



CANDIDATE
NAME

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CENTRE
NUMBER

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CANDIDATE
NUMBER

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0620/32

February/March 2024

1 hour 15 minutes

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 **20** pages.

- 1 A list of substances is shown.

brass
calcium oxide
carbon monoxide
diamond
glucose
hydrogen
litmus
magnesium bromide
methyl orange
sodium chloride
stainless steel
thymolphthalein
water
zinc oxide

Answer the following questions about these substances.
Each substance may be used once, more than once or not at all.

State which substance:

- (a) is formed by the thermal decomposition of calcium carbonate in the blast furnace

..... [1]

- (b) is a mixture of copper and zinc

..... [1]

- (c) turns yellow when an alkali is added

..... [1]

- (d) is a reactant in photosynthesis

..... [1]

- (e) is a salt that contains a positive ion with a charge of 1+

..... [1]

- (f) is a compound that reduces iron(III) oxide in the blast furnace.

..... [1]

[Total: 6]

- 2 Table 2.1 shows the masses of some of the ions in a 1000 cm^3 sample of river water.

Table 2.1

name of ion	formula of ion	mass of ion in 1000 cm^3 of river water / mg
	NH_4^+	0.4
calcium	Ca^{2+}	1.4
chloride	Cl^-	0.1
hydrogencarbonate	HCO_3^-	1.2
magnesium	Mg^{2+}	0.6
nitrate	NO_3^-	0.8
phosphate	PO_4^{3-}	1.3
sodium	Na^+	0.5
	SO_4^{2-}	0.4

- (a) Answer these questions using the information in Table 2.1.

- (i) Name the negative ion that has the highest concentration.

..... [1]

- (ii) Name the compound that contains NH_4^+ and SO_4^{2-} ions only.

..... [1]

- (iii) Calculate the mass of hydrogencarbonate ions in 200 cm^3 of river water.

mass = mg [1]

- (b) Give a test for sodium ions.

test

observations

[2]

- (c) Most of the nitrate ions in river water come from fertilisers used on fields.

Describe the benefit of using fertilisers.

..... [1]

- (d) Water from natural sources can be polluted with harmful substances.

State why sewage and phosphates in river water are harmful.

sewage

.....

phosphates

.....

[2]

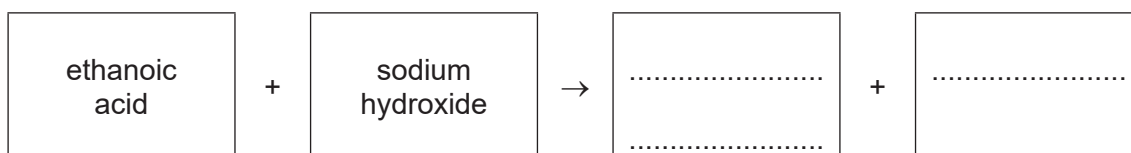
- (e) River water can contain acids such as ethanoic acid and methylbutanoic acid.

- (i) Draw the displayed formula for ethanoic acid.

[1]

- (ii) Ethanoic acid reacts with sodium hydroxide.

Complete the word equation for this reaction.



[2]

- (iii) Methylbutanoic acid has the molecular formula $\text{C}_5\text{H}_{10}\text{O}_2$.

Complete Table 2.2 to calculate the relative molecular mass of $\text{C}_5\text{H}_{10}\text{O}_2$.

Table 2.2

atom	number of atoms	relative atomic mass	
carbon	5	12	$5 \times 12 = 60$
hydrogen		1	
oxygen		16	

relative molecular mass = [2]

[Total: 13]

3 The chemical elements are arranged in the Periodic Table in groups and periods.

- (a) (i) Describe how the metallic character of the elements changes from left to right across a period.

.....
 [1]

- (ii) The elements in Group I are known as the alkali metals.

Describe **two** trends in the properties of the elements, going down Group I.

1
 2 [2]

- (b) Chlorine, bromine and iodine are in Group VII of the Periodic Table.

- (i) Aqueous chlorine reacts with aqueous sodium bromide to produce aqueous bromine and aqueous sodium chloride.

Complete the symbol equation for this reaction.



- (ii) Suggest why aqueous iodine does **not** react with aqueous sodium bromide.

.....
 [1]

- (iii) Complete the dot-and-cross diagram in Fig. 3.1 for a molecule of iodine.

Show outer shell electrons only.

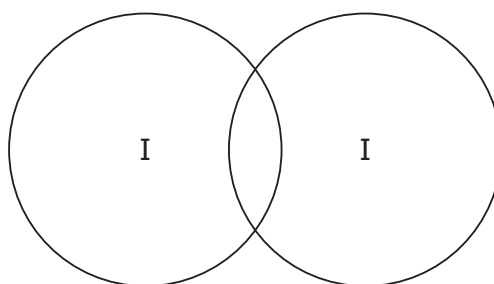


Fig. 3.1

[2]

(c) Molten silver bromide is electrolysed using graphite electrodes.

Name the product formed at each electrode.

product at the anode

product at the cathode

[2]

(d) Fig. 3.2 shows the apparatus used to electroplate a metal object with silver.

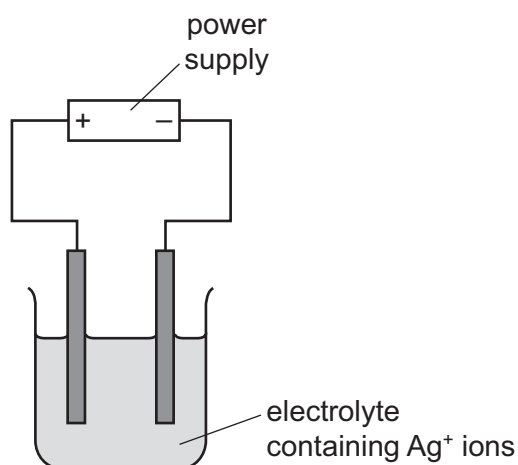


Fig. 3.2

(i) Label Fig. 3.2 to show where the silver is deposited. [1]

(ii) State why objects are electroplated.

..... [1]

[Total: 12]

- 4 Alkenes are a homologous series of hydrocarbons which are made by cracking larger alkane molecules.

(a) (i) Write the general formula for alkenes.

..... [1]

(ii) Explain the need for cracking larger alkane molecules.

.....
 [1]

(iii) Describe **two** conditions needed for cracking.

1

2 [2]

(b) Alkenes are unsaturated compounds.

State the meaning of the term unsaturated.

.....
 [1]

(c) Table 4.1 shows the boiling points of some alkenes.

Table 4.1

alkene	boiling point / °C
ethene	–104
propene	
butene	–6
pentene	30
hexene	63

(i) Predict the boiling point of propene.

..... °C [1]

- (ii) The melting point of butene is -185°C .

Deduce the physical state of butene at -100°C .

Give a reason for your answer.

physical state

reason

[2]

- (d) Fig. 4.1 shows a gas syringe that contains 60 cm^3 of ethene gas.

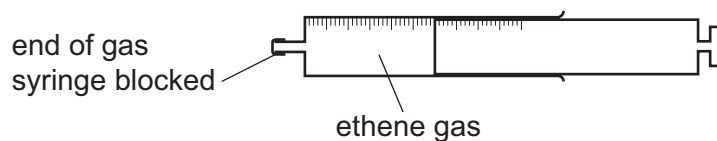


Fig. 4.1

State how the volume of ethene in the gas syringe changes when the temperature is decreased and the pressure remains the same.

[1]

- (e) Poly(ethene) is produced by the polymerisation of ethene. The reaction is exothermic.

- (i) State the meaning of the term exothermic.

[1]

- (ii) Fig. 4.2 shows the reaction pathway diagram for this reaction.

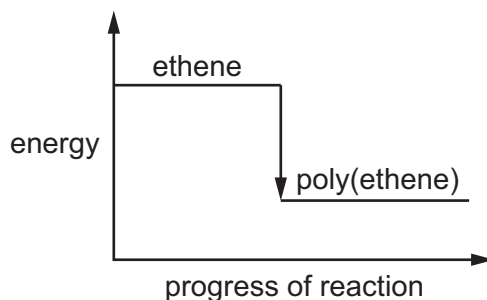


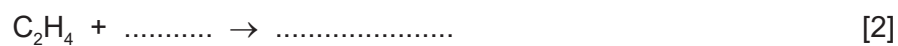
Fig. 4.2

Explain how this reaction pathway diagram shows that the reaction is exothermic.

[1]

(f) Ethene reacts with steam to produce ethanol.

(i) Complete the symbol equation for this reaction.



(ii) Choose the word which describes the type of catalyst used in this reaction.

Draw a circle around your chosen answer.

acid alkali metal salt [1]

[Total: 14]

Question 5 starts on the next page.

5 Samarium is a metal.

(a) Deduce the number of electrons and neutrons in the samarium atom shown.



number of electrons

number of neutrons

[2]

(b) Samarium has properties that are similar to the properties of transition elements.

Choose **one** statement about samarium that is correct.

Tick (✓) **one** box.

Compounds of samarium are colourless.

☐

Samarium has a low melting point.

☐

Samarium and its compounds do **not** act as catalysts.

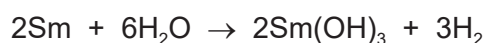
☐

Samarium has a high density.

☐

[1]

(c) Large pieces of samarium react with cold water to produce hydrogen gas.



(i) Complete Fig. 5.1 by drawing the apparatus to show how the volume of hydrogen gas is measured during this reaction.

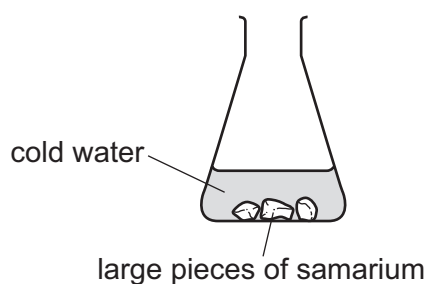


Fig. 5.1

[2]

- (ii) The experiment is repeated using hot water instead of cold water.

All other conditions stay the same.

Describe how the rate of reaction changes when hot water is used.

..... [1]

- (iii) The experiment is repeated using powdered samarium instead of large pieces of samarium.

All other conditions stay the same.

Describe how the rate of reaction changes when powdered samarium is used.

..... [1]

- (d) Table 5.1 shows the observations when samarium and three other metals are heated in oxygen.

Table 5.1

metal	observations
nickel	reacts very slowly
samarium	reacts rapidly
strontium	reacts very rapidly
yttrium	does not react

Put the four metals in order of their reactivity.

Put the least reactive metal first.

least reactive
→
 most reactive

[2]

- (e) Samarium reacts with oxygen to produce samarium oxide, Sm_2O_3 .

Complete the symbol equation for this reaction.



- (f) Hydrated samarium chloride is an ionic compound.

- (i) Define the term hydrated.

.....

..... [1]

(ii) State **two** physical properties of an ionic compound.

1

2

[2]

[Total: 14]

Question 6 starts on the next page.

6 Sulfur is an element in Group VI of the Periodic Table.

(a) State the meaning of the term element.

.....
 [1]

(b) Sulfur has a relative atomic mass of 32.

Complete these sentences about the relative atomic mass of sulfur using terms from the list.

¹²C electrons ¹H isotopes neutrons ¹⁶O protons ³²S

The relative atomic mass of sulfur is the average mass of the sulfur

This average mass is compared to 1/12th of the mass of an atom of

[2]

(c) Sulfur is a solid at room temperature and pressure.

Describe the motion and separation of the particles in solid sulfur.

motion

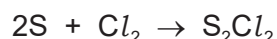
.....

separation

.....

[2]

(d) Liquid sulfur reacts with chlorine to produce disulfur dichloride.



(i) Describe how the general physical properties of a liquid differ from those of a solid.
 Give **two** differences.

1

2

[2]

- (ii) When 6.4 g of sulfur reacts with excess chlorine, 13.5 g of disulfur dichloride is produced.

Calculate the mass of disulfur dichloride produced when 19.2 g of sulfur reacts with excess chlorine.

mass = g [1]

- (e) Sulfur dioxide is formed when sulfur burns in air.

- (i) State the percentage of oxygen in clean, dry air.

..... [1]

- (ii) State **one** source of the pollutant sulfur dioxide in the air other than from burning sulfur.

..... [1]

- (iii) State **one** adverse effect of sulfur dioxide in the air.

..... [1]

- (iv) State **one** method of reducing the emissions of sulfur dioxide.

..... [1]

- (v) Sulfur dioxide dissolves in water to form sulfurous acid.

Give the formula of the ion that is present in all aqueous acids.

..... [1]

- (vi) Sulfur dioxide reacts with oxygen in the presence of a catalyst to form sulfur trioxide.
This is a reversible reaction.

Complete the equation for this reaction by writing the sign for a reversible reaction in the box.



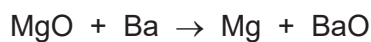
[Total: 14]

7 Magnesium is an element in Group II of the Periodic Table.

(a) Deduce the electronic configuration of magnesium.

..... [1]

(b) Magnesium can be produced by reducing magnesium oxide with barium.



Explain how this equation shows that magnesium oxide is reduced.

..... [1]

(c) Alloys of magnesium and aluminium are resistant to corrosion.

Choose the diagram, **A**, **B**, **C** or **D**, in Fig. 7.1 that best shows the structure of an alloy.

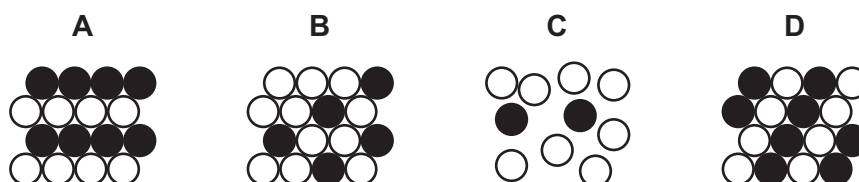


Fig. 7.1

diagram [1]

(d) (i) Complete the word equation for the reaction of magnesium oxide with hydrochloric acid.



[2]

(ii) Magnesium oxide is insoluble in water.

Choose from the list one **other** compound that is insoluble in water.

Tick (✓) **one** box.

magnesium carbonate	☐
magnesium chloride	☐
magnesium nitrate	☐
magnesium sulfate	☐

[1]

(e) Fig. 7.2 shows the electronic configuration of an element in Group II of the Periodic Table.

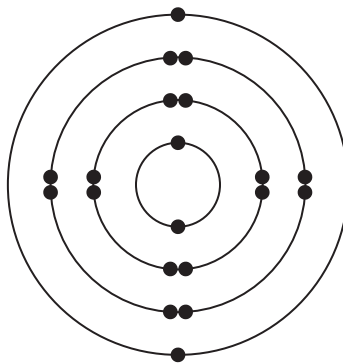


Fig. 7.2

Deduce the period in the Periodic Table to which this element belongs.

Period [1]

[Total: 7]

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The Periodic Table of Elements

Group																																																																				
I	II											III	IV	V	VI	VII	VIII																																																			
3 Li lithium 7 11 Na sodium 23		1 H hydrogen 1 Key atomic number atomic symbol name relative atomic mass																																																																		
		4	Be	beryllium	9							5	6	7	8	9	10																																																			
		12	Mg	magnesium	24							13	14	15	16	17	18																																																			
19	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	P	phosphorus	31	32	Ge	germanium	73	33	As	arsenic	75	34	Se	selenium	79	35	Br	bromine	80	36	Kr	krypton	84
37	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	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	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	euporium	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 dm³ at room temperature and pressure (r.t.p.).