



# Cambridge IGCSE™

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## CHEMISTRY

0620/42

## Paper 4 Theory (Extended)

February/March 2026

**1 hour 15 minutes**

You must answer on the question paper.

No additional materials are needed.

## INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen. Do **not** use correction fluid or tape.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

## INFORMATION

- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [ ].
- The Periodic Table is printed in the question paper.

This document has **16** pages. Any blank pages are indicated.



- 1 The symbols of elements with atomic numbers 21 to 30 are shown in Table 1.1.

**Table 1.1**

| atomic number     | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
|-------------------|----|----|----|----|----|----|----|----|----|----|
| symbol of element | Sc | Ti | V  | Cr | Mn | Fe | Co | Ni | Cu | Zn |

Answer the following questions using only the symbols of the elements in Table 1.1.

The symbol of each element can be used once, more than once or not at all.

Give the symbol of the element that:

- (a) is the catalyst in the Haber process

..... [1]

- (b) is used to galvanise iron objects

..... [1]

- (c) has a blue anhydrous chloride used to detect the presence of water

..... [1]

- (d) is the catalyst used in the reaction of alkenes with hydrogen

..... [1]

- (e) forms a green precipitate when aqueous sodium hydroxide is added to an aqueous solution of its ions which dissolves in excess aqueous sodium hydroxide

..... [1]

- (f) forms an ion that has 24 electrons and a 3+ charge

..... [1]

- (g) forms brass when mixed with copper.

..... [1]

[Total: 7]

2 Aluminium and indium are elements in Group III of the Periodic Table.

(a) Aluminium is extracted from its purified main ore. The purified ore is mainly aluminium oxide. During this extraction process aluminium oxide is broken down into its elements.

(i) Name the main ore of aluminium.

..... [1]

(ii) Name the process in which aluminium oxide is broken down into its elements.

..... [1]

(iii) Name the substance which is added to aluminium oxide to reduce the operating temperature of this process.

..... [1]

(b) Aluminium oxide reacts with both acids and bases to form salts.

(i) State the type of oxide that reacts with both acids and bases.

..... [1]

(ii) State the name and give the formula of the salt formed when aluminium oxide reacts with dilute hydrochloric acid.

name .....

formula .....

[2]

(c) The salt formed when aluminium oxide reacts with aqueous sodium hydroxide is sodium aluminate,  $\text{NaAlO}_2$ .

(i) Complete the equation for the reaction of aluminium oxide with aqueous sodium hydroxide by inserting the missing formula and balancing the equation.



[2]

(ii) Write the formula of the anion in  $\text{NaAlO}_2$ .

..... [1]



(d) Indium has an atomic number of 49.

(i) State the number of occupied electron shells in an atom of indium.

..... [1]

(ii) A sample of indium contains two isotopes,  $^{113}\text{In}$  and  $^{115}\text{In}$ .

Complete Table 2.1 to show the number of protons and the number of neutrons in one atom of each isotope of indium.

**Table 2.1**

| isotope           | number of protons | number of neutrons |
|-------------------|-------------------|--------------------|
| $^{113}\text{In}$ |                   |                    |
| $^{115}\text{In}$ |                   |                    |

[2]

(iii) Table 2.2 shows the relative abundances of the two isotopes in the sample of indium.

**Table 2.2**

| isotope            | $^{113}\text{In}$ | $^{115}\text{In}$ |
|--------------------|-------------------|-------------------|
| relative abundance | 1                 | 19                |

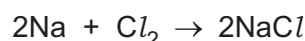
Calculate the relative atomic mass of this sample of indium to **one** decimal place.

relative atomic mass = ..... [2]

[Total: 14]

3 The salt sodium chloride,  $\text{NaCl}$ , can be prepared in the laboratory by different methods.

method 1 Burning sodium metal is placed into a gas jar of chlorine gas. Solid sodium chloride is formed.



method 2 Dilute hydrochloric acid is added to a known volume of aqueous sodium hydroxide in the presence of an indicator until a neutral solution is formed.

(a) (i) State the colour of the flame sodium metal burns with before it is placed into the chlorine gas in method 1.

..... [1]

(ii) State the colour of the chlorine gas before the burning sodium metal is added to it in method 1.

..... [1]

(iii) Calculate the mass of sodium chloride formed when excess burning sodium metal is placed into  $960 \text{ cm}^3$  of chlorine gas at room temperature and pressure in method 1.

mass = ..... g [3]

(b) (i) Write the ionic equation which represents the neutralisation reaction that takes place in method 2.

..... [1]

(ii) Name a suitable indicator to use in method 2.

..... [1]

(iii) Name the experimental technique used in method 2.

..... [1]



(c) In Figure 3.1, complete the dot-and-cross diagram of the ions in sodium chloride.

Give the charges on the ions.

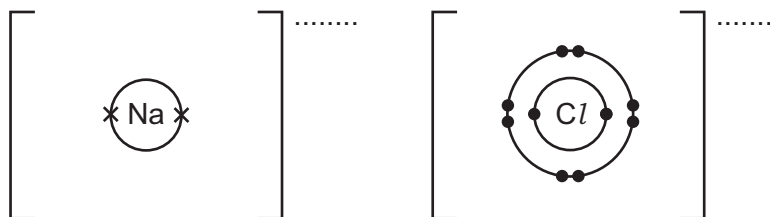


Figure 3.1

[3]

(d) Molten and aqueous sodium chloride are separately electrolysed using inert electrodes.

(i) Name a suitable inert non-metal electrode and a suitable inert metal electrode.

non-metal electrode .....

metal electrode .....

[2]

(ii) Complete Table 3.1 to show the name of the product formed at the cathode during the electrolysis of different forms of sodium chloride.

Table 3.1

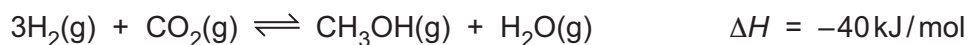
| form of sodium chloride       | name of product formed at the cathode |
|-------------------------------|---------------------------------------|
| molten                        |                                       |
| dilute aqueous solution       |                                       |
| concentrated aqueous solution |                                       |

[3]

[Total: 16]

- 4 When hydrogen reacts with carbon dioxide in a sealed vessel at 130 °C using a suitable catalyst, methanol is produced.

The equation is shown.



The activation energy,  $E_a$ , of the forward reaction is +220 kJ/mol.

- (a) State how the information shows that this reaction is reversible and exothermic.

reversible .....

exothermic .....

[2]

- (b) Complete Table 4.1 to show the effect, if any, for each change of condition.

Use only the words **increases**, **decreases** or **no change**.

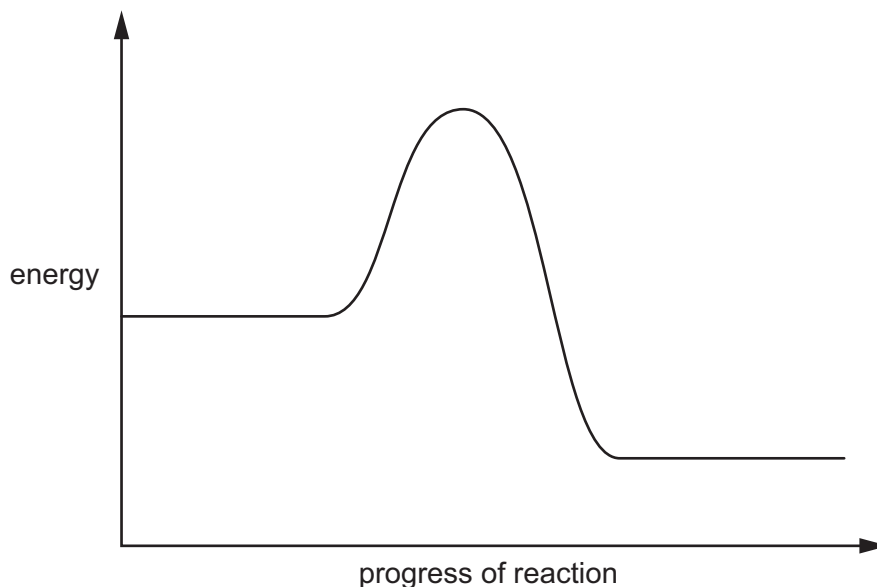
Table 4.1

| change of condition                          | effect on the concentration of methanol at equilibrium | effect on the rate of the forward reaction |
|----------------------------------------------|--------------------------------------------------------|--------------------------------------------|
| temperature is decreased                     |                                                        |                                            |
| pressure in the reaction vessel is decreased |                                                        | decreases                                  |
| the catalyst is removed                      | no change                                              |                                            |

[4]



(c) Figure 4.1 shows an incomplete reaction pathway diagram for the forward reaction.



**Figure 4.1**

(i) Complete the reaction pathway diagram in Figure 4.1.

In your diagram, include:

- the formulas of the reactants and the products
- an arrow, labelled  $E_a$ , to show the activation energy of the forward reaction
- an arrow, labelled  $\Delta H$ , to show the enthalpy change of the forward reaction.

[3]

(ii) Use Figure 4.1 and the information given to determine:

- the enthalpy change, in kJ/mol, of the reverse reaction

Include a sign with your answer.

..... kJ/mol

- the activation energy, in kJ/mol, of the reverse reaction.

Include a sign with your answer.

..... kJ/mol  
[2]

- (d) The equation for the reaction of hydrogen with carbon dioxide can be represented as shown in Figure 4.2.

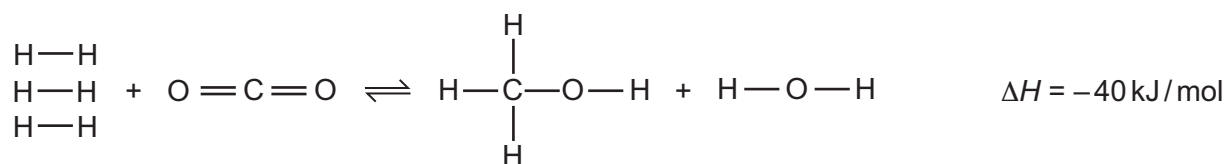


Figure 4.2

Table 4.2 shows some bond energies.

Table 4.2

| bond                  | H–H | C=O | O–H | C–O |
|-----------------------|-----|-----|-----|-----|
| bond energy in kJ/mol | 440 | 805 | 460 | 360 |

Use the bond energies in Table 4.2 and the value of  $\Delta H$  for the forward reaction to calculate the C–H bond energy in kJ/mol.

Use the following steps.

- Calculate the energy needed to break the bonds in the reactants.

..... kJ

- Calculate the energy released when the bonds in water form.

..... kJ

- Calculate the bond energy of the C–H bond.

..... kJ/mol  
[4]



(e) In Figure 4.3, complete the dot-and-cross diagram of a molecule of methanol.

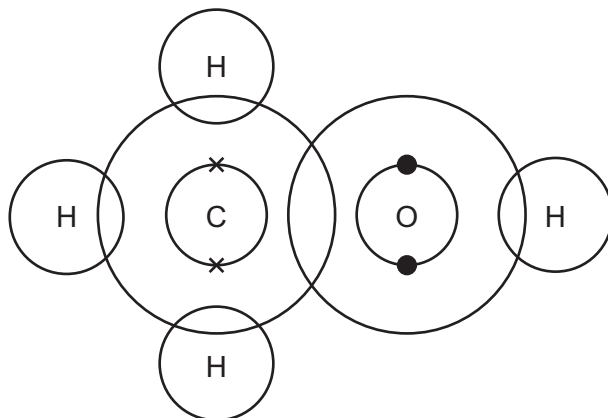
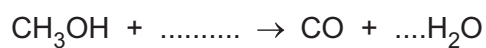


Figure 4.3

[3]

(f) Ethanol is a common fuel. Methanol can also be used as a fuel.

Complete and balance the symbol equation for the incomplete combustion of methanol,  $\text{CH}_3\text{OH}$ .



[1]

[Total: 19]

- 5 **A, B, C** and **D** are the first four members of a family of organic compounds with similar chemical properties.

Table 5.1 gives either the molecular formula or the name of **A, B, C** and **D**.

**Table 5.1**

| <b>A</b>                | <b>B</b>      | <b>C</b>       | <b>D</b>      |
|-------------------------|---------------|----------------|---------------|
| $\text{CH}_2\text{O}_2$ | ethanoic acid | propanoic acid | butanoic acid |

- (a) State the term given to a family of organic compounds with similar chemical properties.

..... [1]

- (b) Explain why members of a family of organic compounds show similar chemical properties.

..... [1]

- (c) State the general formula of the family of organic compounds in Table 5.1.

..... [1]

- (d) Complete Table 5.2.

**Table 5.2**

|                                |  |
|--------------------------------|--|
| <b>name of A</b>               |  |
| <b>structural formula of B</b> |  |
| <b>molecular formula of C</b>  |  |
| <b>empirical formula of D</b>  |  |

[4]

- (e) **C** is made by oxidation of an alcohol. The oxidising agent used has the formula  $\text{KMnO}_4$ .

- (i) Name the alcohol which is oxidised to form **C**.

..... [1]

- (ii) Give the chemical name of  $\text{KMnO}_4$ .

..... [1]



(iii) State the **two** conditions needed for the oxidation of the alcohol in **5(e)(i)** with  $\text{KMnO}_4$ .

1 .....

2 ..... [2]

(f) **D** reacts with ethanol to form an ester.

(i) State the type of catalyst needed for this reaction.

..... [1]

(ii) Complete the word equation for this reaction.

butanoic acid + ethanol  $\rightleftharpoons$  ..... + ..... [2]

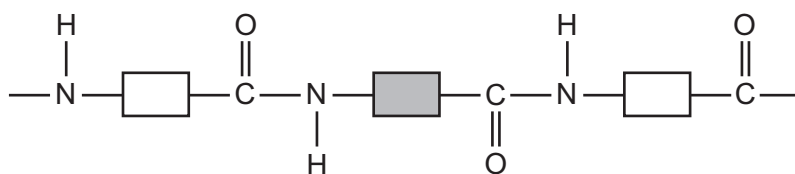
(iii) Draw the displayed formula of the ester formed.

[2]

[Total: 16]

- 6 Polyamides are condensation polymers.  
Proteins are natural polyamides formed from amino acid monomers.

Figure 6.1 shows part of the structure of a protein.



**Figure 6.1**

- (a) Deduce the number of different types of amino acid monomers needed to make the part of the protein shown in Figure 6.1.

..... [1]

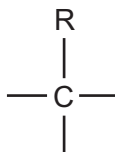
- (b) Deduce the number of water molecules produced when the part of the protein shown in Figure 6.1 forms from amino acid monomers.

..... [1]

- (c) Complete Figure 6.2 to show the general structure of an amino acid monomer.

R represents a side-chain.

Show all of the atoms and all of the bonds.



**Figure 6.2**

[3]



(d) Figure 6.3 shows part of the structure of a different polymer.

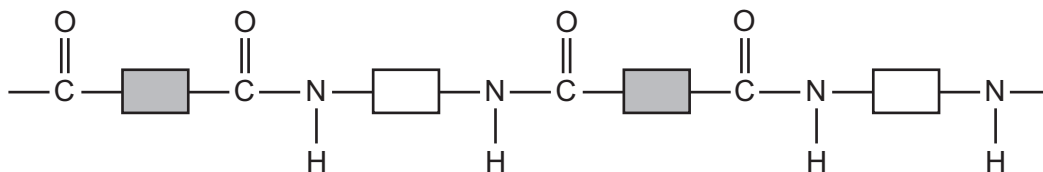


Figure 6.3

(i) Deduce the number of repeat units shown in Figure 6.3.

..... [1]

(ii) Name the **two** types of organic compounds needed to make the polymer shown in Figure 6.3.

1 .....

2 .....

[2]

[Total: 8]

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