Cambridge Assessment International Education

Cambridge IGCSE™ (9–1)

CHEMISTRY **0971/21**

Paper 2 Multiple Choice (Extended) **May/June 2025**

45 minutes

You must answer on the multiple choice answer sheet.

You will need: Multiple choice answer sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)

INSTRUCTIONS

- There are **forty** questions on this paper. Answer **all** questions.
- For each question there are four possible answers **A**, **B**, **C** and **D**. Choose the **one** you consider correct and record your choice in soft pencil on the multiple choice answer sheet.
- Follow the instructions on the multiple choice answer sheet.
- Write in soft pencil.
- Write your name, centre number and candidate number on the multiple choice answer sheet in the spaces provided unless this has been done for you.
- Do **not** use correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.

INFORMATION

- The total mark for this paper is 40.
- Each correct answer will score one mark.
- Any rough working should be done on this question paper.
- The Periodic Table is printed in the question paper.

This document has **16** pages.

1 A gas is placed in a sealed container with a fixed volume.

The gas is heated.

Which statements are correct?

1 The gas molecules move around faster.

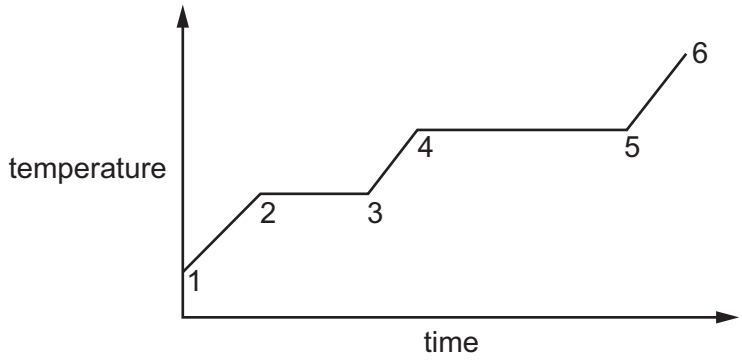
2 The gas particles collide with the walls of the container more frequently.

3 The pressure in the container decreases.

A 1 and 2 **B** 1 only **C** 2 and 3 **D** 2 only

2 A sample of ethanol is heated at a constant rate.

The heating curve for this sample is shown.



Which statement about the heating curve is correct?

A Ethanol changes its physical state between 3 and 4.

B Ethanol condenses between 2 and 3.

C Energy is absorbed between 3 and 4 but **not** absorbed between 4 and 5.

D More energy is absorbed between 4 and 5 than between 2 and 3.

3 Which atom has an equal number of protons, neutrons and electrons?

A ^{40}Ar **B** ^{1}H **C** ^{23}Na **D** ^{14}N

4 The only naturally occurring isotopes in a sample of europium are ^{151}Eu and ^{153}Eu. This sample of europium has a relative atomic mass, A_r, of 152.

What is the percentage of ^{151}Eu present in this sample to three significant figures?

A 0.987% **B** 50.0% **C** 76.0% **D** 98.7%

5 Which statement about potassium chloride is correct?

A It has a high melting point because it is a giant structure with strong covalent bonds.

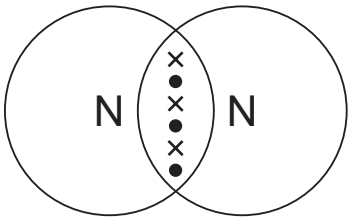
B It conducts electricity when solid because of its oppositely charged ions.

C It conducts electricity when molten because its ions can move.

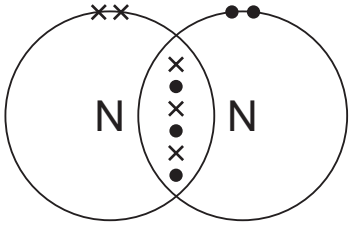
D It is insoluble in water because of its strong bonding.

6 Which dot-and-cross diagram shows the outer shell electron arrangement in a molecule of nitrogen?

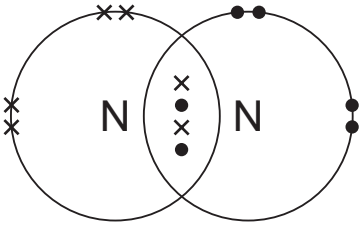
A



B



C



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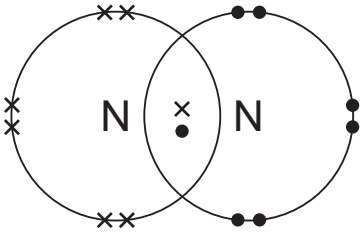


7 Which statement about silicon(IV) oxide is correct?

A It contains silicon ions and oxide ions arranged in a giant lattice.

B It is used in electrical circuits because it can conduct electricity.

C Its bonds each contain one shared pair of electrons.

D Its atoms are arranged in the same way as the atoms in graphite.

[Turn over

8 Three organic molecules are described.

- The molecular formula of propanoic acid is CH_3CH_2COOH.
- The molecular formula of lactic acid is $CH_3CH(OH)COOH$.
- A glucose molecule consists of 6 carbon atoms, 6 oxygen atoms and 12 hydrogen atoms only.

Which molecules have the same empirical formula?

A propanoic acid, lactic acid and glucose

B propanoic acid and lactic acid only

C propanoic acid and glucose only

D lactic acid and glucose only

9 Calcium carbonate reacts with dilute hydrochloric acid.

The equation for the reaction is shown.

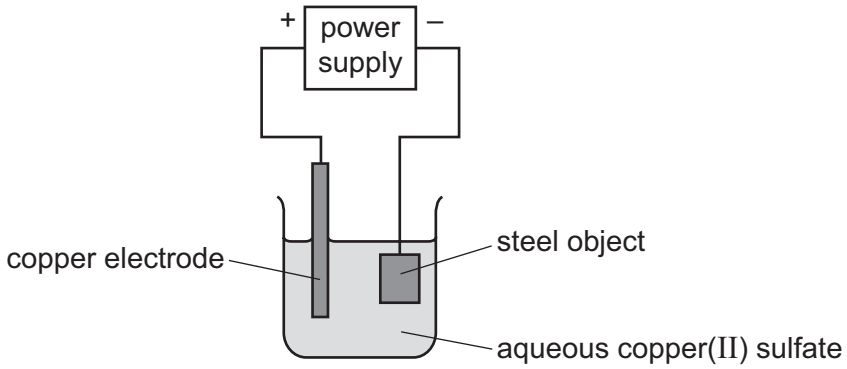
$$CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$$

1.00 g of calcium carbonate is added to 50.0 cm^3 of 0.0500 mol / dm^3 hydrochloric acid.

Which volume of carbon dioxide is made in this reaction?

A 30 cm^3 **B** 60 cm^3 **C** 120 cm^3 **D** 240 cm^3

10 The diagram shows the electroplating of a steel object.



A student makes three statements.

1 The steel object turns a reddish-brown colour.

2 The aqueous copper(II) sulfate changes to a paler blue colour.

3 The copper electrode becomes thinner.

Which statements are correct?

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

11 Concentrated aqueous sodium chloride is electrolysed using inert electrodes.

Which equation shows the correct ionic half-equation for the reaction at the anode?

A $Cl^- + e^- \rightarrow Cl$

B $2Cl^- \rightarrow Cl_2 + 2e^-$

C $H^+ \rightarrow H + e^-$

D $2H^+ + 2e^- \rightarrow H_2$

12 Which equation represents the overall reaction in a hydrogen–oxygen fuel cell?

A $2H_2 + O_2 \rightarrow 2H_2O$

B $2H_2O \rightarrow 2H_2 + O_2$

C $H_2 + O_2 \rightarrow H_2O_2$

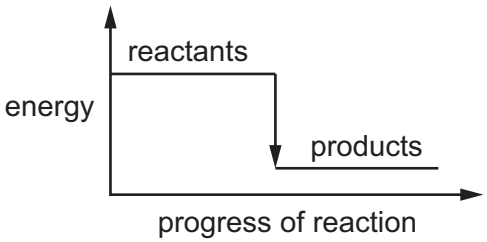
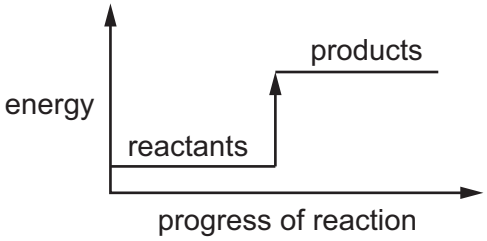
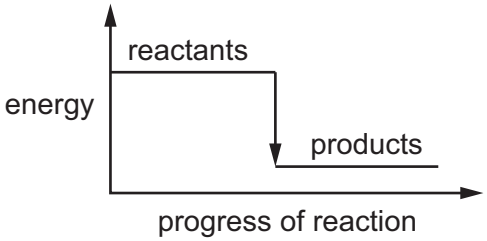
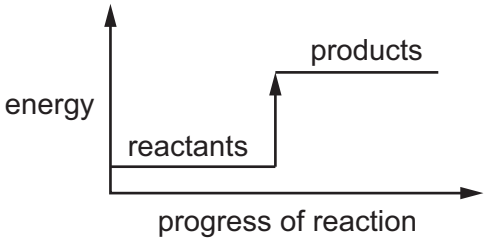
D $H_2O_2 \rightarrow H_2 + O_2$

[Turn over

13 Water is added to anhydrous copper(II) sulfate in a test-tube.

The mixture becomes hot.

Which type of reaction and reaction pathway diagram apply to this reaction?

	type of reaction	reaction pathway diagram
A	endothermic	
B	endothermic	
C	exothermic	
D	exothermic	

14 The equation represents the reaction between ethanoic acid and ethanol.

$$CH_3COOH + CH_3CH_2OH \rightleftharpoons CH_3COOCH_2CH_3 + H_2O$$

Which type of reaction does this show?

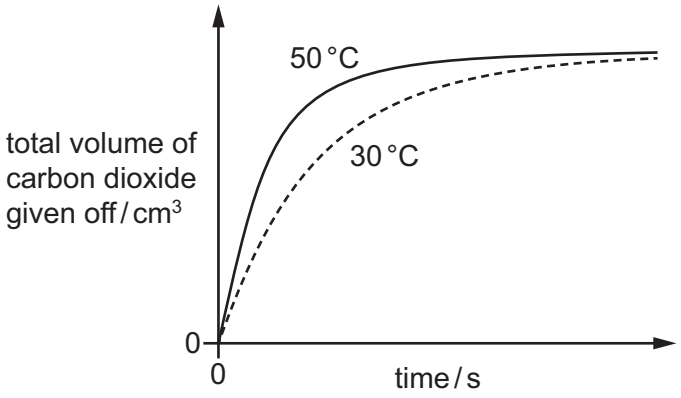
A addition

B neutralisation

C reduction

D reversible

15 The graph shows the results of adding excess calcium carbonate to hydrochloric acid at 50 °C and at 30 °C. Only the temperature is changed.



Which row describes the reacting particles at 30 °C compared to those at 50 °C?

	frequency of collisions between particles	average kinetic energy of particles
A	higher	higher
B	higher	lower
C	lower	higher
D	lower	lower

16 Industrially, ammonia is made by the Haber process. The equation is shown.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \qquad \Delta H = -92\,kJ/mol$$

The conditions used are 450 °C and 200 atm.

Which statements about the conditions are correct?

1 Temperatures below 450 °C give a lower rate of reaction.

2 Temperatures below 450 °C give a lower yield of ammonia.

3 Pressures above 200 atm give a lower yield of ammonia.

4 Pressures above 200 atm are too expensive to maintain.

A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 3 and 4

17 Ethanol is warmed with acidified aqueous potassium manganate(VII).

Which row describes the type of reaction of the ethanol and the colour change observed in the reaction mixture?

	type of reaction	colour change
A	oxidation	colourless to purple
B	oxidation	purple to colourless
C	reduction	colourless to purple
D	reduction	purple to colourless

18 Two experiments involving acids R or S are done.

- 0.10 mol of acid R completely dissolves in 500 cm^3 of water. 0.0048 mol of acid R is dissociated in the solution.
- 0.10 mol of acid S completely dissolves in 500 cm^3 of water. 0.0179 mol of acid S is dissociated in the solution.

Which statement about acids R and S is correct?

A Acid R is a strong acid, and acid S is a weak acid.

B Acid R is a weak acid, and acid S is a strong acid.

C Acid R and acid S are both strong acids.

D Acid R and acid S are both weak acids.

19 Lead(II) sulfate is an insoluble salt.

Which process is **not** used to prepare a pure sample of this salt?

A crystallisation

B drying

C filtration

D precipitation

20 The formulae of two hydrated salts are shown.

- $CuSO_4 \cdot xH_2O$
- $CoCl_2 \cdot yH_2O$

What are the values of *x* and *y*?

	x	*y*
A	5	5
B	5	6
C	6	5
D	6	6

21 The properties of the elements change from left to right across the Periodic Table.

Which statement describes how the properties change across Period 3?

A Elements change from gases to solids.

B Elements change from non-conductors to electrical conductors.

C Elements change from metal to non-metal.

D Elements have a decreasing number of electron shells.

22 Which property decreases down Group VII of the Periodic Table, from chlorine to iodine?

A atomic number

B density

C reactivity

D melting point

23 Some properties of elements are listed.

1 They have good electrical conductivity.

2 They have high melting points.

3 They are malleable.

4 They have ions with variable oxidation numbers.

Which properties are correct for **both** iron and lithium?

A 1 and 3 **B** 1 and 4 **C** 2 and 3 **D** 2 and 4

24 Two statements about noble gases are listed.

1 Noble gases are reactive, monatomic gases.

2 Noble gases all have a full outer shell of electrons.

Which statements about noble gases are correct?

A Both statements are correct, and statement 2 explains statement 1.

B Both statements are correct but statement 2 does **not** explain statement 1.

C Statement 1 is correct but statement 2 is **not** correct.

D Statement 2 is correct but statement 1 is **not** correct.

25 Which statement about the properties and uses of copper is correct?

A It is used in electrical wiring, and it is ductile.

B It is mixed with tin to make the alloy brass.

C It is used in overhead electrical cables because it has a low density.

D It is used in takeaway food containers because of its resistance to corrosion.

26 Three statements about solid Z are listed.

- It reacts with dilute hydrochloric acid to produce hydrogen.
- It reacts very slowly with cold water and quickly with steam.
- It is a good thermal conductor.

What is solid Z?

A gold

B magnesium

C potassium

D silver

27 Four metals J, K, L and M are added separately to aqueous solutions of their ions.

The results are shown.

	aqueous ions			
metal	J^{2+}	K^{2+}	L^{2+}	M^{2+}
J	✗	✓	✓	✓
K	✗	✗	✗	✓
L	✗	✓	✗	✓
M	✗	✗	✗	✗

key

✓ = reaction

✗ = no reaction

Which statement about the metals is correct?

A J has a greater tendency to form positive ions than K.

B L has a greater tendency to form positive ions than J.

C K has a greater tendency to form positive ions than L.

D M has a greater tendency to form positive ions than K.

28 Which process is used in the extraction of iron from hematite?

A electrolysis

B precipitation

C reduction

D fractional distillation

29 Galvanising prevents iron from rusting.

Which statements about galvanising are correct?

1 Galvanising involves coating the iron with silver.

2 Galvanising prevents oxygen and water from coming into contact with the iron.

3 Galvanising works because the metal coating loses electrons more readily than iron.

A 1, 2 and 3 **B** 1 and 3 only **C** 2 and 3 only **D** 2 only

[Turn over

30 Nitrogen, phosphorus and potassium are essential elements for improved plant growth.

Which mixture provides all **three** essential elements?

	mixture	formulae
A	ammonium phosphate + potassium chloride	$(NH_4)_3PO_4$ + KCl
B	ammonium phosphate + ammonium nitrate	$(NH_4)_3PO_4$ + NH_4NO_3
C	ammonium phosphate + ammonium chloride	$(NH_4)_3PO_4$ + NH_4Cl
D	ammonium nitrate + potassium chloride	NH_4NO_3 + KCl

31 Which statements help explain why an increasing amount of carbon dioxide or methane in the atmosphere causes global warming?

1 Carbon dioxide absorbs thermal energy from the Earth.

2 Methane does **not** absorb thermal energy from the Sun.

3 Carbon dioxide does **not** reflect thermal energy from the Sun to the Earth.

4 Methane reflects thermal energy from the Earth back to the Earth.

A 1 and 3 **B** 1 and 4 **C** 2 and 3 **D** 2 and 4

32 The exhaust gases from cars contain oxides of nitrogen.

How are these oxides of nitrogen formed?

A Nitrogen and oxygen from the air react together at the high temperatures in the engine.

B Nitrogen and oxygen from the petrol react together in the car exhaust.

C Nitrogen from the petrol reacts with oxygen at the high temperatures in the engine.

D Nitrogen reacts with oxygen from the air in the catalytic converter.

33 The structural formula of methyl ethanoate is CH_3COOCH_3.

Which compounds are structural isomers of methyl ethanoate?

1 $HCOOCH_2CH_3$

2 CH_3CH_2COOH

3 $HOCH_2CH_2CH_2OH$

A 1, 2 and 3 **B** 1 and 2 only **C** 2 and 3 only **D** 3 only

34 What is the **total** number of covalent bonds in one molecule of propane?

A 8 **B** 9 **C** 10 **D** 11

35 Industrially, ethanol is produced by fermentation or by the reaction of ethene with steam.

Which row is correct?

	fermentation	ethene + steam
A	uses a temperature of 100 °C	uses a temperature of 350 °C
B	needs the presence of yeast	does **not** need a catalyst
C	slow reaction	fast reaction
D	high yield of ethanol	low yield of ethanol

36 Some properties of an organic compound, J, are listed.

- It is a liquid at room temperature.
- It is soluble in water.
- A solution of J reacts with calcium carbonate to form carbon dioxide.
- A solution of J has a pH of 3.

In which homologous series does J belong?

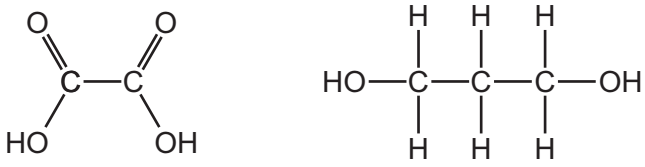
A alkane

B alkene

C alcohol

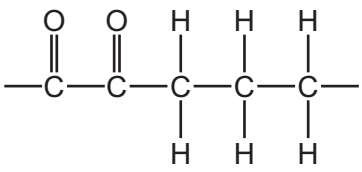
D carboxylic acid

37 The structures of two monomers that are used to make a condensation polymer are shown.

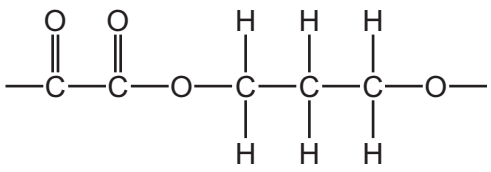


Which structure represents one repeat unit of the condensation polymer formed?

A



B



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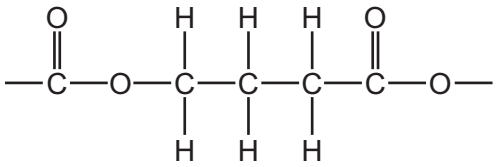

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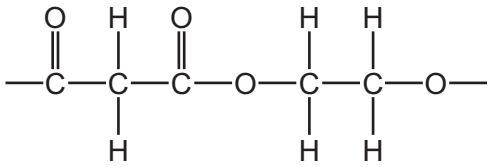
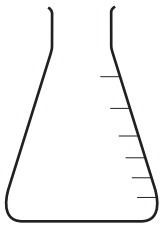


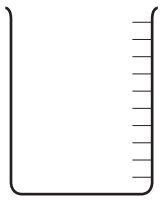
38 Which item of apparatus is used to measure 25.0 cm^3 of aqueous sodium hydroxide?

A

B



C



D

39 Which method is used to obtain copper(II) sulfate crystals from an aqueous solution of copper(II) sulfate?

A chromatography

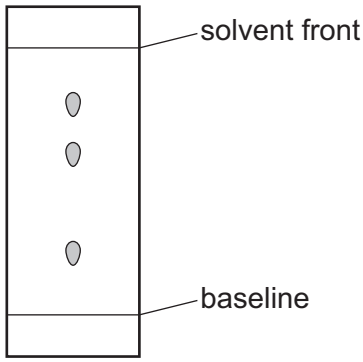
B condensation

C evaporation

D filtration

40 A mixture of four different colourless amino acids is analysed by paper chromatography.

The final chromatogram is shown.



Why does the chromatogram only show three spots?

A A locating agent is **not** used.

B One of the amino acids is insoluble in the solvent.

C The solvent front is too near the top of the paper.

D Two of the amino acids have the same R_f value.

The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	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.).