Cambridge Assessment International Education

Cambridge O Level

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

7820045975

CHEMISTRY **5070/22**

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.

1 Choose from the following substances to answer the questions.

anhydrous copper(II) sulfate

calcium carbonate

carbon monoxide

chlorine

ethanoic acid

iron

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 Contact process

..... [1]

(b) is a reducing agent in the blast furnace

..... [1]

(c) changes from a white solid to a blue solid when water is added to it

..... [1]

(d) kills microbes during the treatment of the domestic water supply

..... [1]

(e) has the empirical formula CH_2O.

..... [1]

[Total: 5]

2 Aluminium carbide, Al_4C_3, reacts with water to form methane, CH_4, and aluminium hydroxide.

(a) Construct the symbol equation for this reaction.

..... [2]

(b) Methane is a saturated hydrocarbon.

(i) Explain why methane is a hydrocarbon.

.....

..... [1]

(ii) Explain why methane is saturated.

.....

..... [1]

(iii) Methane reacts with chlorine in the presence of ultraviolet light.

State the formulae of **two** products of this reaction.

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

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

Show only the outer shell electrons.

[1]

(c) The equation for the complete combustion of methane is shown.

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

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. 2.1 for the complete combustion of methane.

Label the:

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

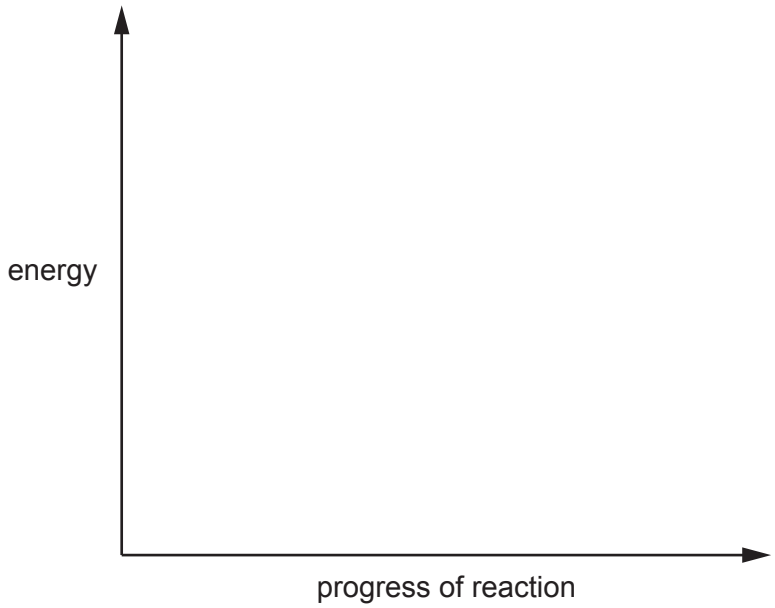

Fig. 2.1

[3]

[Total: 12]

3 Aqueous hydrogen peroxide decomposes when heated to form oxygen.

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

(a) A 35.0 cm^3 sample of 0.266 mol/dm^3 H_2O_2 is completely decomposed.

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

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

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

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

.....

.....

..... [2]

(c) Describe and explain the effect of increasing the concentration of hydrogen peroxide on the rate of this reaction.

.....

.....

..... [2]

(d) A sample of aqueous hydrogen peroxide has a pH of 5.5.

(i) State which ion is responsible for this pH value.

..... [1]

(ii) A pH meter is used to measure the pH of an aqueous solution.

Describe one **other** way to measure the pH of an aqueous solution.

.....

.....

..... [2]

[Total: 10]

4 Calcium bromide, $CaBr_2$, is an ionic solid composed of a lattice of calcium ions and bromide ions.

(a) Explain why calcium bromide has a high melting point.

.....

..... [1]

(b) Describe how calcium atoms and bromine molecules react to form calcium ions and bromide ions. Use ideas about electron transfer.

.....

.....

.....

..... [2]

(c) Predict the products at each electrode during the electrolysis of dilute aqueous calcium bromide.

at anode .....

at cathode .....
[2]

(d) **(i)** Ozone is an oxidising agent.

Describe the colour change when ozone gas is bubbled through aqueous potassium iodide.

..... [1]

(ii) Zinc is a reducing agent.

Describe the colour change when excess zinc is added to acidified potassium manganate(VII).

..... [1]

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

$$2Br^-(aq) + Cl_2(aq) \rightarrow Br_2(aq) + 2Cl^-(aq)$$

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

.....

.....

..... [2]

[Total: 9]

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

$$ZnCO_3(s) \rightleftharpoons ZnO(s) + CO_2(g)$$

The forward reaction is endothermic.

(a) The temperature of the closed system is decreased 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 increased 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 4.23 g of zinc carbonate.

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

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

Explain why.

.....

.....

..... [2]

(e) Solid zinc carbonate reacts with dilute nitric acid to give a colourless solution and bubbles of a gas.

Construct the symbol equation for this reaction.

Include state symbols.

..... [2]

[Total: 11]

6 Methane, nitrogen monoxide and sulfur dioxide are air pollutants.

(a) Describe **one** adverse effect of higher levels of methane in air.

..... [1]

(b) The combustion of fossil fuels that contain sulfur produces sulfur dioxide.

Describe **two** strategies to reduce the emission of sulfur dioxide from the combustion of fossil fuels.

1 .....

.....

2 .....

.....

[2]

(c) Nitrogen monoxide, NO, is linked to acid rain.

(i) This pollutant is present in the gases made in car engines.

Describe how nitrogen monoxide is removed from these gases.

Include a word equation in your answer.

.....

.....

..... [2]

(ii) State two **other** adverse effects of oxides of nitrogen pollutants in the air.

1 .....

2 .....

[2]

[Total: 7]

7 Oxygen is a gas at room temperature.

Sulfur is a solid at room temperature.

(a) A sample of oxygen has a volume of 540 cm^3 at room temperature and pressure.

The temperature of the sample is increased but the pressure is unchanged.

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

.....

.....

.....

..... [2]

(b) Sulfur is a gas above 445 °C.

Describe the changes in particle separation, arrangement and motion when a sample of sulfur gas is cooled down to room temperature.

separation .....

.....

arrangement .....

.....

motion .....

.....

[3]

(c) Describe diffusion in terms of kinetic particle theory.

.....

..... [1]

(d) The symbol of a sulfide ion is shown.

$$^{33}_{16}S^{2-}$$

Complete Table 7.1 about this sulfide 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.

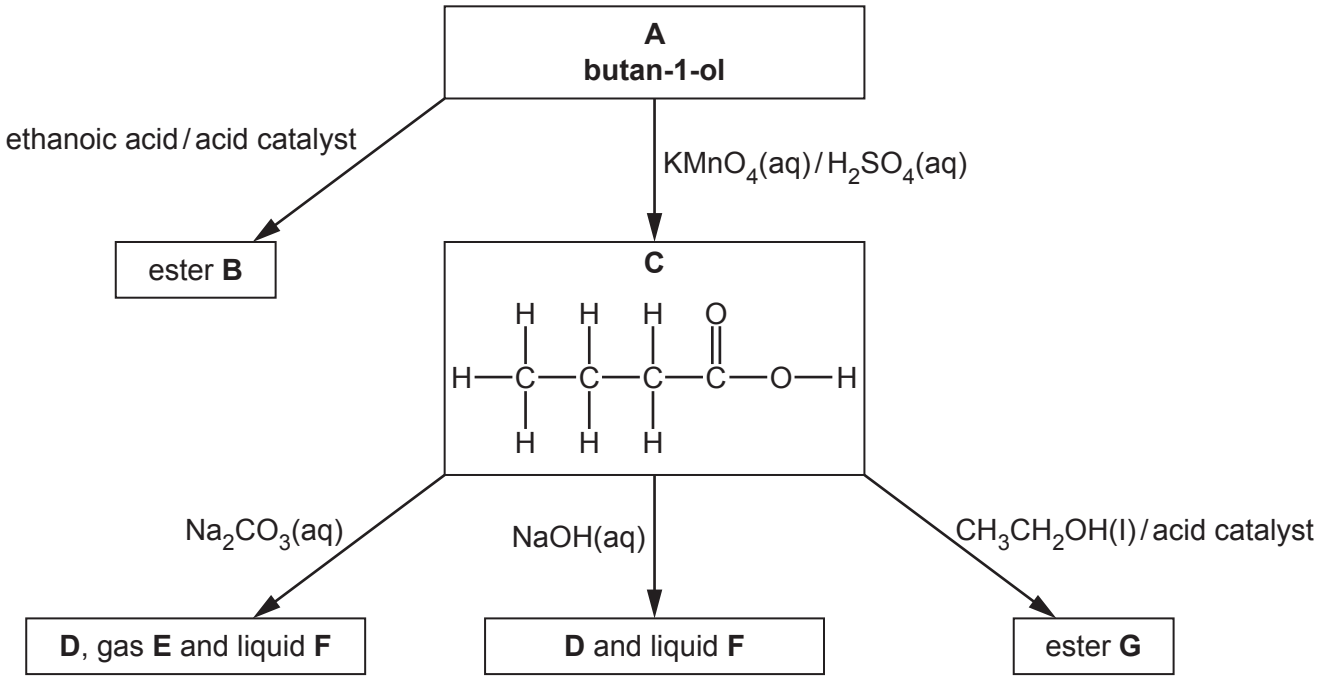

Fig. 8.1

(a) Draw the displayed formula of compound **A**.

[1]

(b) State the name of ester **B**.

..... [1]

(c) **(i)** State the name of compound **C**.

..... [1]

(ii) Deduce the molecular formula of compound **C**.

..... [1]

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

name .....

formula .....
[2]

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

E .....

F .....
[2]

(f) Draw the structural formula of ester **G**.

[1]

[Total: 9]

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

(a) Fig. 9.1 shows the equation for the reaction used to prepare a polymer.

The monomer is both an alcohol and a carboxylic acid.

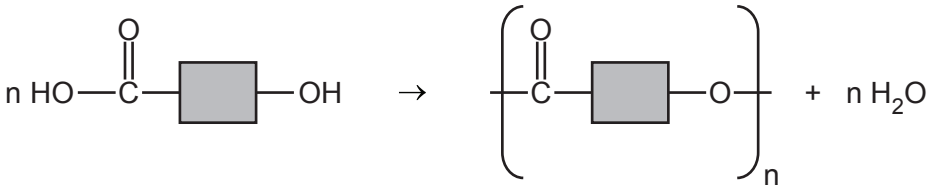

Fig. 9.1

(i) Name the type of linkage that bonds the repeat units to one another in this polymer.

..... [1]

(ii) Explain how the equation shows that the polymer is made by a condensation reaction.

.....

..... [1]

(b) A polymer contains 10.8% carbon, 17.1% fluorine and 72.1% bromine by mass.

Calculate the empirical formula of this polymer.

empirical formula ..... [3]

(c) Some plastics are made from polymers that are hydrocarbons.

There are many environmental challenges caused by plastics.

(i) Explain why there is an accumulation of plastics in the oceans.

Use ideas about the properties of plastics.

.....

..... [1]

(ii) Explain why the disposal of plastics causes an environmental challenge.

.....

.....

..... [2]

[Total: 8]

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.).