Cambridge Assessment International Education

Cambridge IGCSE™ (9–1)

CHEMISTRY **0971/22**

Paper 2 Multiple Choice (Extended) **May/June 2024**

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. Any blank pages are indicated.

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1 Which gas has the slowest rate of diffusion?

A H_2 **B** NH_3 **C** CH_4 **D** CO_2

2 Which statements about the position of the elements in the Periodic Table are correct?

1 Elements in the same group have similar chemical properties.
2 Elements in the same period have similar chemical properties.
3 Elements in the same group have the same number of electron shells.
4 Elements in the same group have the same number of outer shell electrons.

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

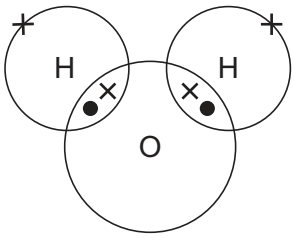
3 Which statements about isotopes are correct?

1 Isotopes are atoms of different elements with the same number of protons.
2 Isotopes of the same element have the same chemical properties.
3 Isotopes are atoms with the same relative atomic mass.
4 Isotopes of the same element have the same electronic configuration.

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

4 Which diagram shows the arrangement of the outer shell electrons in a molecule of water?

A



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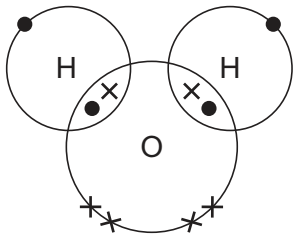

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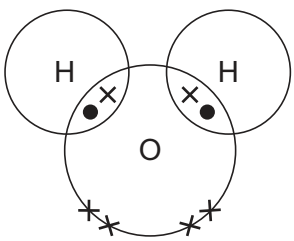

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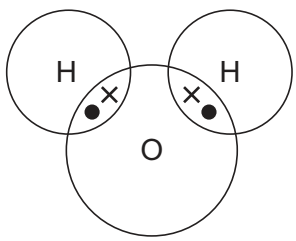
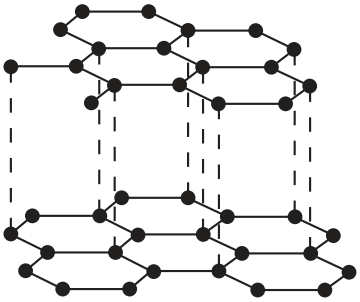


5 The structures of three substances are shown.

1



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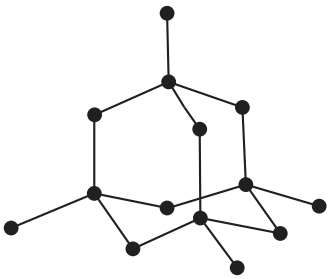

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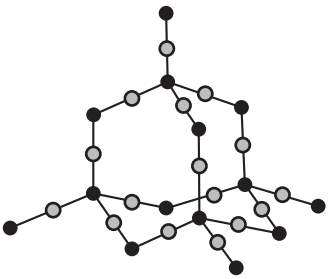


Which substances are hard and have a high melting point?

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

6 Information about four substances, W, X, Y and Z, is shown.

	melting point / °C	electrical conductivity
W	1710	does not conduct when solid
X	3500	conducts when solid
Y	120	does not conduct
Z	801	conducts when molten

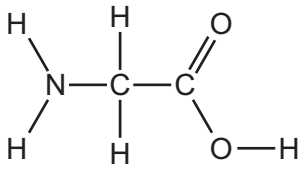
W, X, Y and Z are graphite, poly(ethene), sodium chloride and silicon(IV) oxide but not in that order.

What are W, X, Y and Z?

	W	X	Y	Z
A	graphite	poly(ethene)	silicon(IV) oxide	sodium chloride
B	sodium chloride	graphite	poly(ethene)	silicon(IV) oxide
C	poly(ethene)	sodium chloride	graphite	silicon(IV) oxide
D	silicon(IV) oxide	graphite	poly(ethene)	sodium chloride

[Turn over

7 The structure of glycine is shown.



Which row is correct?

	formula of glycine	number of different elements in glycine
A	CH_5O_2N	10
B	$C_2H_5O_2N$	4
C	$C_2H_5O_2N$	10
D	$H_2NCHCOOH$	4

8 The incomplete equation for photosynthesis is shown.

$$w CO_2 + x H_2O \rightarrow P + y O_2$$

Compound P is a product of the reaction.

Which row describes the values of *w*, *x* and *y* and gives the empirical formula of compound P?

	values of *w*, *x* and *y*	empirical formula of compound P
A	*w*, *x* and *y* are all the same	CH_2O
B	*w*, *x* and *y* are all the same	$C_6H_{12}O_6$
C	*w* and *x* are the same and both are greater than *y*	CH_2O
D	*w* and *x* are the same and both are greater than *y*	$C_6H_{12}O_6$

9 The concentration and volume of an aqueous alkali are known.

Which additional information is required to calculate the number of moles of acid needed to neutralise the aqueous alkali?

A the concentration of the acid

B the equation for the acid–alkali reaction

C the formula of the acid

D the volume of the acid required for neutralisation

10 Which statement about electrolysis is correct?

A Electrons move through the electrolyte from the cathode to the anode.

B Electrons move in the external circuit towards the cathode.

C Negative ions move in the external circuit towards the anode.

D Positive ions move through the electrolyte towards the anode.

11 Aqueous copper(II) sulfate is electrolysed using copper electrodes.

What is the half-equation for the reaction at the cathode?

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

B $4OH^- \rightarrow O_2 + 2H_2O + 4e^-$

C $Cu \rightarrow Cu^{2+} + 2e^-$

D $Cu^{2+} + 2e^- \rightarrow Cu$

12 Three statements about activation energy, E_a, are listed.

1 Colliding particles must have at least E_a before they can react.

2 E_a for exothermic reactions is always greater than for endothermic reactions.

3 E_a is always endothermic.

Which statements are correct?

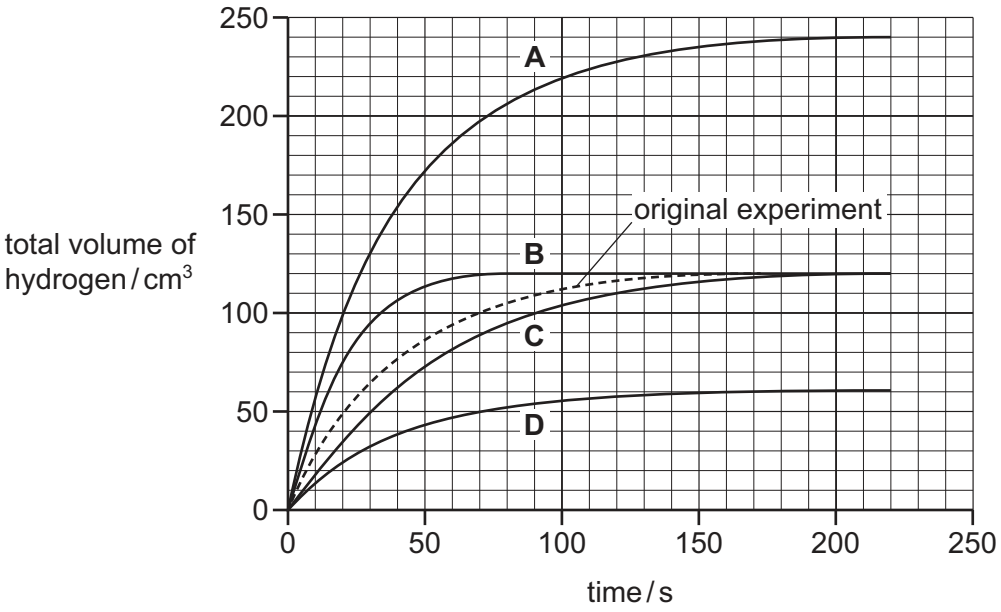
A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

13 A student adds excess magnesium ribbon to 10 cm^3 of 0.5 mol/dm^3 sulfuric acid.

The hydrogen gas produced is collected and its total volume is measured every 10 seconds.

The experiment is repeated with 5 cm^3 of 0.5 mol/dm^3 sulfuric acid added to 5 cm^3 of water using the same mass of magnesium ribbon.

Which line on the graph shows the results of the second experiment?



14 The equation represents the reversible reaction between ethene and steam.

$$C_2H_4(g) + H_2O(g) \rightleftharpoons C_2H_5OH(g) \qquad \Delta H \text{ is negative}$$

Which row describes the conditions that produce the greatest yield of ethanol?

	pressure	temperature
A	low	low
B	low	high
C	high	low
D	high	high

15 Which row identifies the pressure and the catalyst used for the conversion of sulfur dioxide to sulfur trioxide in the Contact process?

	pressure / atm	catalyst
A	2	iron
B	2	vanadium(V) oxide
C	200	iron
D	200	vanadium(V) oxide

16 Which equation represents a redox reaction?

A $AgNO_3 + NaCl \rightarrow AgCl + NaNO_3$

B $PCl_5 + 4H_2O \rightarrow H_3PO_4 + 5HCl$

C $3Fe + 4H_2O \rightarrow Fe_3O_4 + 4H_2$

D $MgCO_3 + 2HCl \rightarrow MgCl_2 + CO_2 + H_2O$

17 The equation for the reaction between aluminium and copper(II) oxide is shown.

$$2Al + 3CuO \rightarrow Al_2O_3 + 3Cu$$

Which statements about this equation are correct?

1 The oxidation number of the aluminium reactant is +2.

2 The oxidation number of the aluminium in the product is +6.

3 The oxidation number of the copper in the reactant is +2.

4 The oxidation number of the copper product is 0.

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

18 What is the colour of thymolphthalein in dilute hydrochloric acid?

A blue

B red

C yellow

D colourless

19 Two acids, P and Q, with the same concentration and volume are reacted separately with the same mass of magnesium ribbon.

The reactions produce the same total volume of hydrogen gas but acid Q reacts much more slowly than acid P.

Which explanation for the difference between P and Q is correct?

A Acid P has a higher pH than acid Q.

B Acid P has a lower concentration of hydrogen ions.

C Acid Q is partially dissociated and acid P is fully dissociated.

D Acid Q is a proton acceptor.

20 Which process is **not** used in the preparation of an insoluble salt?

A filtration

B washing

C crystallisation

D drying

21 Lithium and potassium are metals in Group I of the Periodic Table.

Lithium has a melting point of 181 °C and a density of 0.53 g / cm^3.

Which row describes the melting point and density of potassium?

	melting point in °C	density in g / cm^3
A	less than 181	less than 0.53
B	less than 181	greater than 0.53
C	greater than 181	less than 0.53
D	greater than 181	greater than 0.53

22 Which statements about transition elements are correct?

1 They have a low density.

2 They form ions with variable oxidation numbers.

3 They have a high melting point.

4 They form only colourless compounds.

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

23 Which statements describe the elements in Group VIII of the Periodic Table?

1 Their atoms have full outer electron shells.

2 They are unreactive metals.

3 They are monatomic gases.

4 They are diatomic gases.

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

24 Four metals, Q, R, S and T, are each added to separate samples of water, steam and dilute hydrochloric acid.

The results are shown.

	observation with water	observation with steam	observation with dilute hydrochloric acid
Q	slow reaction	fast reaction	fast reaction
R	no reaction	no reaction	no reaction
S	no reaction	very slow reaction	slow reaction
T	fast reaction	explodes	explodes

Which statements are correct?

1 R is the least reactive metal.

2 T could be potassium.

3 S is more reactive than Q and R.

4 Metals generally react faster with steam than they react with water.

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

25 Metal X acts as a sacrificial metal to prevent iron from corroding.

Metal X does **not** act as a sacrificial metal to prevent aluminium from corroding.

What is X?

A copper

B magnesium

C silver

D zinc

26 Which equation represents the reduction of a compound found in hematite in the blast furnace?

A $2Al_2O_3 \rightarrow 4Al + 3O_2$

B $CaO + SiO_2 \rightarrow CaSiO_3$

C $2FeO + CO \rightarrow Fe_2O_3 + C$

D $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$

27 Which statements about the treatment of domestic water supplies are correct?

1 Filtration is used to remove insoluble substances from the water.

2 Sedimentation is used to remove soluble substances from the water.

3 Carbon is used to remove tastes and odours from the water.

4 Chlorine is used to lower the pH of the water.

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

28 Which statement about water is correct?

A It turns anhydrous copper(II) sulfate from pink to blue.

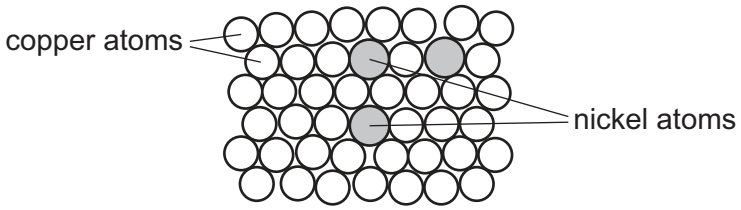
B It turns anhydrous copper(II) sulfate from white to blue.

C It turns cobalt(II) chloride paper from blue to white.

D It turns cobalt(II) chloride paper from pink to blue.

29 Cupronickel is used to make coins.

The arrangement of atoms in cupronickel is shown.



Which kind of substance is cupronickel?

A an alloy

B an isotope

C a compound

D a transition element

30 Which physical properties are typical of **all** metals?

1 good heat conductivity
2 low density
3 malleability

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

31 Which oxide is used to neutralise acidic gases in flue gas desulfurisation?

A calcium oxide
B carbon dioxide
C nitrogen oxide
D sulfur dioxide

32 Some information about three gases, P, Q and R, is listed.

- Gas P forms when magnesium reacts with dilute hydrochloric acid.
- Gas Q makes up 78% of the air.
- Gas R forms when gas P reacts with gas Q.

What is gas R?

A ammonia
B methane
C nitrogen dioxide
D water vapour

33 Which formula represents an alkene?

A CH_4 **B** C_2H_4 **C** C_2H_6 **D** C_2H_5OH

34 The structures of two compounds used to make an ester are shown.

What is the name of the ester?

A ethyl propanoate

B propyl ethanoate

C ethyl ethanoate

D propyl propanoate

35 Which statement about a homologous series is correct?

A All members have the same general formula.

B All members have the same molecular formula.

C All members have similar physical properties.

D Members show a trend in their chemical properties.

36 Which statements about aqueous ethanoic acid are correct?

1 It contains the functional group –COOH.

2 It reacts with carbonates to produce hydrogen.

3 It turns universal indicator paper blue.

4 It has a pH lower than pH 7.

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

37 Alkenes react with steam in an addition reaction.

Some alkenes produce only one alcohol product.
Some alkenes produce two different alcohols which are structural isomers.

Which row gives the number of alcohol isomers formed when ethene reacts with steam and when propene reacts with steam?

	number of alcohol isomers formed	
	ethene + steam	propene + steam
A	1	1
B	1	2
C	2	1
D	2	2

38 What is an advantage of manufacturing ethanol by fermentation rather than by the addition of steam to ethene?

A No gases that cause global warming are produced.

B The ethanol that is produced is pure.

C Fermentation is a fast process.

D Fermentation uses renewable raw materials.

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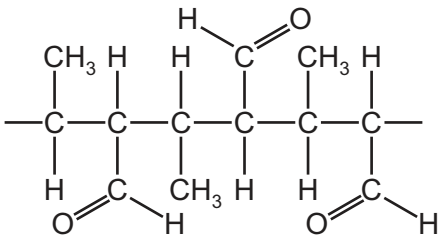
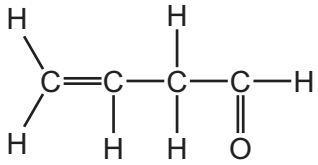
39 The diagram shows the structure of a polymer.

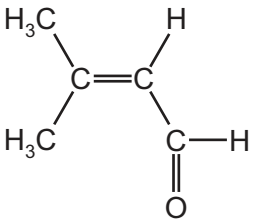


Which structure represents the monomer for this polymer?

A



B



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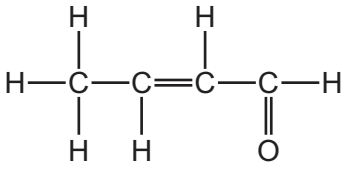

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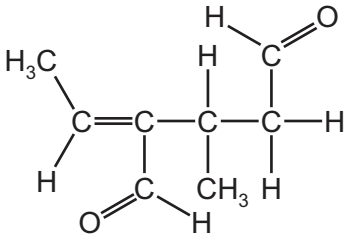

40 Which piece of apparatus is used to measure 24.5 cm^3 of gas produced during a reaction?

A beaker

B conical flask

C measuring cylinder

D volumetric pipette

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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.).