equation for the complete combustion of ethene in oxygen.

(30)

(b) The diagram shows the preparation and collection of ethyne ( $C_2H_2$ ).



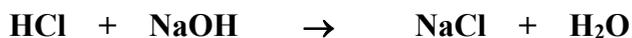
- Identify solid X.
- Describe how a combustion test on a sample of ethyne supplied in a stoppered test tube could be carried out.  
What would be observed?
- Give one major use for ethyne.

(20)

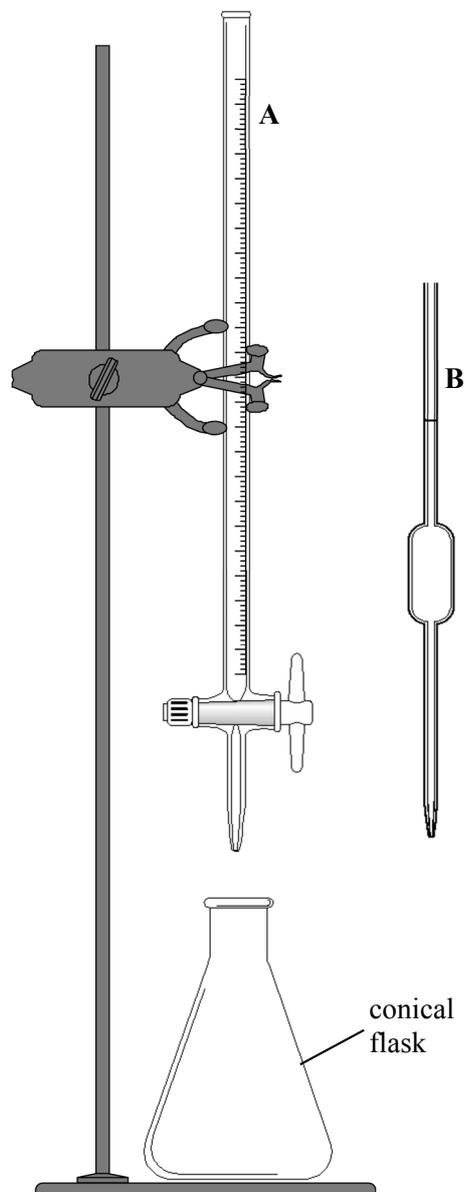
2. The concentration of a sodium hydroxide (**NaOH**) solution was found by titration with a 0.10 M hydrochloric acid (**HCl**) solution using an indicator to identify the end point.

It was found that exactly 25 cm<sup>3</sup> of the sodium hydroxide solution required, on average, 22.5 cm<sup>3</sup> of the 0.10 M hydrochloric acid solution for neutralisation.

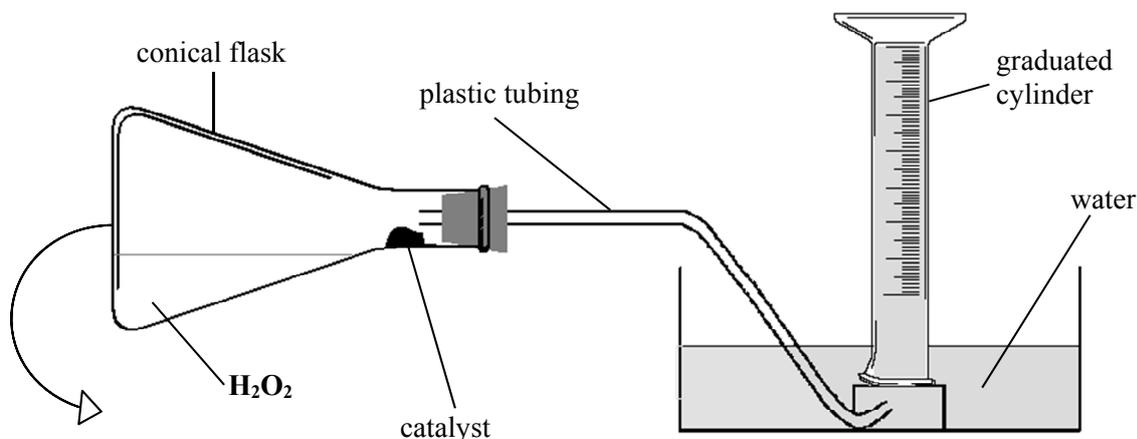
The equation for the titration reaction is:



- (a) Explain the underlined term. (5)
- (b) Name a suitable indicator for the titration. (6)
- (c) (i) Describe the procedure for rinsing **A** for use in the titration.  
(ii) Name the piece of glassware **B** used to measure out exactly 25 cm<sup>3</sup> of sodium hydroxide into the conical flask. (9)
- (d) Calculate the concentration of the sodium hydroxide solution  
(i) in moles per litre,  
(ii) in grams per litre. (15)
- (e) Describe with the aid of a labelled diagram how to then obtain a pure, dry sample of the sodium chloride (**NaCl**) product of this reaction. (9)
- (f) A sample of the salt obtained was held in the centre of a Bunsen burner flame. What colour was observed? (6)



3. Hydrogen peroxide ( $\text{H}_2\text{O}_2$ ) decomposes rapidly in the presence of a suitable catalyst, and releases oxygen ( $\text{O}_2$ ) gas. A student used a powdered catalyst and the apparatus shown in the diagram and measured the volume of oxygen collected at two minute intervals at room temperature. To start the reaction the conical flask was moved into the upright position so that the catalyst fell into the hydrogen peroxide solution.



The results obtained are shown in the following table.

Time (minutes)	0	2	4	6	8	10	12
Volume ( $\text{cm}^3$ )	0	50	69	75	78	79	79

- (a) What is a catalyst?  
Give the name *or* formula of a suitable catalyst for this reaction. (11)
- (b) In your answerbook complete and balance the equation for the reaction:  

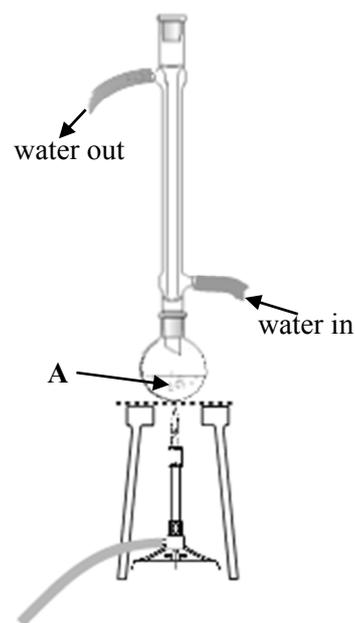
$$\text{H}_2\text{O}_2 \rightarrow \text{ \_\_\_\_\_\_ } + \text{O}_2$$
 (6)
- (c) On graph paper, plot a graph of the volume (*y*-axis) against time (*x*-axis). (15)
- (d) Find from your graph the volume of oxygen produced during the first three minutes of reaction.  
Explain why the reaction slows down as it proceeds. (12)
- (e) Sketch on your graph the curve you would expect to plot if the reaction were repeated with the conical flask cooled in ice-water. (6)

## 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) What are the three states of matter?
- (b) The idea that matter is made from tiny indivisible (*atomos*) particles, was proposed in ancient times in a certain country. Name the country.
- (c) Explain why smoke from a burning sofa could fill a room.
- (d) Name the apparatus used to measure the calorific value of a food, e.g. a new snack bar.
- (e) Explain what happens when liquid **A** in the apparatus shown on the right begins to boil.
- (f) According to Boyle's law, what is the relationship between the volume of a certain mass of gas and its pressure at a constant temperature?
- (g) What is the volume at s.t.p. of 2 moles of helium (**He**) gas?
- (h) What term is used to describe the time interval during which the number of nuclei of a certain radioactive isotope in a sample reduces by 50%?
- (i) State one beneficial effect on the environment of removing nitrates and phosphates in tertiary sewage treatment.
- (j) Each molecule shown below has six carbon atoms.



hexane	cyclohexane	benzene
$  \begin{array}{cccccc}  \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} \\    &   &   &   &   &   \\  \text{H}-\text{C}-\text{C}-\text{C}-\text{C}-\text{C}-\text{C}-\text{H} \\    &   &   &   &   &   \\  \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H}  \end{array}  $		

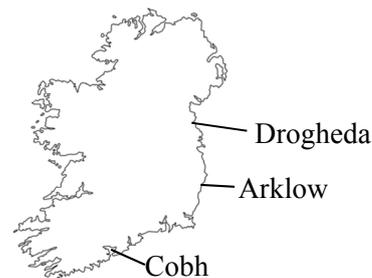
Which molecule is aromatic?

- (k) **A** Give two physical properties shared by *all* metals.

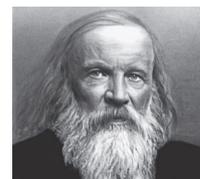
*or*

- B** Select the town nearest the factory you took as your case study of the Irish chemical industry and give a reason for the location of the factory near that town.

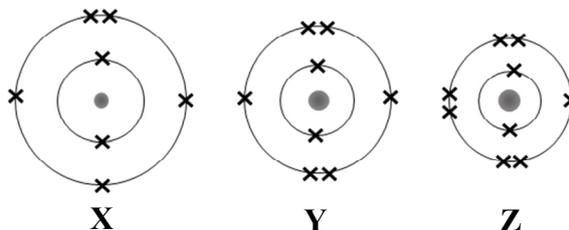
State the product of the manufacturing process that is (or was) carried out in that factory.



5. (a) Name the Russian scientist pictured on the right who was the first person to successfully devise a periodic table of the elements. State one property that elements in the same group of the modern periodic table have in common. (11)

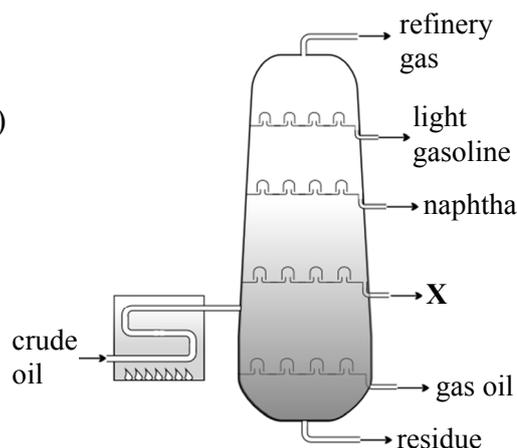


- (b) The diagrams below represent neutral atoms of elements **X**, **Y** and **Z** from the second period of the periodic table. Each cross represents an electron.



- (i) Identify elements **X**, **Y** and **Z**.
- (ii) If an atom of **Z** has ten neutrons in its nucleus, what is its mass number?
- (iii) Draw a similar diagram to show the arrangement of electrons in an atom of neon.
- (iv) Why is neon chemically unreactive?
- (v) Explain why the atomic radius *decreases* from **X** to **Z**. (27)
- (c) Define *electronegativity* of an element. Use electronegativity values (page 81 *Formulae and Tables* booklet) to predict the type of bond formed between element **Z** and sodium (**Na**). (12)

6. In an oil refinery a fractionating column like that shown separates crude oil into different useful hydrocarbon fractions.



(a) What are *hydrocarbons*? (5)

(b) Liquid petroleum gas (LPG) is obtained from refinery gas.

(i) Name the two main components of LPG.

(ii) Draw the structural formula of one of these compounds.

(iii) Why are small quantities of *mercaptans* added to LPG? (18)

(c) Petrol is obtained from the light gasoline and naphtha fractions.

(i) What is meant by the *octane number* of petrol?

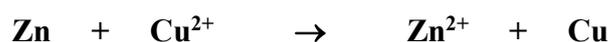
(ii) Give one way of increasing the octane number of a fuel. (12)

(d) (i) Name fraction **X** that is used as a fuel for jet aircraft and as a central-heating oil.

(ii) Give a use for the residue obtained at the base of the fractionating column. (15)

7. (a) Define (i) *oxidation*, (ii) *reduction*, in terms of electron transfer. (12)

(b) When a piece of zinc is left in a solution of copper sulfate, the zinc becomes coated with copper and the solution gradually loses its blue colour. The equation for the reaction is:



(i) Which species is oxidised?

(ii) How many electrons are transferred when one zinc atom reacts according to the equation above?

(iii) Identify the oxidising agent and the reducing agent. (18)

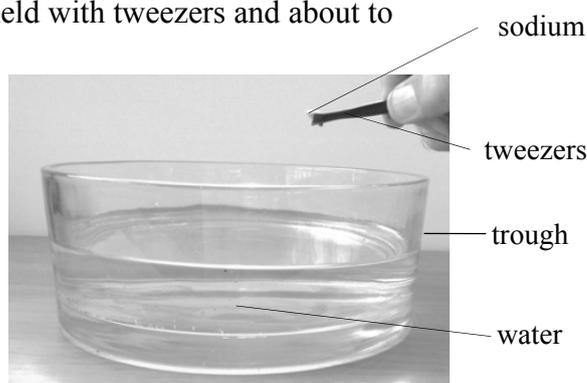
(c) The picture shows a small piece of sodium, held with tweezers and about to be dropped into water.

(i) Why must sodium never be held with the fingers?

(ii) What is observed when the sodium reacts with the water?

(iii) Name the gas produced when sodium reacts with water.

(iv) What difference would you observe if potassium were used instead of sodium? (20)



8. Consider the four compounds **A**, chloroethane, **B** and **C**.



- (a) Draw the structure of each of the three compounds **A**, **B** and **C**, showing all the atoms and all the bonds.  
Mark clearly with an asterisk (\*) the only carbon atom in your three structures that is in planar geometry. (17)
- (b) Give the IUPAC names for **A**, **B** and **C**. (12)
- (c) Which two of compounds **A**, **B** and **C** are very soluble in water? (6)
- (d) Categorise as an *addition*, a *substitution*, or an *oxidation* reaction  
(i) conversion **X**,  
(ii) conversion **Y**.  
Chlorine gas is the reagent required to bring about conversion **X**.  
What other condition is required for this reaction? (15)

9. (a) The following words or phrases are omitted from the passage below:

**lime                      sand and gravel                      fluorine                      chlorine**  
**plastic                      a flocculating agent**

Write in your answerbook the word or phrase corresponding to each number **1** to **6**.

In the treatment of a water supply to make it suitable for drinking, 1 is added and the water is allowed to 'settle'. Any suspended matter remaining in the water is then removed by filtration through a bed of 2. To disinfect the water 3 is added. A compound of 4 may also be added to prevent tooth decay and where the pH of the water is too low 5 is added. In the Irish public water system, any pipework made of lead is being replaced by 6.

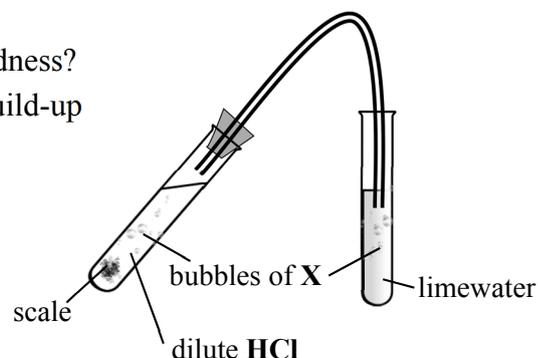
(25)

- (b) A student scraped a solid scale from the element of an electric kettle that had been used in a district with hard water and brought some of it to school for analysis.
- (i) Explain the underlined term.
- (ii) What are the two different types of water hardness?
- (iii) Which of the two types is suggested by the build-up of the scale on the element of the kettle?  
Explain your answer.

The scale reacted with dilute hydrochloric acid producing gas **X** that turned limewater 'milky'.

- (iv) Identify gas **X**.

(25)



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

(a) Describe with the aid of labelled diagrams an experiment you carried out to separate a mixture of three indicators using chromatography.

Identify (i) the mobile phase, (ii) the stationary phase, in your experiment.

Describe and explain the result of your experiment. (25)

(b) Define (i) an acid, (ii) a base. (8)



Define pH.

Both nitric acid and sulfuric acid are strong acids.

Calculate the pH of a 0.2 M solution of nitric acid ( $\text{HNO}_3$ ).

Which has the *higher* pH value, 0.2 M nitric acid ( $\text{HNO}_3$ ) or 0.2 M sulfuric acid ( $\text{H}_2\text{SO}_4$ )?  
Explain your answer. (17)

(c) What type of bond is formed when one pair of electrons is *shared* between two atoms?

Draw a dot and cross diagram to show this type of bonding in a methane ( $\text{CH}_4$ ) molecule. (13)

State the shape of a methane molecule.

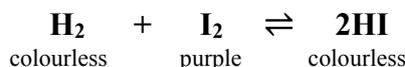
Would you expect methane to be water soluble?

Explain your answer. (12)

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

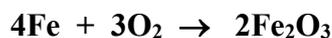
(2 × 25)

- (a) Equal volumes of hydrogen gas and iodine vapour are mixed in a container. When chemical equilibrium is reached at a certain temperature some hydrogen iodide gas has been formed according to the following balanced equation:



- (i) Explain the underlined term. (7)
- (ii) How would you expect the colour of the equilibrium mixture of gases to compare with the colour of the original mixture of hydrogen and iodine? (3)
- (iii) Write the equilibrium constant ( $K_c$ ) expression for this reaction. (6)
- (iv) Copy and complete the following statement of Le Châtelier's principle.  
'When a stress is applied to a system in chemical equilibrium, reaction will occur to ..... the stress.'  
Use this principle to predict the effect on the equilibrium position of adding more hydrogen. (9)

- (b) The type of disposable hand warmer shown uses a chemical reaction of iron to generate heat. When the outer packaging is removed, oxygen from the air enters the porous inner pouch and reacts rapidly with the iron powder inside according to the following balanced equation:



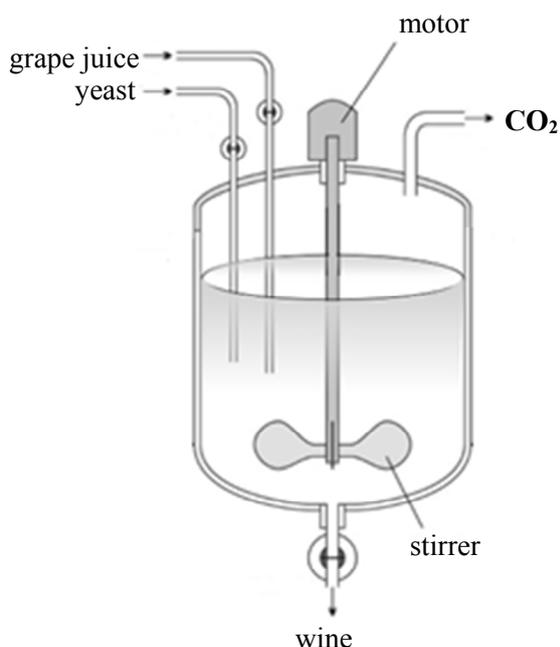
- (i) What term is used to describe reactions that give out heat energy? (4)
- (ii) Predict the result you would expect if iron pellets were used instead of the iron powder. Explain your answer. (9)
- (iii) If a pouch contains 28 g of iron, how many moles of iron are present?  
How many moles of iron oxide ( $\text{Fe}_2\text{O}_3$ ) are produced when all of the iron in this pouch reacts? (12)



(c) Answer part A or part B.

**A**

Wine-making is an example of a *batch process*. The picture shows a fermentation reaction vessel used in wine making. It contains grape juice and yeast. This mixture is kept at a temperature of about 20 °C for about 10 days. Ethanol is then present in the mixture and carbon dioxide gas, the co-product, has bubbled away. The liquid (wine) is then pumped out at the bottom of the reactor to the next stage of the process.



- (i) What is a *batch process*?
- (ii) Explain the underlined term.
- (iii) Yeast contains an enzyme that allows fermentation to occur. What is an enzyme?
- (iv) Reaction vessels are often made of steel. Give a reason for this choice of material.

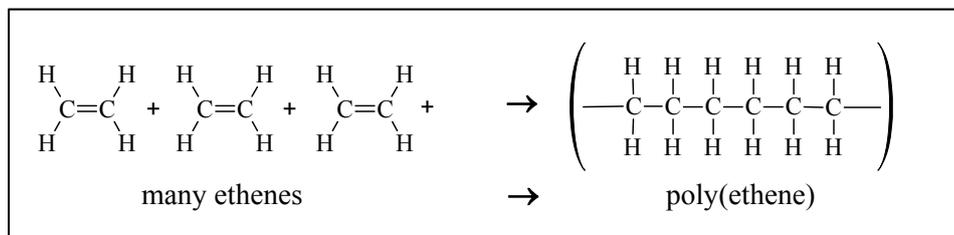
(25)

*or*

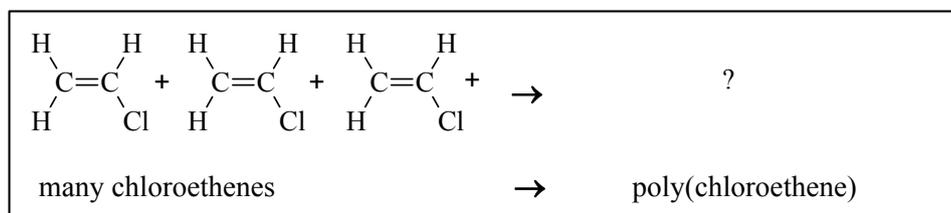
**B**

- (i) In a polymerisation reaction, what is a monomer?

Poly(ethene) is formed from ethene in an addition polymerisation reaction as shown.



- (ii) Copy and complete the similar addition polymerisation reaction below to give the structure of poly(chloroethene).



- (iii) Why is it desirable that we recycle plastic as much as possible?
- (iv) The first four stages of recycling plastic are sorting, shredding, washing, and drying. What happens at the next stage?

(25)

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