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.

DC (PQ/CB) 329305/3
© UCLES 2024

BLANK PAGE

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.

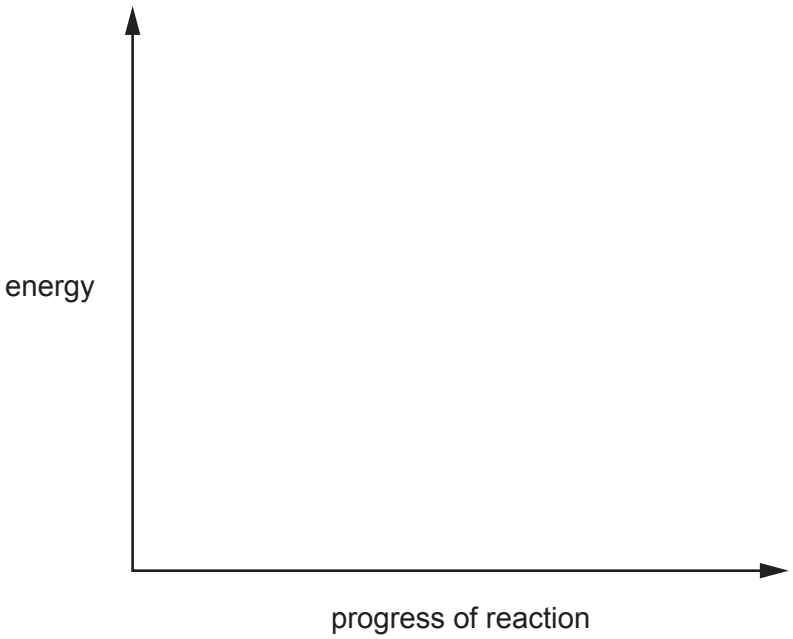

Fig. 2.2

[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]

© UCLES 2024

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.

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

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.

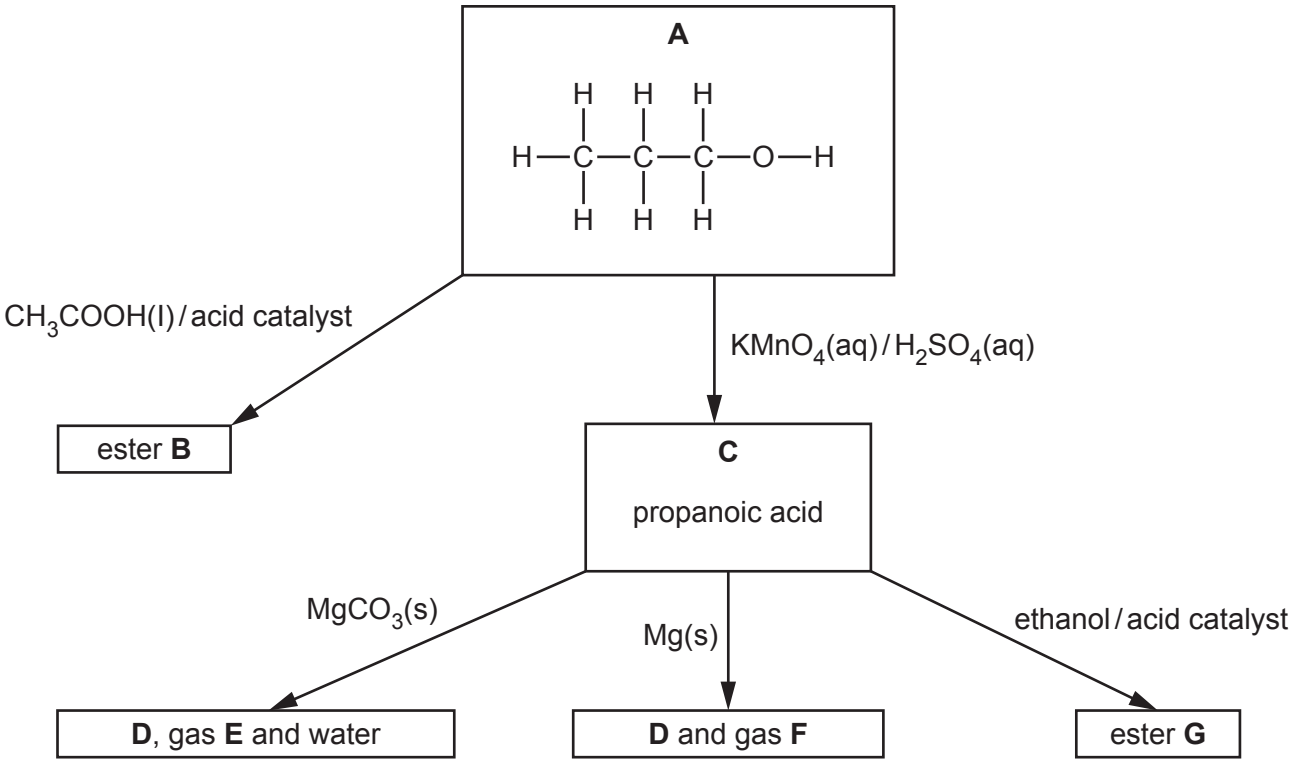

Fig. 8.1

(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]

BLANK PAGE

Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (UCLES) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest possible opportunity.

To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced online in the Cambridge Assessment International Education Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download at www.cambridgeinternational.org after the live examination series.

Cambridge Assessment International Education is part of Cambridge Assessment. Cambridge Assessment is the brand name of the University of Cambridge Local Examinations Syndicate (UCLES), which is a department of the University of Cambridge.

© UCLES 2024

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.).

© UCLES 2024