



## Cambridge IGCSE™

CANDIDATE  
NAMECENTRE  
NUMBER

|  |  |  |  |  |
|--|--|--|--|--|
|  |  |  |  |  |
|--|--|--|--|--|

CANDIDATE  
NUMBER

|  |  |  |  |
|--|--|--|--|
|  |  |  |  |
|--|--|--|--|

## CHEMISTRY

0620/41

Paper 4 Theory (Extended)

May/June 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 **20** pages. Any blank pages are indicated.

1 A list of symbol equations and word equations, **A** to **J**, is shown.

**A** ethene + hydrogen  $\rightarrow$  ethane

**B**  $2\text{KBr} + \text{Cl}_2 \rightarrow 2\text{KCl} + \text{Br}_2$

**C**  $\text{Al}^{3+} + 3\text{e}^- \rightarrow \text{Al}$

**D** glucose  $\rightarrow$  ethanol + carbon dioxide

**E**  $6\text{CO}_2 + 6\text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$

**F**  $\text{N}_2 + 3\text{H}_2 \rightarrow 2\text{NH}_3$

**G** calcium carbonate  $\rightarrow$  calcium oxide + carbon dioxide

**H**  $\text{C}_8\text{H}_{18} \rightarrow \text{C}_6\text{H}_{14} + \text{C}_2\text{H}_4$

**I** sulfur dioxide + oxygen  $\rightarrow$  sulfur trioxide

**J** glucose + oxygen  $\rightarrow$  carbon dioxide + water

Each equation may be used once, more than once, or not at all.

Give the letter, **A** to **J**, for the equation that represents:

(a) a reaction that occurs in the blast furnace

..... [1]

(b) a reaction catalysed by vanadium(V) oxide

..... [1]

(c) cracking

..... [1]

(d) photosynthesis

..... [1]

(e) a reaction that occurs in the Haber process

..... [1]

(f) a displacement reaction

..... [1]





(g) a reaction catalysed by yeast.

..... [1]

[Total: 7]



2 This question is about elements.

(a) Identify the element that:

(i) is used in the manufacture of overhead electrical cables because of its low density

..... [1]

(ii) is in Group VII and Period 4 of the Periodic Table

..... [1]

(iii) contains atoms with exactly 23 protons

..... [1]

(iv) kills microbes in the domestic water supply

..... [1]

(v) is approximately 78% of clean, dry air

..... [1]

(vi) has an acidic oxide which forms slag in the blast furnace.

..... [1]

(b) Isotopes are different atoms of the same element.

(i) Explain, in terms of protons and neutrons, the similarity and difference between isotopes of the same element.

.....

..... [2]



- (ii) A sample of magnesium contains three isotopes.

Table 2.1 shows the percentage abundances and the relative masses of the three isotopes of magnesium in this sample.

Table 2.1

| percentage abundance | relative mass |
|----------------------|---------------|
| 80                   | 24            |
| 10                   | 25            |
| 10                   | 26            |

Calculate the relative atomic mass of magnesium to **one** decimal place.

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

[Total: 10]

3 This question is about structure and bonding.

(a) Magnesium fluoride is an ionic compound.

(i) In Figure 3.1, complete the dot-and-cross diagrams to show the bonding in magnesium fluoride. The inner shells of electrons are shown.

Show the charge on each ion.

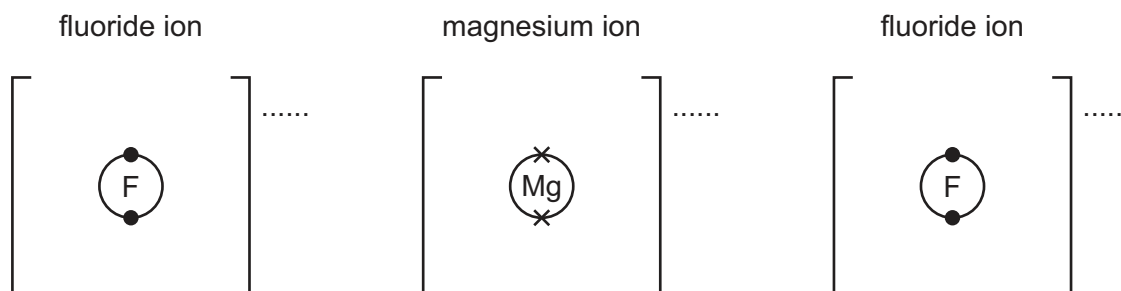


Figure 3.1

[3]

(ii) Explain why magnesium fluoride has a high melting point.

.....  
 .....  
 .....  
 ..... [2]

(iii) Explain why magnesium fluoride conducts electricity when it is molten.

.....  
 ..... [1]



(b) Fluorine,  $F_2$ , consists of simple molecules.

(i) In Figure 3.2, complete the dot-and-cross diagram of a molecule of fluorine.

Show outer shell electrons only.

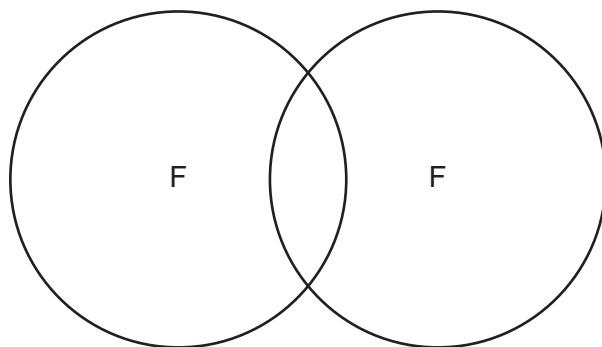


Figure 3.2

[2]

(ii) The melting point and boiling point of fluorine are shown in Table 3.1.

Table 3.1

|                    |      |
|--------------------|------|
| melting point / °C | –220 |
| boiling point / °C | –188 |

Deduce the physical state of fluorine at  $-240^{\circ}\text{C}$ .

Use the data in Table 3.1 to explain your answer.

physical state .....

explanation .....

.....

[2]

[Total: 10]



- 4 Aqueous hydrogen peroxide,  $\text{H}_2\text{O}_2$ , decomposes to produce water and oxygen gas.

Manganese(IV) oxide is a catalyst in this reaction.

A student adds powdered manganese(IV) oxide to aqueous hydrogen peroxide in a conical flask as shown in Figure 4.1. The volume in the gas syringe is measured at regular time intervals. The volume increases as time increases.

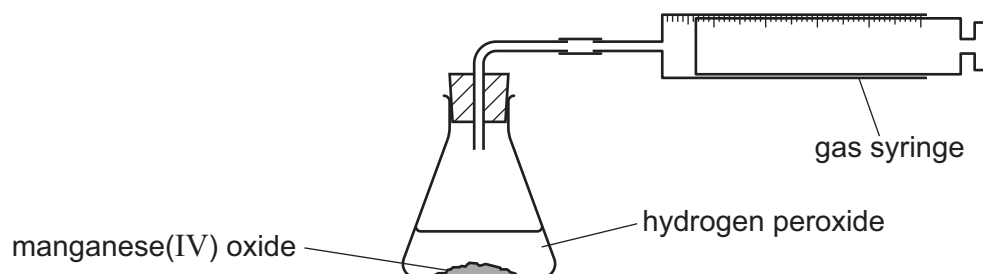


**Figure 4.1**

- (a) Write a symbol equation for the decomposition of aqueous hydrogen peroxide.

Include state symbols.

..... [3]

- (b) State what is meant by the term catalyst.

..... [2]

- (c) The rate of reaction is highest at the start of the reaction. The rate of reaction decreases as time increases. The reaction eventually stops.

- (i) Explain why the rate of reaction is highest at the start of the reaction.

..... [1]

- (ii) Explain why the reaction stops.

..... [1]



(d) The experiment is repeated at a lower temperature.

Explain why the rate of reaction is lower at the lower temperature.

.....

.....

.....

.....

..... [3]

[Total: 10]



5 This question is about the effects of electricity on chemical substances.

- (a) Dilute aqueous sodium chloride decomposes when an electric current is passed through it. Graphite electrodes are used.

The products are:

- oxygen at the anode
- hydrogen at the cathode.

- (i) Name the process that occurs when an aqueous ionic compound decomposes by the passage of an electric current.

..... [1]

- (ii) Give **two** reasons why graphite is suitable for use as an electrode.

1 .....

2 ..... [2]

- (iii) Write an ionic half-equation for the formation of hydrogen at the cathode.

..... [2]

- (iv) Explain why oxygen is produced at the anode.

..... [2]

- (v) Name the type of particle responsible for the transfer of charge in the conducting wires of the external circuit.

..... [1]

- (vi) Name the products formed at each electrode when an electric current is passed through **concentrated** aqueous sodium chloride.

anode .....

cathode ..... [2]



(b) Aluminium is extracted when electricity is used to decompose an electrolyte containing a purified ore of aluminium. The electrodes are made of carbon.

(i) Name the ore of aluminium that is purified.

..... [1]

(ii) Name the compound of aluminium that is present in this ore of aluminium.

..... [1]

(iii) Name the substance that the compound of aluminium in **5(b)(ii)** is dissolved in during this extraction.

..... [1]

(iv) Explain why the carbon anodes have to be replaced.

.....

..... [2]

[Total: 15]

6 This question is about metallic compounds.

(a) Zinc oxide,  $\text{ZnO}$ , reacts with both acids and alkalis to produce salts.

(i) State the term given to oxides that react with both acids and alkalis.

..... [1]

(ii) When zinc oxide reacts with aqueous sodium hydroxide it forms sodium zincate.

Sodium zincate contains sodium ions,  $\text{Na}^+$ , and zincate ions,  $\text{ZnO}_2^{2-}$ .

Write the formula of sodium zincate.

..... [1]

(iii) The reaction between zinc oxide and dilute sulfuric acid forms aqueous zinc sulfate as one of the products.

Write the symbol equation for the reaction between zinc oxide and dilute sulfuric acid.

..... [2]

(iv) When aqueous barium chloride is added to aqueous zinc sulfate, a precipitate of barium sulfate,  $\text{BaSO}_4$ , is produced.

Write an ionic equation for this precipitation reaction.

Include state symbols.

..... [2]

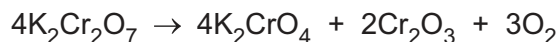
(v) Give the colour of the precipitate that forms in **6(a)(iv)**.

..... [1]



- (b) (i) Chromium(III) oxide is a product of the thermal decomposition of potassium dichromate(VI),  $\text{K}_2\text{Cr}_2\text{O}_7$ . The other products are potassium chromate(VI),  $\text{K}_2\text{CrO}_4$ , and oxygen,  $\text{O}_2$ .

The equation for the thermal decomposition is shown.



Calculate the maximum mass of  $\text{Cr}_2\text{O}_3$  that is produced by the thermal decomposition of 11.76 g of  $\text{K}_2\text{Cr}_2\text{O}_7$ .

[ $M_r$ :  $\text{K}_2\text{Cr}_2\text{O}_7$ , 294;  $\text{Cr}_2\text{O}_3$ , 152]

Use the following steps.

- Calculate the number of moles of  $\text{K}_2\text{Cr}_2\text{O}_7$  used.

..... mol

- Calculate the number of moles of  $\text{Cr}_2\text{O}_3$  formed.

..... mol

- Calculate the mass of  $\text{Cr}_2\text{O}_3$  formed.

..... g  
[3]

- (ii) Give the meaning of (VI) in potassium chromate(VI).

.....  
..... [2]

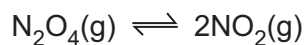
- (iii) Potassium dichromate(VI) is an orange solid.

Identify the element which causes potassium dichromate(VI) to be coloured.

..... [1]



- (c) Dinitrogen tetroxide,  $\text{N}_2\text{O}_4$ , decomposes into nitrogen dioxide,  $\text{NO}_2$ . The reaction is reversible.



The forward reaction is endothermic.

A mixture of  $\text{N}_2\text{O}_4$  and  $\text{NO}_2$  gases are allowed to reach equilibrium in a closed container.

Complete Table 6.1 using **only** the words **increases**, **decreases** or **no change**.

Table 6.1

| change in condition             | effect on the equilibrium concentration of $\text{NO}_2(\text{g})$ |
|---------------------------------|--------------------------------------------------------------------|
| pressure increases              |                                                                    |
| temperature decreases           |                                                                    |
| addition of a suitable catalyst |                                                                    |

[3]

[Total: 16]



7 This question is about hydrocarbons.

(a) Alkanes are a homologous series of hydrocarbons.

(i) State what is meant by the term hydrocarbon.

..... [1]

(ii) State **two** characteristics that all individual members of the same homologous series have in common.

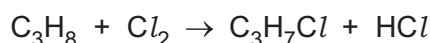
1 .....

2 ..... [2]

(iii) Give the molecular formula of the alkane that has 10 carbon atoms.

..... [1]

(b) Propane reacts with chlorine in a photochemical reaction. An equation for the reaction is shown.



(i) State the meaning of the term photochemical.

.....

..... [1]

(ii) Draw the displayed formula of **two** structural isomers with the formula  $\text{C}_3\text{H}_7\text{Cl}$ .

[2]





(c) Addition polymers are made from alkenes.

(i) Give the empirical formula of all alkenes.

..... [1]

(ii) Name **two** unbranched alkene molecules that each contain four carbon atoms.

1 .....

2 ..... [2]

(iii) Complete Figure 7.1 to show one repeat unit of the addition polymer formed from propene.

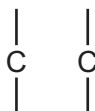


Figure 7.1

[2]

[Total: 12]







Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (Cambridge University Press & Assessment) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest possible opportunity.

To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced online in our Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download at [www.cambridgeinternational.org](http://www.cambridgeinternational.org) after the live examination series.

Cambridge International Education is the name of our awarding body and a part of Cambridge University Press & Assessment, which is a department of the University of Cambridge.



The Periodic Table of Elements

| Group                                                                                                                                                 |                             |                            |                                 |                             |                              |                             |                              |                              |                                |                               |                               |                             |                             |                             |                               |                              |                             |
|-------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|----------------------------|---------------------------------|-----------------------------|------------------------------|-----------------------------|------------------------------|------------------------------|--------------------------------|-------------------------------|-------------------------------|-----------------------------|-----------------------------|-----------------------------|-------------------------------|------------------------------|-----------------------------|
| I                                                                                                                                                     | II                          |                            |                                 |                             |                              |                             |                              |                              |                                |                               |                               | III                         | IV                          | V                           | VI                            | VII                          | VIII                        |
| <div><div>1<br/>H<br/>hydrogen<br/>1</div><div><div>Key</div><div>atomic number<br/>atomic symbol<br/>name<br/>relative atomic mass</div></div></div> |                             |                            |                                 |                             |                              |                             |                              |                              |                                |                               |                               |                             |                             |                             |                               |                              |                             |
| 3<br>Li<br>lithium<br>7                                                                                                                               | 4<br>Be<br>beryllium<br>9   |                            |                                 |                             |                              |                             |                              |                              |                                |                               |                               | 5<br>B<br>boron<br>11       | 6<br>C<br>carbon<br>12      | 7<br>N<br>nitrogen<br>14    | 8<br>O<br>oxygen<br>16        | 9<br>F<br>fluorine<br>19     | 10<br>Ne<br>neon<br>20      |
| 11<br>Na<br>sodium<br>23                                                                                                                              | 12<br>Mg<br>magnesium<br>24 |                            |                                 |                             |                              |                             |                              |                              |                                |                               |                               | 13<br>Al<br>aluminium<br>27 | 14<br>Si<br>silicon<br>28   | 15<br>P<br>phosphorus<br>31 | 16<br>S<br>sulfur<br>32       | 17<br>Cl<br>chlorine<br>35.5 | 18<br>Ar<br>argon<br>40     |
| 19<br>K<br>potassium<br>39                                                                                                                            | 20<br>Ca<br>calcium<br>40   | 21<br>Sc<br>scandium<br>45 | 22<br>Ti<br>titanium<br>48      | 23<br>V<br>vanadium<br>51   | 24<br>Cr<br>chromium<br>52   | 25<br>Mn<br>manganese<br>55 | 26<br>Fe<br>iron<br>56       | 27<br>Co<br>cobalt<br>59     | 28<br>Ni<br>nickel<br>59       | 29<br>Cu<br>copper<br>64      | 30<br>Zn<br>zinc<br>65        | 31<br>Ga<br>gallium<br>70   | 32<br>Ge<br>germanium<br>73 | 33<br>As<br>arsenic<br>75   | 34<br>Se<br>selenium<br>79    | 35<br>Br<br>bromine<br>80    | 36<br>Kr<br>krypton<br>84   |
| 37<br>Rb<br>rubidium<br>85                                                                                                                            | 38<br>Sr<br>strontium<br>88 | 39<br>Y<br>yttrium<br>89   | 40<br>Zr<br>zirconium<br>91     | 41<br>Nb<br>niobium<br>93   | 42<br>Mo<br>molybdenum<br>96 | 43<br>Tc<br>technetium<br>— | 44<br>Ru<br>ruthenium<br>101 | 45<br>Rh<br>rhodium<br>103   | 46<br>Pd<br>palladium<br>106   | 47<br>Ag<br>silver<br>108     | 48<br>Cd<br>cadmium<br>112    | 49<br>In<br>indium<br>115   | 50<br>Sn<br>tin<br>119      | 51<br>Sb<br>antimony<br>122 | 52<br>Te<br>tellurium<br>128  | 53<br>I<br>iodine<br>127     | 54<br>Xe<br>xenon<br>131    |
| 55<br>Cs<br>caesium<br>133                                                                                                                            | 56<br>Ba<br>barium<br>137   | 57–71<br>lanthanoids       | 72<br>Hf<br>hafnium<br>178      | 73<br>Ta<br>tantalum<br>181 | 74<br>W<br>tungsten<br>184   | 75<br>Re<br>rhenium<br>186  | 76<br>Os<br>osmium<br>190    | 77<br>Ir<br>iridium<br>192   | 78<br>Pt<br>platinum<br>195    | 79<br>Au<br>gold<br>197       | 80<br>Hg<br>mercury<br>201    | 81<br>Tl<br>thallium<br>204 | 82<br>Pb<br>lead<br>207     | 83<br>Bi<br>bismuth<br>209  | 84<br>Po<br>polonium<br>—     | 85<br>At<br>astatine<br>—    | 86<br>Rn<br>radon<br>—      |
| 87<br>Fr<br>francium<br>—                                                                                                                             | 88<br>Ra<br>radium<br>—     | 89–103<br>actinoids        | 104<br>Rf<br>rutherfordium<br>— | 105<br>Db<br>dubnium<br>—   | 106<br>Sg<br>seaborgium<br>— | 107<br>Bh<br>bohrium<br>—   | 108<br>Hs<br>hassium<br>—    | 109<br>Mt<br>meitnerium<br>— | 110<br>Ds<br>darmstadtium<br>— | 111<br>Rg<br>roentgenium<br>— | 112<br>Cn<br>copernicium<br>— | 113<br>Nh<br>nihonium<br>—  | 114<br>Fl<br>flerovium<br>— | 115<br>Mc<br>moscovium<br>— | 116<br>Lv<br>livermorium<br>— | 117<br>Ts<br>tennessine<br>— | 118<br>Og<br>oganesson<br>— |

lanthanoids

|                              |                            |                                 |                              |                             |                             |                             |                               |                            |                               |                              |                           |                               |                              |                              |
|------------------------------|----------------------------|---------------------------------|------------------------------|-----------------------------|-----------------------------|-----------------------------|-------------------------------|----------------------------|-------------------------------|------------------------------|---------------------------|-------------------------------|------------------------------|------------------------------|
| 57<br>La<br>lanthanum<br>139 | 58<br>Ce<br>cerium<br>140  | 59<br>Pr<br>praseodymium<br>141 | 60<br>Nd<br>neodymium<br>144 | 61<br>Pm<br>promethium<br>— | 62<br>Sm<br>samarium<br>150 | 63<br>Eu<br>europium<br>152 | 64<br>Gd<br>gadolinium<br>157 | 65<br>Tb<br>terbium<br>159 | 66<br>Dy<br>dysprosium<br>163 | 67<br>Ho<br>holmium<br>165   | 68<br>Er<br>erbium<br>167 | 69<br>Tm<br>thulium<br>169    | 70<br>Yb<br>ytterbium<br>173 | 71<br>Lu<br>lutetium<br>175  |
| 89<br>Ac<br>actinium<br>—    | 90<br>Th<br>thorium<br>232 | 91<br>Pa<br>protactinium<br>231 | 92<br>U<br>uranium<br>238    | 93<br>Np<br>neptunium<br>—  | 94<br>Pu<br>plutonium<br>—  | 95<br>Am<br>americium<br>—  | 96<br>Cm<br>curium<br>—       | 97<br>Bk<br>berkelium<br>— | 98<br>Cf<br>californium<br>—  | 99<br>Es<br>einsteinium<br>— | 100<br>Fm<br>fermium<br>— | 101<br>Md<br>mendelevium<br>— | 102<br>No<br>nobelium<br>—   | 103<br>Lr<br>lawrencium<br>— |

actinoids

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).

