Cambridge Assessment International Education

Cambridge IGCSE™ (9–1)

CHEMISTRY **0971/21**

Paper 2 Multiple Choice (Extended) **May/June 2023**

45 minutes

You must answer on the multiple choice answer sheet.

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

INSTRUCTIONS

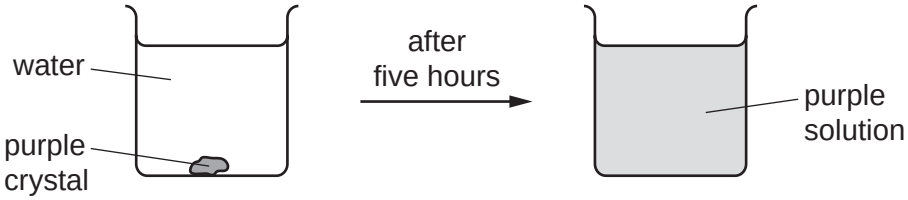
- There are **forty** questions on this paper. Answer **all** questions.
- For each question there are four possible answers **A**, **B**, **C** and **D**. Choose the **one** you consider correct and record your choice in soft pencil on the multiple choice answer sheet.
- Follow the instructions on the 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.

1 The diagram shows the result of dropping a purple crystal into water.



Which processes take place in this experiment?

	chemical reaction	diffusing	dissolving
A	✓	✓	✗
B	✓	✗	✗
C	✗	✗	✓
D	✗	✓	✓

2 Which row about elements, mixtures and compounds is correct?

	metallic element	non-metallic element	mixture	compound
A	copper	methane	brass	sulfur
B	brass	sulfur	copper	methane
C	copper	sulfur	brass	methane
D	brass	methane	copper	sulfur

3 The atomic structures of four particles, W, X, Y and Z, are shown.

	electrons	neutrons	protons
W	2	2	2
X	2	2	3
Y	2	3	2
Z	3	2	3

Which particles are isotopes of the same element?

A W and X **B** W and Y **C** X and Y **D** X and Z

4 Which statement explains why isotopes of the same element have the same chemical properties?

A They have the same number of outer shell electrons.

B They have the same number of neutrons.

C They have different numbers of protons.

D They have different mass numbers.

5 Nitrogen forms a nitride ion with the formula N^{3-}.

Which particle does **not** have the same electronic configuration as the nitride ion?

A Al^{3+} **B** Cl^{-} **C** Na^{+} **D** O^{2-}

6 Which row describes the formation of single covalent bonds in methane?

A	atoms share a pair of electrons	both atoms gain a noble gas electronic structure
B	atoms share a pair of electrons	both atoms have the same number of electrons in their outer shell
C	electrons are transferred from one atom to another	both atoms gain a noble gas electronic structure
D	electrons are transferred from one atom to another	both atoms have the same number of electrons in their outer shell

7 Which formula is an empirical formula?

A C_2H_4O

B $C_4H_8O_2$

C C_3H_7COOH

D $CH_3CH_2CH_2COOH$

8 Heating iron sulfide, FeS_2, in air produces sulfur dioxide.

$$4FeS_2 + 11O_2 \rightarrow 2Fe_2O_3 + 8SO_2$$

What is the maximum mass of sulfur dioxide produced from 120 kg of iron sulfide?

A 64 kg **B** 128 kg **C** 240 kg **D** 512 kg

9 Which substance produces hydrogen and bromine when electrolysed?

A concentrated aqueous copper(II) bromide

B concentrated aqueous sodium bromide

C dilute aqueous potassium bromide

D molten lead(II) bromide

10 Which statements about hydrogen fuel cells are correct?

1 Water is formed as the only waste product.

2 Both water and carbon dioxide are formed as waste products.

3 The overall reaction is $2H_2 + O_2 \rightarrow 2H_2O$.

4 The overall reaction is endothermic.

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

11 Ethene gas, C_2H_4, is completely burned in excess oxygen to form carbon dioxide and water.

The equation for this exothermic reaction is shown.

$$C_2H_4 + 3O_2 \rightarrow 2CO_2 + 2H_2O$$

The table shows the bond energies involved in the reaction.

bond	bond energy in kJ / mol
C=C	614
C–H	413
O=O	495
C=O	799
O–H	467

What is the total energy change in this reaction?

A –954 kJ / mol

B –1010 kJ / mol

C –1313 kJ / mol

D –1369 kJ / mol

12 Which row describes the effect on the activation energy and the frequency of particle collisions when the temperature of a chemical reaction is increased?

	activation energy	frequency of collisions
A	increases	increases
B	no change	increases
C	increases	no change
D	no change	no change

13 Solid copper(II) sulfate exists in two different forms, anhydrous and hydrated.

One of these forms is blue and the other is white.

The change between these two forms is reversible.

$$\text{blue form} \rightleftharpoons \text{white form}$$

What is the blue form and how is the change from the blue form to the white form brought about?

	blue form	change to white form
A	anhydrous	add water
B	anhydrous	heat
C	hydrated	add water
D	hydrated	heat

14 Sodium ions, Na^+, and oxygen ions, O^{2-}, combine with chromium ions to form a salt.

The salt sodium dichromate has the formula $Na_2Cr_2O_7$.

What is the oxidation state of chromium in this salt?

A +2 **B** +3 **C** +6 **D** +12

15 The concentration of hydrogen ions in 100 cm^3 of 0.1 mol/dm^3 hydrochloric acid is higher than the concentration of hydrogen ions in 100 cm^3 of 0.1 mol/dm^3 ethanoic acid.

Which statement explains the difference in hydrogen ion concentration?

A Ethanoic acid is an organic acid.

B Ethanoic acid has a lower pH than hydrochloric acid.

C Ethanoic acid is partially dissociated.

D Ethanoic acid is a strong acid.

16 Which oxide is classified as an amphoteric oxide?

A aluminium oxide

B calcium oxide

C copper(II) oxide

D nitrogen oxide

17 Which method produces the salt copper(II) carbonate?

A Add copper(II) oxide to water, then add excess aqueous sodium carbonate. Filter off the precipitate.

B Add copper(II) oxide to dilute sulfuric acid, then add excess aqueous sodium carbonate. Filter off the precipitate.

C Add copper to dilute hydrochloric acid, then add aqueous sodium carbonate. Filter off the precipitate.

D Add copper(II) oxide to excess aqueous sodium carbonate. Filter off the precipitate.

18 Which statements about the trends across a period of the Periodic Table are correct?

1 Aluminium is more metallic than sodium.

2 Beryllium is more metallic than carbon.

3 Boron is more metallic than lithium.

4 Magnesium is more metallic than silicon.

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

19 Some information about elements in Group II of the Periodic Table is shown.

element	time taken to make 10 cm^3 of hydrogen gas when 1 g of metal is added to cold water	density in g/cm^3	melting point / °C
beryllium	no reaction	1.85	1280
magnesium	>300 seconds	1.74	650
calcium	60 seconds	1.54	850
strontium	30 seconds	2.62	768
barium	10 seconds	3.51	714

Which row shows the correct trends in reactivity, density and melting point of the elements going down Group II of the Periodic Table?

	reactivity	density	melting point
A	decreases down group	increases down group	decreases down group
B	decreases down group	decreases down group	no clear trend
C	increases down group	no clear trend	increases down group
D	increases down group	no clear trend	no clear trend

20 A new element oxfordium, Ox, was discovered with the following properties.

solubility	electrical conduction	formula of element	bonding in a molecule of Ox_2
insoluble in water	does not conduct	Ox_2	Ox≡Ox

In which group of the Periodic Table should the new element be placed?

A Group III

B Group V

C Group VII

D Group VIII

21 Which row describes a similarity and a difference between chlorine and bromine?

	similarity	difference
A	both are gases at room temperature and pressure	chlorine and bromine have different colours
B	both exist as diatomic molecules	chlorine is more dense than bromine
C	both have atoms with seven outer-shell electrons	only bromine will react with aqueous sodium chloride
D	both react with aqueous potassium iodide	chlorine is more reactive than bromine

22 Which statement describes transition elements?

A They have high densities and high melting points.

B They have high densities and low melting points.

C They have low densities and high melting points.

D They have low densities and low melting points.

23 Which gas is made when powdered zinc is added to dilute hydrochloric acid?

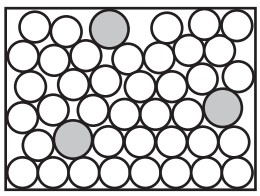
A carbon dioxide

B chlorine

C hydrogen

D oxygen

24 The diagram represents the structure of a solid.



Which solids does the diagram represent?

	brass	graphite	sodium chloride
A	✓	✓	✗
B	✓	✗	✗
C	✗	✓	✓
D	✗	✗	✓

25 Steel is an alloy of iron.

Which statement explains why steel is stronger than iron?

A Steel contains carbon which is a very hard substance.

B The carbon atoms in steel bond together very strongly.

C The carbon atoms in steel make the iron atoms bond together very strongly.

D The carbon atoms prevent layers of iron atoms from sliding over each other.

26 Three students, X, Y and Z, are told that solid P reacts with dilute acids and also conducts electricity.

The table shows the students' suggestions about the identity of P.

X	Y	Z
copper	iron	graphite

Which students are correct?

A X, Y and Z **B** X only **C** Y only **D** Z only

27 Which statement explains why aluminium appears to be unreactive?

A It is coated in an oxide layer.

B It has a low density.

C It is low in the reactivity series.

D It is solid at room temperature.

28 During the electrolysis of aluminium oxide, the mass of the carbon anode changes.

Which row describes the change and gives a reason for this change?

	mass change of the anode	reason
A	decreases	carbon reacts to form carbon dioxide
B	decreases	carbon dissolves in molten cryolite
C	increases	electrodes become coated with cryolite
D	increases	electrodes become coated with aluminium

29 Several processes are used to treat domestic water.

Which row identifies a reason for the given process?

	process	reason
A	chlorination	removes impurities
B	filtration	removes insoluble solids
C	sedimentation	removes soluble solids
D	use of carbon	kills bacteria

30 What is the equation for photosynthesis?

A $CO_2 + 3H_2 \rightarrow CH_3OH + H_2O$

B $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$

C $C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$

D $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$

31 Which statement describes how the C–H bonds in methane gas in the atmosphere contribute to global warming?

A They absorb thermal energy from the Sun and emit some of this energy into space.

B They absorb thermal energy from the Sun and emit all of this energy towards the Earth.

C They absorb thermal energy from the Earth and emit all of this energy towards the Earth.

D They absorb thermal energy from the Earth and emit some of this energy towards the Earth.

32 The structural formulae of two hydrocarbons are shown.

$CH_3CH_2CH_2CH_3$ $CH_3CH(CH_3)CH_3$

Which statement about the hydrocarbons is correct?

A They are both alkenes.

B They decolourise aqueous bromine.

C They are structural isomers.

D They undergo addition reactions.

33 The structural formula of compound Q is given.

$$CH_3CH_2CH_2COOCH_2CH_2CH_3$$

What is compound Q?

A butyl butanoate

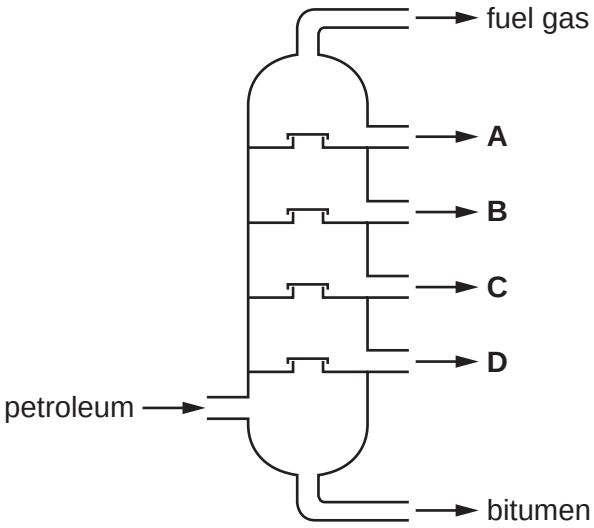
B butyl propanoate

C propyl butanoate

D propyl propanoate

34 The fractional distillation of petroleum is shown.

Which fraction contains hydrocarbons with the longest chain length?



35 Which equation represents the cracking of an alkane?

A $3C_2H_4 \rightarrow C_6H_{12}$

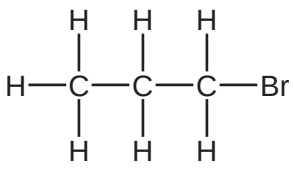
B $C_6H_{12} + H_2 \rightarrow C_6H_{14}$

C $C_6H_{14} \rightarrow 6C + 7H_2$

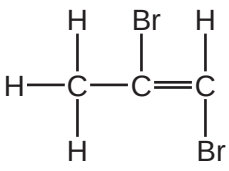
D $C_6H_{14} \rightarrow C_2H_4 + C_4H_{10}$

36 What is the structure of the product of the reaction of propene with bromine?

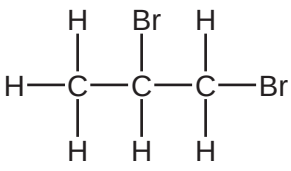
A



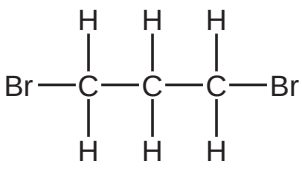
B



C



D



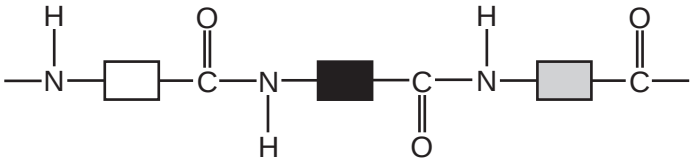
37 In reaction R, 2000 molecules of $CH_2=CH_2$ react to form a single molecule X only.

$$2000\ CH_2=CH_2 \rightarrow X$$

Which terms describe reaction R, $CH_2=CH_2$ and X?

	reaction R	$CH_2=CH_2$	X
A	addition	monomer	polymer
B	addition	polymer	monomer
C	substitution	monomer	polymer
D	substitution	polymer	monomer

38 Part of the structure of a polymer is shown.



Which statements about the polymer are correct?

1 The polymer is nylon.

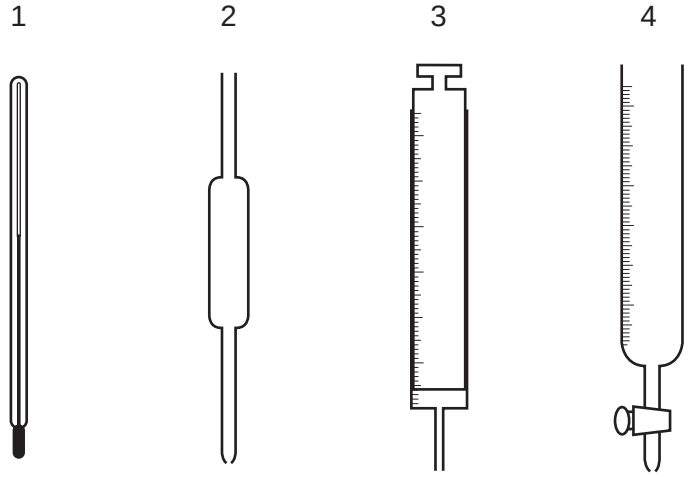
2 The polymer is formed by condensation polymerisation.

3 There are ester linkages between the monomers.

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

39 The concentration of acids and alkalis can be determined by titration.

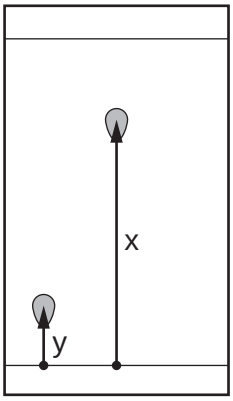
Which pieces of equipment are needed to perform a titration?



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

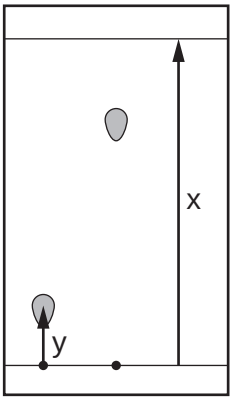
40 Which chromatogram shows how the R_f value of a substance is calculated?

A



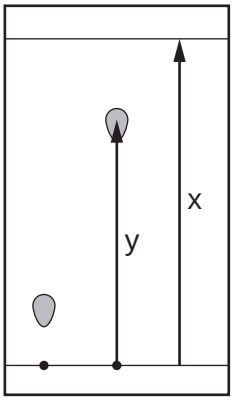
$R_f = \frac{y}{x}$

B



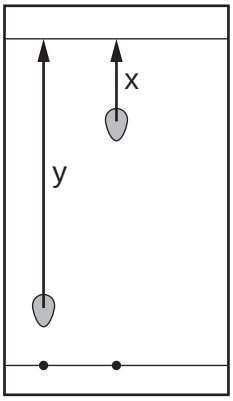
$R_f = \frac{y}{x}$

C



$R_f = \frac{x}{y}$

D



$R_f = \frac{x}{y}$

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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.).