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Cambridge Assessment International Education

Cambridge O Level

CANDIDATE NAME	

CENTRE NUMBER						CANDIDATE NUMBER				

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CHEMISTRY **5070/22**

Paper 2 Theory **May/June 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 **16** pages.

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1 Choose from the following salts to answer the questions.

aluminium sulfate

barium chloride

copper(II) nitrate

copper(II) sulfate

magnesium chloride

potassium iodide

potassium manganate(VII)

silver chloride

sodium bromide

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

State which salt:

(a) is prepared using a precipitation reaction

..... [1]

(b) gives a yellow flame test colour

..... [1]

(c) dissolves to form a dark purple aqueous solution

..... [1]

(d) has an aqueous solution that reacts with dilute sulfuric acid to give a white precipitate

..... [1]

(e) has an aqueous solution that reacts with aqueous bromine.

..... [1]

[Total: 5]

DO NOT WRITE IN THIS MARGIN

2 A dilute aqueous solution of magnesium chloride is electrolysed using graphite electrodes.

(a) Graphite has a high melting point and is inert.

(i) Explain why graphite has a high melting point.

Use ideas about structure and bonding.

.....

.....

.....

..... [2]

(ii) State one **other** property of graphite that makes it suitable for use as an electrode during electrolysis.

..... [1]

(b) Predict the products of the electrolysis of dilute aqueous magnesium chloride with graphite electrodes.

product at anode .....

product at cathode .....
[2]

(c) Molten aluminium oxide is electrolysed using graphite electrodes to form oxygen and aluminium.

Construct the ionic half-equation for the reaction at each electrode.

reaction at anode .....

reaction at cathode .....
[2]

(d) A metal object is electroplated with copper.

The metal object is the cathode during this electrolysis.

State the name of the substance used for the anode and for the electrolyte.

anode .....

electrolyte .....
[2]

[Total: 9]

DO NOT WRITE IN THIS MARGIN

3 The equation for the reaction between ethene and bromine is shown in Fig. 3.1.

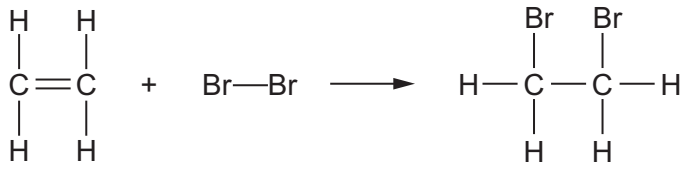

Fig. 3.1

(a) Describe the observation when ethene gas is bubbled through aqueous bromine.

.....

..... [1]

(b) Table 3.1 shows some bond energies.

Table 3.1

bond	bond energy in kJ / mol
C—H	410
C—C	350
C═C	610
Br—Br	193
C—Br	280

Show by calculation that the enthalpy change of the reaction between ethene and bromine, ΔH, is –107 kJ / mol.

[3]

DO NOT WRITE IN THIS MARGIN

(c) Complete the reaction pathway diagram in Fig. 3.2 for the reaction between ethene and bromine.

Label the:

- reactants
- product
- enthalpy change of the reaction, ΔH
- activation energy, E_a.

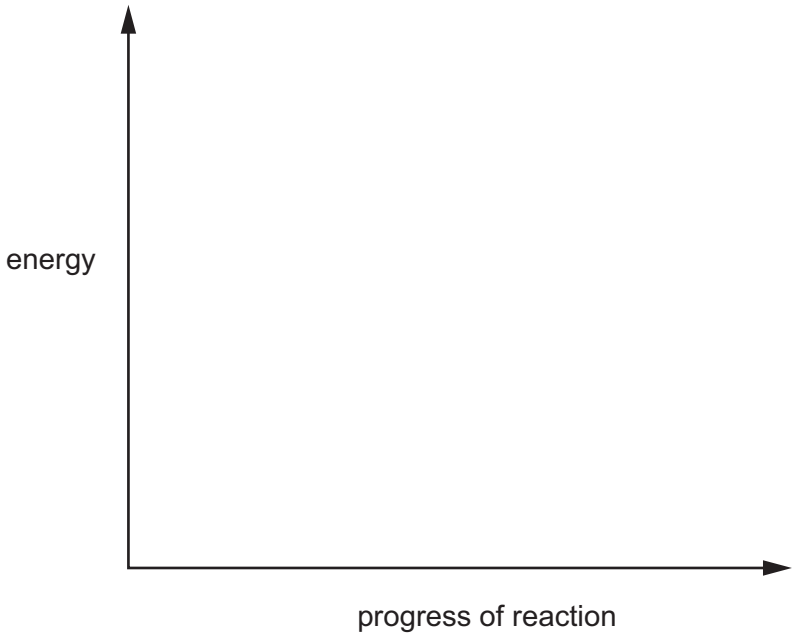

Fig. 3.2

[3]

(d) Draw a dot-and-cross diagram to show the electronic configuration in a molecule of ethene.

Show only the outer shell electrons.

[2]

[Total: 9]

DO NOT WRITE IN THIS MARGIN

4 Ethanoic acid, CH_3COOH, is a member of the homologous series of carboxylic acids.

(a) Give the general formula of the homologous series of carboxylic acids.

..... [1]

(b) One characteristic of a homologous series is that all the compounds share similar chemical properties.

Explain why the compounds share similar chemical properties.

.....

..... [1]

(c) The equation for the reaction between calcium and dilute ethanoic acid is shown.

$$Ca + 2CH_3COOH \rightarrow H_2 + Ca(CH_3COO)_2$$

(i) State the name of the compound $Ca(CH_3COO)_2$.

..... [1]

(ii) A sample of 1.35 g of calcium is added to excess dilute ethanoic acid.

Calculate the volume of hydrogen formed measured at room temperature and pressure.

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

volume = ... dm^3 [3]

(d) Dilute ethanoic acid is a component of vinegar.

Describe the manufacture of vinegar.

Include the reactants and conditions.

.....

.....

.....

..... [3]

DO NOT WRITE IN THIS MARGIN

(e) Butanoic acid and propanoic acid are two other carboxylic acids.

(i) State the molecular formula of butanoic acid.

..... [1]

(ii) Draw the displayed formula of propanoic acid.

[1]

(iii) Solid sodium carbonate is added to dilute propanoic acid.

Predict an observation for this reaction.

.....

..... [1]

(iv) Aqueous sodium hydroxide is added to dilute butanoic acid.

State the names of the products of this reaction.

..... [1]

[Total: 13]

DO NOT WRITE IN THIS MARGIN

5 The combustion of fossil fuels is used in some power stations.

(a) Some power stations use diesel oil as a fuel.

(i) One compound in diesel oil has the formula $C_{12}H_{26}$.

Construct the symbol equation to show the complete combustion of $C_{12}H_{26}$.

..... [1]

(ii) The complete combustion of $C_{12}H_{26}$ produces an air pollutant.

State **one** adverse effect of this pollutant.

..... [1]

(iii) Explain how diesel oil is separated from petroleum.

.....

.....

.....

.....

..... [3]

(b) Sulfur dioxide is removed from the emissions from a power station using calcium carbonate powder.

(i) State **one** adverse effect of sulfur dioxide as an air pollutant.

..... [1]

(ii) One mole of sulfur dioxide reacts with one mole of calcium carbonate to make one mole of carbon dioxide and only one other product.

Suggest the formula of this product.

formula ..... [1]

(iii) State and explain the effect of increasing the temperature on the rate of this reaction.

.....

.....

..... [2]

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(iv) Lumps of calcium carbonate are used instead of calcium carbonate powder.

State and explain the effect of this change on the rate of this reaction.

.....

.....

..... [2]

[Total: 11]

DO NOT WRITE IN THIS MARGIN

6 Bromine, Br_2, is in Group VII of the Periodic Table.

(a) The melting point of bromine is –7 °C and the boiling point is 59 °C.

(i) Explain why bromine is a solid at –50 °C.

.....

..... [1]

(ii) Describe the arrangement and motion of bromine molecules at –50 °C.

.....

.....

.....

..... [3]

(b) A sample of bromine liquid contains 2.408×10^{25} molecules.

One mole of bromine liquid contains 6.02×10^{23} molecules.

Calculate the mass of this sample of bromine liquid.

mass of sample = ... g [2]

(c) The ionic equation shows the reaction of bromine with warm concentrated aqueous sodium hydroxide.

$$3Br_2 + 6OH^- \rightarrow BrO_3^- + 5Br^- + 3H_2O$$

(i) State the oxidation number of bromine in Br_2 and in Br^-.

Br_2 .....

Br^- .....

[2]

(ii) During the reaction bromine is reduced.

Explain why, using ideas about electrons.

.....

..... [1]

DO NOT WRITE IN THIS MARGIN

(d) Bromine reacts with hydrogen in a closed system to form an equilibrium mixture. The forward reaction releases thermal energy into the surroundings.

$$Br_2(g) + H_2(g) \rightleftharpoons 2HBr(g)$$

(i) The temperature of the equilibrium mixture is increased. The pressure remains constant.

State and explain what happens to the position of equilibrium.

statement .....

explanation .....

.....

.....
[2]

(ii) The pressure of the equilibrium mixture is increased. The temperature remains constant.

State and explain what happens to the position of equilibrium.

statement .....

explanation .....

.....

.....
[2]

(e) A bromide of phosphorus contains 7.2% phosphorus by mass.

Calculate the empirical formula of this bromide.

Show your working.

empirical formula ..... [3]

[Total: 16]

DO NOT WRITE IN THIS MARGIN

7 Iron is used to make stainless steel.

Stainless steel is used to make cutlery because it is resistant to rusting.

(a) Give one **other** reason why stainless steel is used to make cutlery.

..... [1]

(b) Stainless steel is an alloy.

Give the meaning of the term alloy.

.....

.....

..... [1]

(c) Iron nails are galvanised with zinc to prevent rusting.

Explain **two** ways in which galvanising iron nails with zinc prevents rusting.

.....

.....

.....

.....

.....

..... [3]

(d) Iron reacts with hot dilute sulfuric acid to form hydrogen and aqueous iron(III) sulfate as the only products.

Construct a symbol equation for this reaction.

Include state symbols.

..... [2]

[Total: 7]

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8 Fig. 8.1 shows the displayed formula of compound **A**.

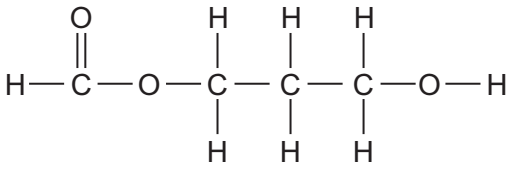

Fig. 8.1

(a) Compound **A** is both a saturated alcohol and a saturated ester.

(i) Explain why compound **A** is saturated.

.....

..... [1]

(ii) Explain why compound **A** is an alcohol.

.....

..... [1]

(iii) Explain why compound **A** is an ester.

.....

..... [1]

(b) Fig. 8.2 shows compound **B**.

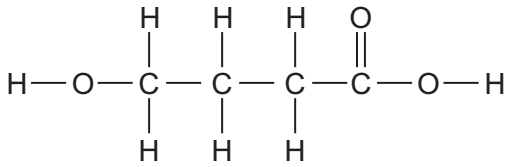

Fig. 8.2

Explain why compound **A** and compound **B** are a pair of structural isomers.

.....

..... [1]

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(c) The displayed formula of compound **C** is shown in Fig. 8.3.

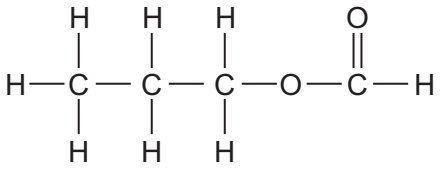

Fig. 8.3

Compound **C** is an ester.

Compound **C** is made by the reaction of an alcohol and a carboxylic acid in the presence of a catalyst.

(i) State the name of the type of catalyst used in this reaction.

..... [1]

(ii) State the name and draw the displayed formula of the alcohol used in this reaction.

name .....

displayed formula

[2]

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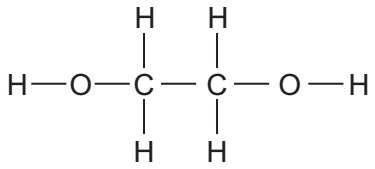
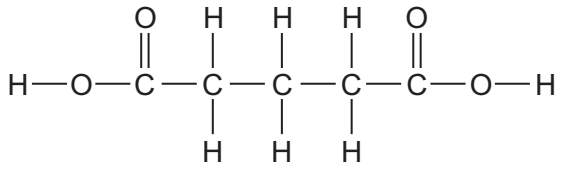
(d) Fig. 8.4 shows two monomers that react to make a condensation polymer.



monomer **D**



monomer **E**

Fig. 8.4

(i) Draw the structure of **one** repeat unit of this condensation polymer.

[2]

(ii) An equal number of moles of the monomers **D** and **E** are reacted to make the condensation polymer.

The total mass of the monomers **D** and **E** is 80 g. There is a 100% yield.

Explain why the mass of the condensation polymer made is less than 80 g.

.....

..... [1]

[Total: 10]

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The Periodic Table of Elements

Key

atomic number
atomic symbol
name
relative atomic mass

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 –

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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