Cambridge Assessment International Education

Cambridge O Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

0361278732

CHEMISTRY **5070/21**

Paper 2 Theory **May/June 2024**

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. Any blank pages are indicated.

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1 Choose from the following substances to answer the questions.

carbon

chlorine

glucose

hydrated copper(II) sulfate

iron

magnesium sulfate

methanoic acid

methanol

nickel

silicon(IV) oxide

vanadium(V) oxide

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

State which substance:

(a) is a catalyst in the Haber process

..... [1]

(b) has a giant covalent structure

..... [1]

(c) changes from a blue solid to a white solid when heated

..... [1]

(d) removes tastes and odours during the treatment of the domestic water supply

..... [1]

(e) has the empirical formula CH_2O.

..... [1]

[Total: 5]

2 Calcium carbide, CaC_2, reacts with water to form a flammable gas ethyne, C_2H_2, and calcium hydroxide.

(a) Construct the symbol equation for this reaction.

..... [2]

(b) Calcium carbide is ionic.

Deduce the formula of the carbide ion.

..... [1]

(c) Fig. 2.1 shows the displayed formula of ethyne.

Fig. 2.1

Ethyne is an unsaturated hydrocarbon.

(i) Explain why ethyne is a hydrocarbon.

.....

..... [1]

(ii) Suggest why ethyne is unsaturated.

.....

..... [1]

(iii) Aqueous bromine reacts with ethyne.

Predict the colour change that happens during this reaction.

..... [1]

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

Show only the outer shell electrons.

[2]

(d) The equation for the complete combustion of ethyne is shown.

$$2C_2H_2 + 5O_2 \rightarrow 4CO_2 + 2H_2O$$

This reaction is exothermic.

(i) Explain, using ideas about bond breaking and bond making, why this reaction is exothermic.

.....

.....

..... [2]

(ii) Complete the reaction pathway diagram in Fig. 2.2 for the complete combustion of ethyne.

Label the:

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

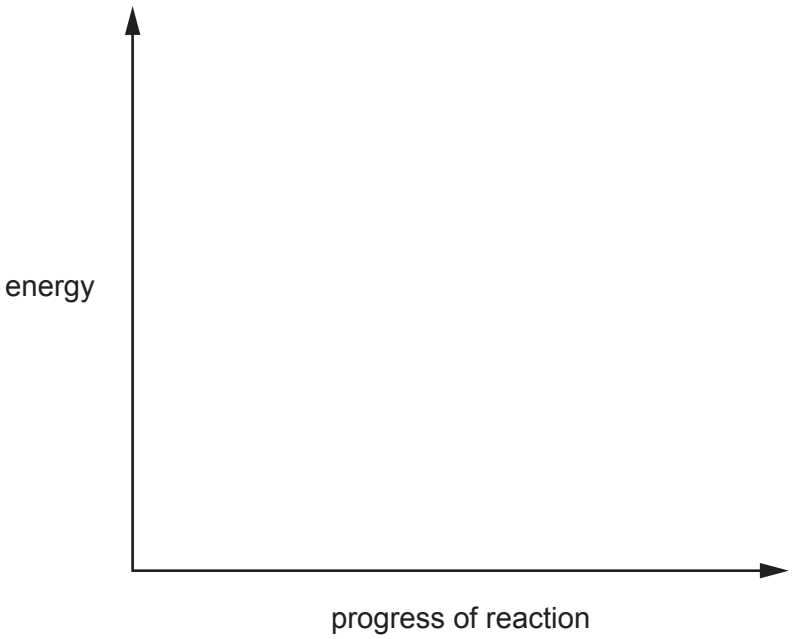

Fig. 2.2

[3]

[Total: 13]

3 Aqueous ammonium nitrite decomposes when heated to form nitrogen.

$$NH_4NO_2(aq) \rightarrow N_2(g) + 2H_2O(l)$$

(a) A 25.0 cm^3 sample of 0.133 mol/dm^3 NH_4NO_2 is completely decomposed.

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

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

volume of nitrogen = ... dm^3 [3]

(b) Describe and explain the effect of increasing the temperature on the rate of this reaction.

.....

.....

..... [2]

(c) Describe and explain the effect of decreasing the concentration of ammonium nitrite on the rate of this reaction.

.....

.....

..... [2]

(d) One way to measure the pH of aqueous ammonium nitrite is to use a pH meter.

Describe one **other** way to measure the pH of aqueous ammonium nitrite.

.....

.....

..... [2]

[Total: 9]

4 Potassium iodide, KI, is an ionic solid composed of a lattice of potassium ions and iodide ions.

(a) Explain why potassium iodide has a high melting point.

.....

..... [1]

(b) Describe how potassium atoms and iodine molecules react to form potassium ions and iodide ions. Use ideas about electron transfer.

.....

.....

.....

..... [2]

(c) Predict the products at each electrode during the electrolysis of concentrated aqueous potassium iodide.

at anode .....

at cathode .....
[2]

(d) Aqueous potassium iodide reacts with aqueous acidified potassium manganate(VII).

Suggest the colour changes that happen during this reaction.

.....

..... [2]

(e) The ionic equation for the reaction between aqueous potassium iodide and aqueous chlorine is shown.

$$2I^-(aq) + Cl_2(aq) \rightarrow I_2(aq) + 2Cl^-(aq)$$

Explain, in terms of electrons, why this reaction involves both oxidation and reduction.

.....

.....

.....

..... [2]

[Total: 9]

5 When a sample of zinc sulfite is heated in a closed system, an equilibrium mixture is formed.

$$ZnSO_3(s) \rightleftharpoons ZnO(s) + SO_2(g)$$

The forward reaction is endothermic.

(a) The temperature of the closed system is increased and the pressure is kept constant.

Predict how the position of equilibrium of this reaction is affected.

Explain your answer.

.....

.....

..... [2]

(b) The pressure of the closed system is decreased and the temperature is kept constant.

Predict how the position of equilibrium of this reaction is affected.

Explain your answer.

.....

.....

..... [2]

(c) Calculate the maximum mass of zinc oxide that can be made from 25.5 g of zinc sulfite.

mass of zinc oxide = ... g [3]

(d) Zinc oxide reacts with both aqueous sodium hydroxide and dilute hydrochloric acid, but sulfur dioxide only reacts with aqueous sodium hydroxide.

Explain why.

.....

.....

..... [2]

(e) Solid zinc sulfite reacts with dilute nitric acid to give sulfur dioxide gas, an aqueous zinc salt and a colourless liquid.

Construct the symbol equation for this reaction.

Include state symbols.

..... [2]

[Total: 11]

6 Carbon dioxide is a greenhouse gas that is linked to increased global warming.

(a) Describe **one** adverse effect of increased global warming.

..... [1]

(b) Describe how carbon dioxide causes global warming.

.....

.....

.....

.....

..... [3]

(c) Photosynthesis removes carbon dioxide from the atmosphere.

(i) Write the word equation for photosynthesis.

..... [1]

(ii) Describe the conditions needed for photosynthesis.

.....

..... [1]

(d) Explain **one** strategy to reduce global warming caused by carbon dioxide.

.....

..... [1]

[Total: 7]

7 Chlorine is a gas at room temperature.

Iodine is a solid at room temperature.

(a) A sample of chlorine has a volume of 240 cm^3 at room temperature and pressure.

The pressure of the sample is increased at room temperature.

Describe and explain, in terms of kinetic particle theory, what happens to the volume of the sample.

.....

.....

.....

..... [2]

(b) When heated at atmospheric pressure, iodine changes directly into a gas without becoming a liquid.

Describe the changes in particle separation, arrangement and motion during this change.

separation .....

.....

arrangement .....

.....

motion .....

.....

[3]

(c) At the same temperature and pressure, the rate of diffusion of chlorine gas is greater than that of iodine gas.

Explain why.

.....

..... [1]

(d) The symbol of an iodide ion is shown.

$$^{126}_{53}\mathrm{I}^{-}$$

Complete Table 7.1 about this iodide ion.

Table 7.1

particle	number of particles
electrons	
neutrons	
protons	

[3]

[Total: 9]

8 Fig. 8.1 is a flow diagram showing information about some organic chemical reactions.

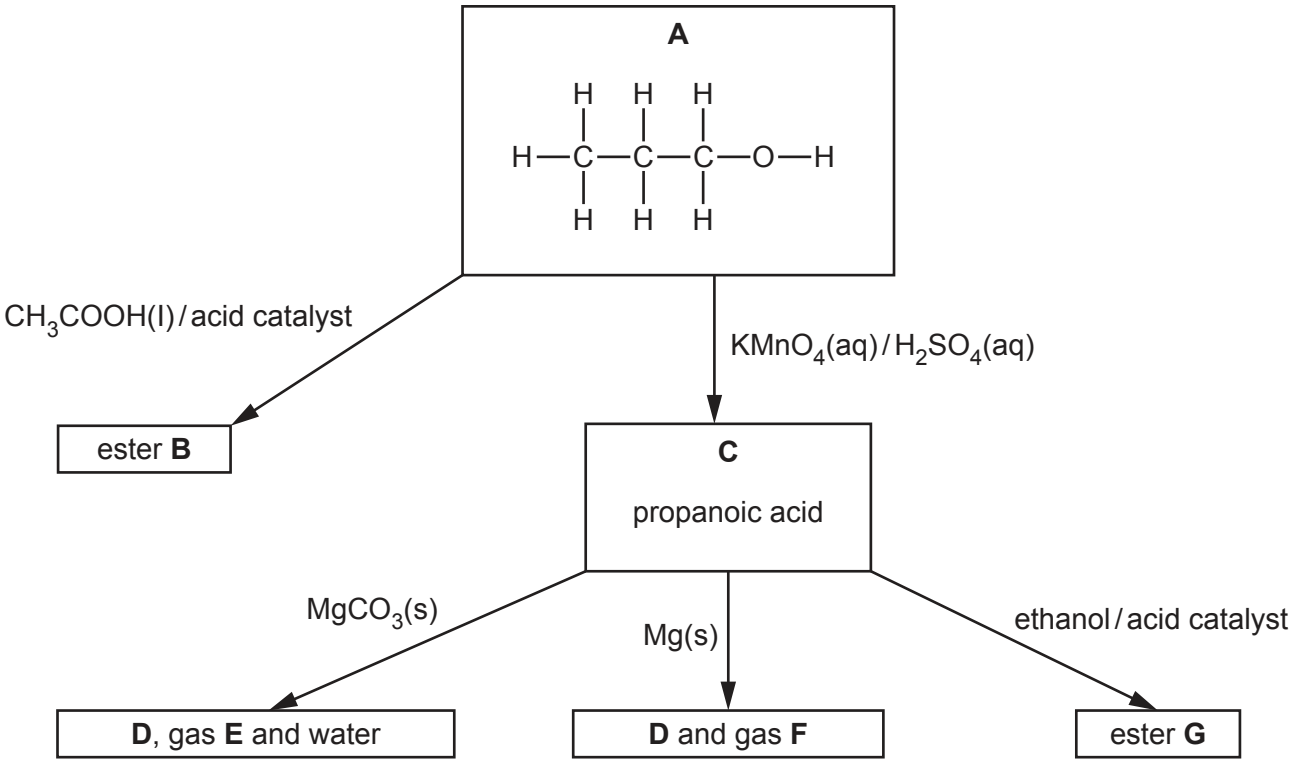

Fig. 8.1

(a) Compound **A** is one of the structural isomers of alcohols with molecular formula C_3H_8O.

(i) State the name of compound **A**.

..... [1]

(ii) Draw the displayed formula of the **other** structural isomer of C_3H_8O that is an alcohol.

[1]

(b) Draw the displayed formula of ester **B**.

[1]

(c) Draw the structural formula of propanoic acid.

[1]

(d) State the name and formula of compound **D**.

name .....

formula .....
[2]

(e) State the name of gas **E** and of gas **F**.

E .....

F .....
[2]

(f) State the name of ester **G**.

..... [1]

[Total: 9]

9 Polymers are made by either an addition reaction or a condensation reaction.

(a) Describe the differences between addition and condensation polymerisation.

.....

.....

.....

..... [2]

(b) PET is a condensation polymer.

Name the type of linkage that bonds the repeat units to one another in PET.

..... [1]

(c) A polymer contains 47.1% carbon, 6.5% hydrogen and 46.4% chlorine by mass.

Calculate the empirical formula of this polymer.

empirical formula ..... [3]

(d) Plastics are made from polymers.

Describe **two** environmental challenges caused by plastics.

1 .....

2 .....

[2]

[Total: 8]

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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.).