International Education

Cambridge O Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

9089876802

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.

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[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

$$\begin{array}{l} H_2C—CH_2 \\ \quad | \quad | \\ H_2C—CH_2 \end{array}$$

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]

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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.

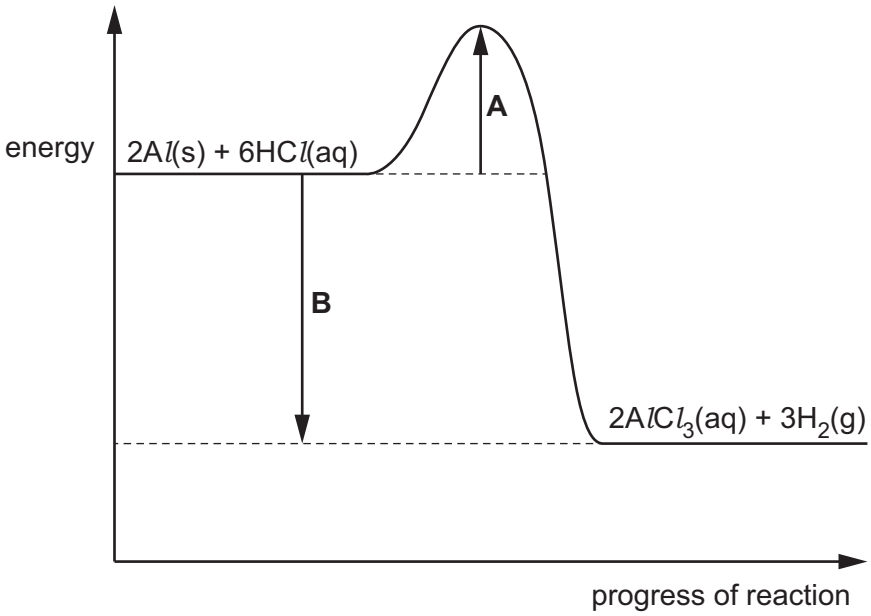


Fig. 3.1

(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]

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(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]

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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]

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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 6.02×10^{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]

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

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

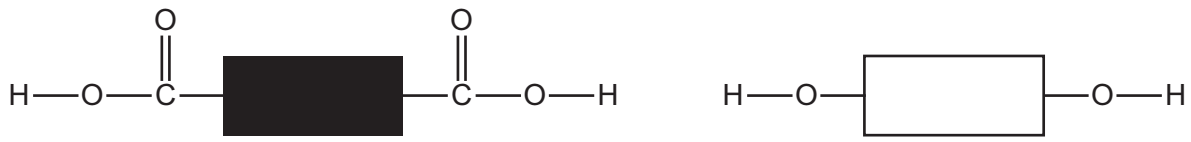


Fig. 7.1

(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**.

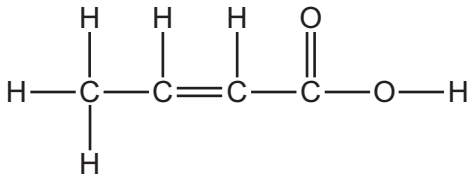


Fig. 8.1

(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]

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(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]

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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]

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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	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group 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.).

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