



CANDIDATE
NAME

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CENTRE
NUMBER

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CANDIDATE
NUMBER

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0620/42

May/June 2023

1 hour 15 minutes

You must answer on the question paper.

No additional materials are needed.

- 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.

- 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 **12** pages.

1 A list of oxides, **A** to **H**, is shown.

- A** calcium oxide
- B** aluminium oxide
- C** silicon(IV) oxide
- D** sulfur dioxide
- E** carbon dioxide
- F** iron(III) oxide
- G** silver oxide
- H** carbon monoxide

Answer the following questions about the oxides, **A** to **H**.
Each letter may be used once, more than once or not at all.

State which of the oxides, **A** to **H**:

(a) is responsible for acid rain

..... [1]

(b) has a giant covalent structure

..... [1]

(c) is a reducing agent in the blast furnace

..... [1]

(d) is the main constituent of bauxite

..... [1]

(e) is the main impurity in iron ore

..... [1]

(f) can be reduced by heating with copper.

..... [1]

[Total: 6]

2 Fluorine, chlorine and bromine are in Group VII of the Periodic Table.

(a) State the name given to Group VII elements.

..... [1]

(b) Explain why Group VII elements have similar chemical properties.

..... [1]

(c) Complete Table 2.1 to show the colour and state at r.t.p. of some Group VII elements.

Table 2.1

element	colour	state at r.t.p.
fluorine	pale yellow	
chlorine		
bromine		liquid

[3]

(d) Bromine has two naturally occurring isotopes, ^{79}Br and ^{81}Br .

(i) State the term given to the numbers 79 and 81 in these isotopes of bromine.

..... [1]

(ii) Complete Table 2.2 to show the number of protons, neutrons and electrons in the atom and ion of bromine shown.

Table 2.2

	^{79}Br	$^{81}\text{Br}^-$
protons		
neutrons		
electrons		

[3]

- (iii) Table 2.3 shows the relative abundances of the two naturally occurring isotopes of bromine.

Table 2.3

isotope	^{79}Br	^{81}Br
relative abundance	55%	45%

Calculate the relative atomic mass of bromine to **one** decimal place.

relative atomic mass = [2]

- (e) Chlorine displaces bromine from aqueous potassium bromide but does **not** displace fluorine from aqueous sodium fluoride.

- (i) Write the symbol equation for the reaction between chlorine and aqueous potassium bromide.

..... [2]

- (ii) State why chlorine does **not** displace fluorine from aqueous sodium fluoride.

..... [1]

- (f) Aqueous silver nitrate is a colourless solution containing $\text{Ag}^+(\text{aq})$ ions.

- (i) Describe what is seen when aqueous silver nitrate is added to aqueous sodium chloride.

..... [1]

- (ii) Write the ionic equation for the reaction between aqueous silver nitrate and aqueous sodium chloride.

Include state symbols.

..... [3]

[Total: 18]

3 Over 200 million tonnes of sulfuric acid are manufactured every year.

(a) State the name of the process used to manufacture sulfuric acid.

..... [1]

(b) Part of the manufacture of sulfuric acid involves converting sulfur dioxide to sulfur trioxide.

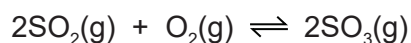
(i) Describe **two** methods by which sulfur dioxide is obtained.

1

2

[2]

The conversion of sulfur dioxide to sulfur trioxide is a reversible reaction which can reach equilibrium.



(ii) State **two** features of an equilibrium.

1

2

[2]

(iii) State the typical conditions and name the catalyst used in the conversion of sulfur dioxide to sulfur trioxide.

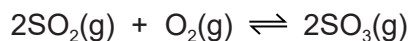
temperature °C

pressure kPa

catalyst

[3]

- (iv) Complete Table 3.1 to show the effect, if any, when the following changes are applied to the conversion of sulfur dioxide to sulfur trioxide.



The forward reaction is exothermic.

Only use the words **increases**, **decreases** or **no change**.

Table 3.1

change	effect on the rate of the forward reaction	effect on the concentration of $\text{SO}_3(\text{g})$ at equilibrium
temperature decreases	decreases	
pressure increases		
no catalyst	decreases	

[4]

- (v) Explain in terms of collision theory why reducing the temperature decreases the rate of the forward reaction.

.....

.....

.....

.....

..... [3]

- (c) Sulfuric acid contains SO_4^{2-} ions.

The oxidation number of O atoms in SO_4^{2-} ions is -2 .

Determine the oxidation number of S atoms in SO_4^{2-} ions. Show your working.

oxidation number = [2]

[Total: 17]

4 Solid sodium hydroxide is a base which dissolves to form an aqueous solution, NaOH(aq).

(a) State what is meant by the term base.

..... [1]

(b) State the term given to a base which dissolves to form an aqueous solution.

(c) State the colour of thymolphthalein in NaOH(aq).

..... [1]

(d) Complete the word equation for the reaction of NaOH(aq) with ammonium chloride.

sodium + ammonium
hydroxide chloride → + +

[3]

(e) Some metal oxides react with NaOH(aq) .

(i) State the term given to metal oxides which react with bases such as NaOH(aq) .

..... [1]

(ii) Name a metal oxide which reacts with NaOH(aq) .

(f) Ethanoic acid, CH_3COOH , is a weak acid.

(i) Complete the dot-and-cross diagram in Fig. 4.1 of a molecule of ethanoic acid.

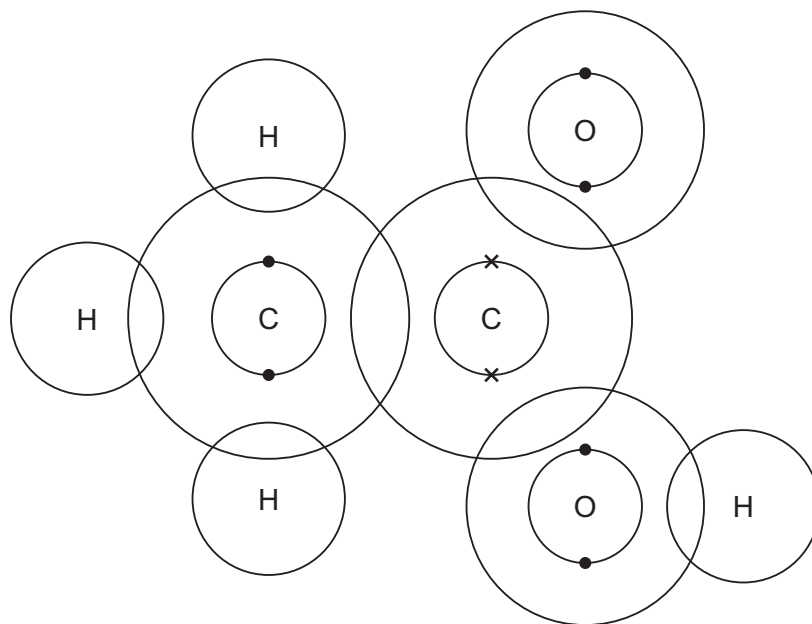


Fig. 4.1

[3]

(ii) Suggest the pH of dilute ethanoic acid.

..... [1]

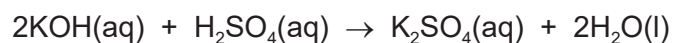
(iii) Complete the symbol equation to show the dissociation of ethanoic acid.

CH_3COOH [3]

(iv) Write the ionic equation for the reaction when an acid neutralises a soluble base.

..... [1]

- (g) In a titration, 25.0 cm³ of 0.0800 mol/dm³ aqueous potassium hydroxide, KOH(aq), is neutralised by 20.0 cm³ of dilute sulfuric acid, H₂SO₄(aq).



Calculate the concentration of H₂SO₄, in g/dm³ using the following steps.

- Calculate the number of moles of KOH used.

..... mol

- Determine the number of moles of H₂SO₄ which react with the KOH.

..... mol

- Calculate the concentration of H₂SO₄ in mol/dm³.

..... mol/dm³

- Calculate the concentration of H₂SO₄ in g/dm³.

..... g/dm³

[5]

[Total: 21]

5 Propane and propene both react with chlorine.

(a) When a molecule of propane, C_3H_8 , reacts with chlorine in the presence of ultraviolet light, one atom of hydrogen is replaced by one atom of chlorine.

(i) State the term given to reactions in which one atom in an alkane is replaced by another atom.

..... [1]

(ii) State the purpose of ultraviolet light in this reaction.

..... [1]

(iii) State the term given to any reaction which requires ultraviolet light.

..... [1]

(iv) Write the symbol equation for the reaction between propane and chlorine.

..... [2]

(b) A molecule of propene, C_3H_6 , is unsaturated and will react with chlorine at room temperature.

(i) State why propene is an unsaturated molecule.

..... [1]

(ii) Give the structural formula of the product of this reaction.

..... [1]

(c) Propene undergoes addition reactions with steam.
There are two possible products, **A** and **B**.

Draw the displayed formula and name each product.

displayed formula of product **A**

name of product **A**

displayed formula of product **B**

name of product **B** [4]

[Total: 11]

6 Carboxylic acids can be converted to esters.

(a) Name the ester formed when butanoic acid, $\text{CH}_3\text{CH}_2\text{CH}_2\text{COOH}$, reacts with ethanol, $\text{CH}_3\text{CH}_2\text{OH}$.

..... [1]

(b) Identify the other product formed in this reaction.

..... [1]

(c) Deduce the empirical formula of the ester formed.

..... [1]

(d) PET is a polyester. Part of the structure of PET is shown in Fig. 6.1.

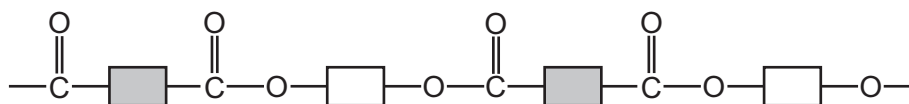


Fig. 6.1

(i) Circle **one** repeat unit of this polymer. [1]

(ii) Draw the structures of the monomers which make up PET. Draw the functional groups using displayed formulae.

[2]

(iii) State the type of polymerisation used in making PET.

..... [1]

[Total: 7]

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Group																																			
I	II						III	IV	V	VI	VII	VIII																							
						1 H hydrogen 1																													
3	Li lithium 7	4	Be beryllium 9	atomic number atomic symbol name relative atomic mass				5	6	7	8	9	10																						
11	Na sodium 23	12	Mg magnesium 24					13	14	15	16	17	18																						
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 58	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	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	

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	europlum	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
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	—