Cambridge Assessment International Education

# Cambridge O Level

CANDIDATE NAME

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**CHEMISTRY** **5070/22**

Paper 2 Theory **October/November 2025**

**1 hour 45 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 or correction fluid.
- 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.




[Turn over

**1** Choose from the following compounds to answer the questions.

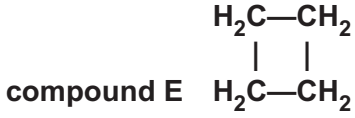
**compound A** $CH_3OH$

**compound B** $HCOOH$

**compound C** $CH_3—CH_2OH$

**compound D** $CH_3—COOCH_3$

**compound E**



**compound F** $CH_3—CH_2—CH_2—CH_3$

**compound G** $CH_3—CH_2—CH=CH_2$

**compound H** $CH_3—CH_2—CH_2—COOH$

Each compound can be used once, more than once or not at all.

**(a)** State which compound:

**(i)** is methanoic acid

..... [1]

**(ii)** is manufactured by the hydration of ethene

..... [1]

**(iii)** has an empirical formula of $C_2H_4O$

..... [1]

**(iv)** is used to make an addition polymer

..... [1]

**(v)** is an ester.

..... [1]

**(b)** State which **two** compounds are structural isomers of one another.

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

[Total: 6]

**2** A sample of titanium found on an asteroid contains four isotopes.

Table 2.1 shows the percentage abundances of these four isotopes.

**Table 2.1**

| isotope | percentage abundance |
|---|---|
| $^{46}_{22}Ti$ | 9 |
| $^{47}_{22}Ti$ | 7 |
| $^{48}_{22}Ti$ | 75 |
| $^{49}_{22}Ti$ | 9 |

**(a)** Describe **one** difference between the isotopes $^{46}_{22}Ti$ and $^{47}_{22}Ti$.

..... [1]

**(b)** Explain why all the isotopes of titanium have the same chemical properties.

.....

..... [1]

**(c)** Show by calculation that the relative atomic mass of titanium for this sample is 47.84.

[2]

[Total: 4]

**3** The equation for the reaction between aluminium and dilute hydrochloric acid is shown.

$$2Al(s) + 6HCl(aq) \rightarrow 2AlCl_3(aq) + 3H_2(g)$$

**(a)** Fig. 3.1 shows the reaction pathway diagram for this reaction.

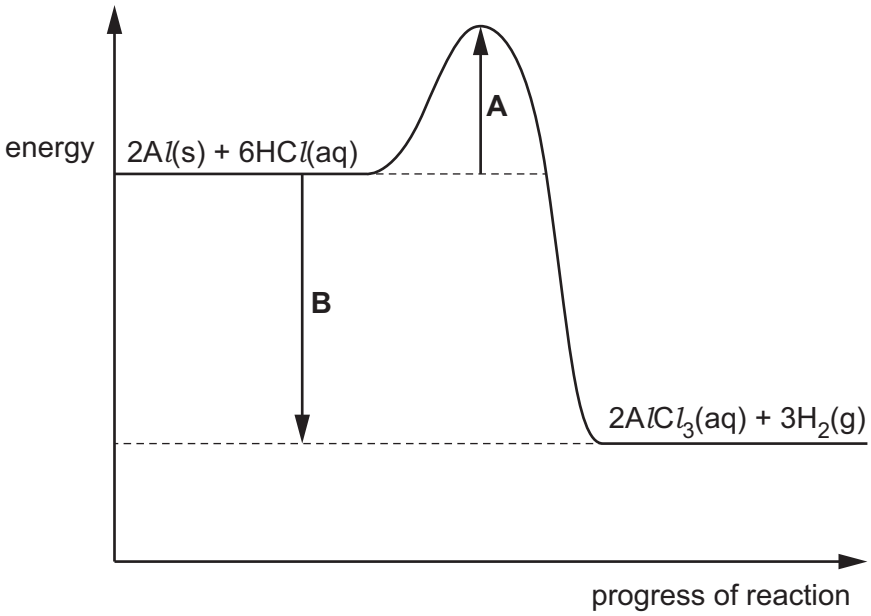



**Fig. 3.1**

**(i)** Identify the energy changes labelled **A** and **B**.

energy change **A** .....

energy change **B** .....

[2]

**(ii)** Use the reaction pathway diagram to explain why the reaction is exothermic.

.....

..... [1]

**(b)** Describe a chemical test for hydrogen.

test .....

observation if hydrogen present .....

.....

[1]

**(c)** A sample of aluminium reacts completely with dilute hydrochloric acid.

A total volume of 366 $cm^3$ of hydrogen, measured at r.t.p., is produced.

Calculate the mass of the sample of aluminium.

Give your answer to **two** significant figures.

mass of aluminium = ..... g [3]

[Total: 7]

**4** Fluorine, chlorine, bromine and iodine are elements in Group VII.

**(a)** Fluorine has a low boiling point. It is a gas at room temperature.

**(i)** Describe the arrangement and motion of molecules in fluorine gas.

.....

.....

.....

..... [2]

**(ii)** Explain why fluorine is a gas at room temperature.

Use ideas about structure and bonding.

.....

..... [1]

**(b)** Bromine reacts with lithium to make the ionic compound lithium bromide.

**(i)** Suggest **two** physical properties of lithium bromide.

1 .....

2 .....

[2]

**(ii)** Construct the ionic half-equation to show the formation of lithium ions from lithium atoms.

..... [1]

**(iii)** Construct the ionic half-equation to show the formation of bromide ions from bromine molecules.

..... [1]

**(c)** Chlorine gas is bubbled into aqueous lithium bromide. A reaction takes place.

Name the **two** products of this reaction.

..... [1]

[Total: 8]

**5** Nickel is a transition element.

**(a)** One of the properties of nickel is that it is a catalyst.

State a reaction that uses nickel as a catalyst.

..... [1]

**(b)** State one **other** chemical property of nickel that is typical of a transition element.

..... [1]

**(c)** The physical properties of nickel and its alloys can be explained using ideas about structure and bonding.

**(i)** Explain why nickel is malleable.

.....

..... [1]

**(ii)** Nickel and other elements are added to iron to make the alloy stainless steel.

Explain why stainless steel is harder than either pure nickel or pure iron.

Include a labelled diagram in your answer.

.....

.....

.....

..... [2]

**(iii)** Stainless steel is used to make cutlery because it is hard and strong.

State one **other** property that makes stainless steel suitable to make cutlery.

..... [1]

**(d)** Compound **X** contains nickel, hydrogen and oxygen only.

**X** contains 2.2% by mass of hydrogen and 34.5% by mass of oxygen.

Calculate the empirical formula of compound **X**.

empirical formula = ..... [3]

**(e)** The equation for the reversible reaction between carbon monoxide and nickel is shown.

$$4CO(g) + Ni(s) \rightleftharpoons Ni(CO)_4(g)$$

The forward reaction is exothermic.

The reversible reaction is allowed to reach equilibrium in a closed system.

Predict and explain the effect of increasing the pressure on the position of equilibrium. The temperature remains constant.

prediction .....

explanation .....

.....

[2]

[Total: 11]

**6** This question is about the covalent compound hydrogen peroxide.

Fig. 6.1 shows the displayed formula of hydrogen peroxide.

H—O—O—H

**Fig. 6.1**

**(a)** Draw the dot-and-cross diagram to show the electronic arrangement in a molecule of hydrogen peroxide.

Only draw the outer shell electrons of oxygen and hydrogen.

[2]

**(b)** A sample of hydrogen peroxide has a mass of 0.170 g.

**(i)** Calculate the number of molecules of hydrogen peroxide in this sample.

One mole of hydrogen peroxide contains $6.02 \times 10^{23}$ molecules.

number of molecules = ..... [2]

**(ii)** Calculate the total number of atoms in this sample of hydrogen peroxide.

number of atoms = ..... [1]

**(c)** When aqueous hydrogen peroxide reacts with acidified aqueous potassium manganate(VII) there is a colour change from purple to colourless.

When aqueous hydrogen peroxide reacts with aqueous potassium iodide there is a colour change from colourless to brown.

Explain what these observations indicate about the chemical properties of aqueous hydrogen peroxide.

.....

.....

.....

..... [2]

**(d)** Barium peroxide reacts with cold dilute sulfuric acid to produce hydrogen peroxide.

Barium peroxide contains the ions $Ba^{2+}$ and $O_2^{2-}$ only.

Deduce the formula of barium peroxide.

..... [1]

**(e)** The equation for the decomposition of aqueous hydrogen peroxide is shown.

$$2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g)$$

**(i)** The rate of decomposition increases as the temperature of the aqueous hydrogen peroxide increases.

Explain why.

.....

.....

..... [2]

**(ii)** Manganese(IV) oxide is a catalyst for the decomposition of aqueous hydrogen peroxide.

Describe how a catalyst increases the rate of reaction.

.....

..... [1]

[Total: 11]

**7** PET is a polyester. It is a condensation polymer.

Fig. 7.1 shows the two monomers needed to make PET.

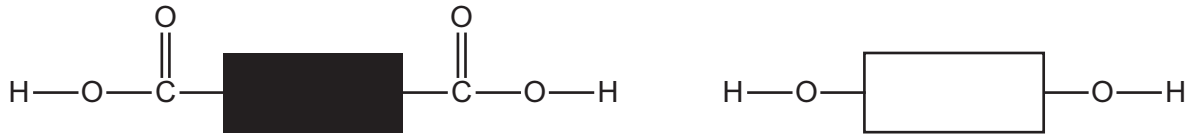


**Fig. 7.1**

**(a)** Name the **two** types of monomer shown in Fig. 7.1.

1 .....

2 .....

[2]

**(b)** The two monomers react to make PET and a small molecule.

**(i)** Name the small molecule.

..... [1]

**(ii)** Draw the structure of PET.

Your structure should show **two** repeat units.

[2]

**(iii)** State **two** environmental challenges caused by the disposal of plastics made of PET.

1 .....

.....

2 .....

.....

[2]

**(c)** Name **one** condensation polymer that is a polyamide.

..... [1]

[Total: 8]

**8** Fig. 8.1 shows the displayed formula of an unsaturated carboxylic acid, **X**.

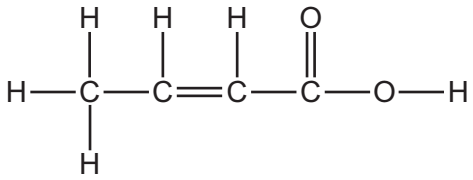


**Fig. 8.1**

**(a)** Explain why **X** is unsaturated.

.....

..... [1]

**(b)** Describe the observations when **X** reacts with aqueous bromine.

.....

..... [2]

**(c)** **X** is a weak acid.

Describe the meaning of the term weak in weak acid.

.....

..... [1]

**(d)** **X** reacts with aqueous sodium carbonate.

Name the gas formed in this reaction.

..... [1]

**(e)** Describe how an ester is prepared from **X**.

.....

.....

..... [2]

**(f)** Ethanoic acid is a saturated carboxylic acid.

**(i)** Describe how ethanoic acid is made from ethanol.

..... [1]

**(ii)** Dilute ethanoic acid reacts with aqueous sodium hydroxide.

Name the **two** products of this reaction.

..... [1]

[Total: 9]

**9** Hydrated zinc chloride is a white solid.

**(a)** State the meaning of the term hydrated.

.....

..... [1]

**(b)** Aqueous ammonia is added dropwise until in excess to a small volume of aqueous zinc chloride.

Describe the observations during this addition.

.....

..... [2]

**(c)** Describe the observations when aqueous silver nitrate is added to aqueous zinc chloride.

..... [1]

**(d)** Dilute and concentrated aqueous zinc chloride are electrolysed separately using carbon electrodes.

Complete Table 9.1.

**Table 9.1**

| | dilute aqueous zinc chloride | concentrated aqueous zinc chloride |
|---|---|---|
| product at anode | | |
| product at cathode | | |

[4]

**(e)** Explain why aqueous zinc chloride conducts electricity but solid zinc chloride does **not** conduct electricity.

.....

.....

..... [1]

[Total: 9]

**10** Water is an important part of the environment.

**(a)** Rivers and lakes are natural sources of water.

**(i)** Name **one** substance in river water that may be harmful.

Explain why this substance may be harmful.

substance .....

explanation .....

.....

[1]

**(ii)** Name **one** substance in river water that is beneficial.

Explain why this substance is beneficial.

substance .....

explanation .....

.....

[1]

**(b)** Describe the **three** processes involved in the treatment of water for the domestic water supply.

State the reason why each process is used.

process 1 .....

reason .....

.....

process 2 .....

reason .....

.....

process 3 .....

reason .....

.....

[3]

**(c)** Describe a qualitative chemical test to show the presence of water.

chemical test .....

observation .....

[1]

**(d)** Explain how the purity of water is tested by measuring its boiling point.

..... [1]

[Total: 7]

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## The Periodic Table of Elements

| Group | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| I | II | | | | | | | | | | | III | IV | V | VI | VII | VIII |
| | | | | | | | 1 H hydrogen 1 | | | | | | | | | | 2 He helium 4 |
| 3 Li lithium 7 | 4 Be beryllium 9 | | | | | | | | | | | 5 B boron 11 | 6 C carbon 12 | 7 N nitrogen 14 | 8 O oxygen 16 | 9 F fluorine 19 | 10 Ne neon 20 |
| 11 Na sodium 23 | 12 Mg magnesium 24 | | | | | | | | | | | 13 Al aluminium 27 | 14 Si silicon 28 | 15 P phosphorus 31 | 16 S sulfur 32 | 17 Cl chlorine 35.5 | 18 Ar argon 40 |
| 19 K potassium 39 | 20 Ca calcium 40 | 21 Sc scandium 45 | 22 Ti titanium 48 | 23 V vanadium 51 | 24 Cr chromium 52 | 25 Mn manganese 55 | 26 Fe iron 56 | 27 Co cobalt 59 | 28 Ni nickel 59 | 29 Cu copper 64 | 30 Zn zinc 65 | 31 Ga gallium 70 | 32 Ge germanium 73 | 33 As arsenic 75 | 34 Se selenium 79 | 35 Br bromine 80 | 36 Kr krypton 84 |
| 37 Rb rubidium 85 | 38 Sr strontium 88 | 39 Y yttrium 89 | 40 Zr zirconium 91 | 41 Nb niobium 93 | 42 Mo molybdenum 96 | 43 Tc technetium – | 44 Ru ruthenium 101 | 45 Rh rhodium 103 | 46 Pd palladium 106 | 47 Ag silver 108 | 48 Cd cadmium 112 | 49 In indium 115 | 50 Sn tin 119 | 51 Sb antimony 122 | 52 Te tellurium 128 | 53 I iodine 127 | 54 Xe xenon 131 |
| 55 Cs caesium 133 | 56 Ba barium 137 | 57–71 lanthanoids | 72 Hf hafnium 178 | 73 Ta tantalum 181 | 74 W tungsten 184 | 75 Re rhenium 186 | 76 Os osmium 190 | 77 Ir iridium 192 | 78 Pt platinum 195 | 79 Au gold 197 | 80 Hg mercury 201 | 81 Tl thallium 204 | 82 Pb lead 207 | 83 Bi bismuth 209 | 84 Po polonium – | 85 At astatine – | 86 Rn radon – |
| 87 Fr francium – | 88 Ra radium – | 89–103 actinoids | 104 Rf rutherfordium – | 105 Db dubnium – | 106 Sg seaborgium – | 107 Bh bohrium – | 108 Hs hassium – | 109 Mt meitnerium – | 110 Ds darmstadtium – | 111 Rg roentgenium – | 112 Cn copernicium – | 113 Nh nihonium – | 114 Fl flerovium – | 115 Mc moscovium – | 116 Lv livermorium – | 117 Ts tennessine – | 118 Og oganesson – |

**Key**

atomic number
atomic symbol
name
relative atomic mass

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

The volume of one mole of any gas is 24 $dm^3$ at room temperature and pressure (r.t.p.).