Cambridge Assessment International Education

Cambridge IGCSE™ (9–1)

CHEMISTRY **0971/22**

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

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 Four physical changes of ethanol are listed.

1 condensation

2 evaporation

3 freezing

4 boiling

In which changes do the particles move further apart?

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

2 An atom of element X contains:

- 5 protons
- 6 neutrons
- 5 electrons.

Which statements about element X are correct?

1 X has an atomic number of 6.

2 X has a nucleon number of 11.

3 X is in Group II of the Periodic Table.

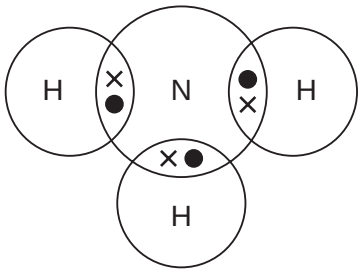
4 X is in the second period of the Periodic Table.

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

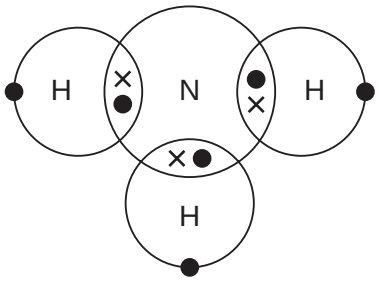
3 Ammonia, NH_3, is a covalent molecule.

Which diagram shows the outer-shell electron arrangement in a molecule of ammonia?

A



B



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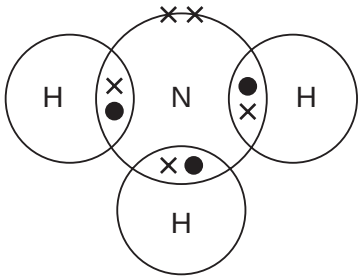

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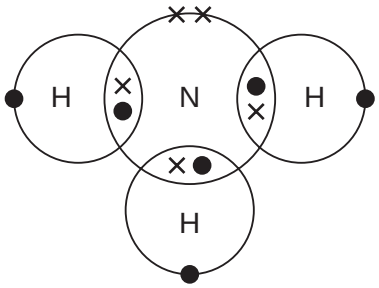


4 Which structure does silicon(IV) oxide most closely resemble?

A carbon dioxide

B diamond

C graphite

D sodium chloride

5 Substance P conducts electricity when solid.

Which particles move in solid P so that it can conduct electricity?

1 anions

2 cations

3 electrons

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

6 Which equation represents a chemical change?

A $BaCl_2(s) \rightarrow BaCl_2(l)$

B $Ca^{2+}(aq) + SO_4^{2-}(aq) \rightarrow CaSO_4(s)$

C $KCl(s) + H_2O(l) \rightarrow K^+(aq) + Cl^-(aq)$

D $Na^+(aq) + NO_3^-(aq) \rightarrow NaNO_3(aq)$

7 Which sample contains the largest number of molecules?

A 16 g of methane, $CH_4(g)$

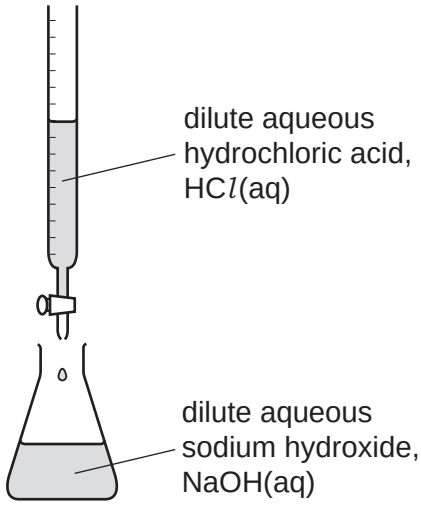
B 16 g of oxygen, $O_2(g)$

C 16 g of phosphorus, $P_4(s)$

D 16 dm^3 of methane at r.t.p., $CH_4(g)$

8 The concentration of a sample of dilute aqueous sodium hydroxide is found by titration.

The apparatus used is shown.



Which information is needed to calculate the concentration of the dilute aqueous sodium hydroxide in mol / dm^3?

	concentration of HCl	volume of HCl used	molar mass of HCl	volume of NaOH used	molar mass of NaOH
A	✓	✓	✓	✓	✓
B	✓	✓	✗	✓	✗
C	✗	✓	✓	✓	✗
D	✓	✗	✗	✗	✓

key

✓ = needed

✗ = not needed

9 In experiment 1, aqueous copper(II) sulfate is electrolysed using graphite electrodes.

In experiment 2, aqueous copper(II) sulfate is electrolysed using copper electrodes.

Which statement identifies a half-equation for a reaction at one of the electrodes?

A In experiment 1, the half-equation for the anode reaction is $4OH^- \rightarrow 2H_2O + O_2 + 4e^-$.

B In experiment 1, the half-equation for the cathode reaction is $2H^+ + 2e^- \rightarrow H_2$.

C In experiment 2, the half-equation for the anode reaction is $Cu^{2+} + 2e^- \rightarrow Cu$.

D In experiment 2, the half-equation for the cathode reaction is $4OH^- \rightarrow 2H_2O + O_2 + 4e^-$.

10 Which substance is **not** produced during the electrolysis of concentrated aqueous sodium chloride?

A chlorine

B hydrogen

C sodium

D sodium hydroxide

11 Methane burns in excess oxygen.

The equation is shown.

$$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$$

Bond energies are shown.

bond	bond energy in kJ / mol
C=O	805
C–H	410
O=O	496
O–H	460

What is the energy change for the reaction?

A $(4 \times 410 + 2 \times 496) - (2 \times 805 + 4 \times 460)$

B $(2 \times 805 + 4 \times 460) - (4 \times 410 + 2 \times 496)$

C $(410 + 2 \times 496) - (805 + 2 \times 460)$

D $(410 + 496) - (805 + 460)$

12 Which change increases the rate of reaction by decreasing the activation energy, E_a?

A addition of a catalyst

B decrease in size of solid reactants

C increase in concentration of solutions

D increase in temperature

13 In the Contact process, sulfur dioxide is reacted with oxygen to form sulfur trioxide.

Which conditions are used in this reaction?

	temperature / °C	pressure / kPa	catalyst
A	300	200	iron
B	300	20 000	vanadium(V) oxide
C	450	200	vanadium(V) oxide
D	450	20 000	iron

14 Which reaction is reversible?

A an iron nail rusting when left in moist air

B limestone reacting with an acid to form carbon dioxide gas

C magnesium burning in air to produce a white ash

D white anhydrous copper(II) sulfate turning blue when water is added

15 The equation for the reaction of sulfur dioxide with acidified potassium dichromate(VI) is shown.

$$3SO_2 + Cr_2O_7^{2-} + 2H^+ \rightarrow 3SO_4^{2-} + 2Cr^{3+} + H_2O$$

What is oxidised and what is the oxidising agent?

	oxidised	oxidising agent
A	SO_2	$Cr_2O_7^{2-}$
B	SO_2	H^+
C	$Cr_2O_7^{2-}$	H^+
D	$Cr_2O_7^{2-}$	$Cr_2O_7^{2-}$

16 What is the definition of a strong acid?

A a proton acceptor that is completely dissociated in aqueous solution

B a proton acceptor that is partially dissociated in aqueous solution

C a proton donor that is completely dissociated in aqueous solution

D a proton donor that is partially dissociated in aqueous solution

17 Which statement about amphoteric oxides is correct?

A They are made by combining an acidic oxide with a basic oxide.

B They react with water to give a solution of pH 7.

C They react with both acids and bases.

D They do not react with acids or bases.

18 Copper(II) carbonate is formed when aqueous sodium carbonate is added to aqueous copper(II) nitrate.

The ionic equation for the reaction is shown.

$$CO_3^{2-}(aq) + Cu^{2+}(aq) \rightarrow CuCO_3(s)$$

How is pure copper(II) carbonate obtained from the reaction mixture?

A evaporate → filter → dry

B evaporate → wash → crystallise

C filter → evaporate → crystallise

D filter → wash → dry

19 Q and R are elements in the same period of the Periodic Table.

Q has 7 electrons in its outer shell and R has 2 electrons in its outer shell.

Which statement about Q and R is correct?

A Q is a metal and R is a non-metal.

B Q and R have different numbers of electron shells.

C R is found to the right of Q in the Periodic Table.

D The proton number of R is less than the proton number of Q.

20 Lead(II) sulfate is an insoluble salt.

Which reaction produces a mixture from which lead(II) sulfate is obtained by filtration?

A adding solid lead(II) carbonate to dilute sulfuric acid

B adding solid lead(II) hydroxide to dilute sulfuric acid

C adding metallic lead to dilute sulfuric acid

D adding aqueous lead(II) nitrate to dilute sulfuric acid

21 Which statement about alkali metals is correct?

A Lithium is more dense than sodium.

B Sodium is more reactive than potassium.

C Sodium has a higher melting point than potassium.

D They are in Group II of the Periodic Table.

22 Which row describes the properties of a transition element?

	melting point	density	forms coloured compounds
A	high	low	no
B	high	high	yes
C	low	low	no
D	low	low	yes

23 Which row identifies the properties of zinc?

	thermal conductivity	reacts with dilute acid
A	good	yes
B	good	no
C	poor	yes
D	poor	no

24 Uses of metals depend on their properties.

Which property is necessary for the use given?

	use of the metal	property of the metal
A	car bodies	ductile
B	cutlery	conducts heat
C	food containers	resists corrosion
D	overhead electrical cables	high density

25 Which compounds **both** contribute to acid rain?

A carbon monoxide and carbon dioxide

B carbon monoxide and oxides of nitrogen

C oxides of nitrogen and sulfur dioxide

D sulfur dioxide and carbon dioxide

26 P, Q, R and S are metals.

P reacts with dilute hydrochloric acid, forming hydrogen.

Q reacts violently with water.

R reacts with water to give hydrogen.

S is formed by heating its oxide with carbon.

Which row identifies the metals?

	P	Q	R	S
A	copper	sodium	potassium	iron
B	zinc	magnesium	calcium	iron
C	zinc	sodium	calcium	magnesium
D	iron	potassium	sodium	zinc

27 Which compound is formed when iron rusts?

A anhydrous iron(II) oxide

B anhydrous iron(III) oxide

C hydrated iron(III) hydroxide

D hydrated iron(III) oxide

28 Why is cryolite used in the extraction of aluminium by electrolysis?

A It dissolves the aluminium oxide.

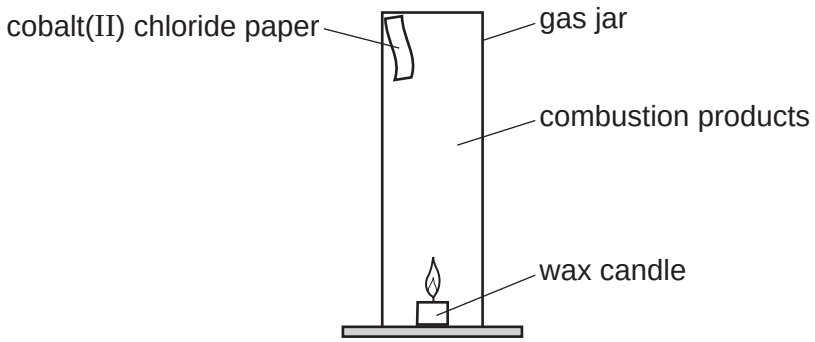
B It protects the anodes from corrosion.

C It changes bauxite to aluminium oxide.

D It decreases the melting point of the aluminium.

29 A wax candle is made from a mixture of hydrocarbons.

The candle is lit and placed in a gas jar along with a strip of cobalt(II) chloride test paper as shown.



After a short time, the oxygen in the jar is used up and the candle flame goes out.

Which substance does the cobalt(II) chloride paper identify?

A carbon dioxide

B carbon monoxide

C sulfur dioxide

D water

30 The hydrocarbon C_4H_8 has two structural isomers, but-1-ene and but-2-ene.

Which statement is correct?

A But-2-ene has the structural formula $CH_3CH{=}CHCH_3$ and the same general formula as butane.

B But-2-ene has the structural formula $CH_3CH{=}CHCH_3$ and the same empirical formula as ethene.

C But-1-ene has the structural formula $CH_3CH_2CH{=}CH_2$ and the same general formula as butane.

D But-1-ene has the structural formula $CH_3CHCH_2{=}CH$ and the same empirical formula as ethene.

31 Which compound rapidly decolourises aqueous bromine?

A propane

B propanoic acid

C propanol

D propene

32 What are the products of the addition reactions of ethene with bromine and hydrogen?

	bromine	hydrogen
A	CH_2BrCH_2Br	CH_3CH_3
B	CH_2BrCH_2Br	CH_2CH_2
C	CH_3CH_2Br	CH_3CH_3
D	CH_3CH_2Br	CH_2CH_2

33 Ethanol is manufactured by fermentation and the catalytic addition of steam to ethene.

Which row describes an advantage of both methods?

	from sugar by fermentation	from ethene and steam
A	ethanol needs to be purified	the process is continuous
B	it is a batch process	ethene comes from petroleum
C	the process is slow	the process is rapid
D	renewable resources are used	the ethanol produced is pure

34 Methanoic acid and propan-1-ol react to form an ester.

What is the structural formula of the ester?

A $HCOOCH_2CH_2CH_3$

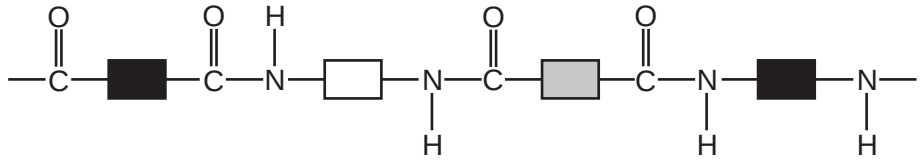
B $CH_3CH_2COOCH_3$

C $CH_3COOCH_2CH_3$

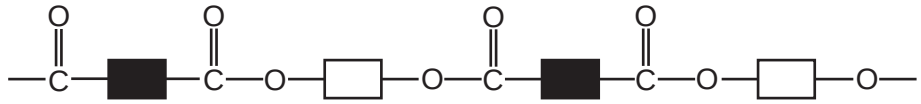
D $CH_3CH_2CH_2COOH$

35 What is the correct structure of PET?

A



B



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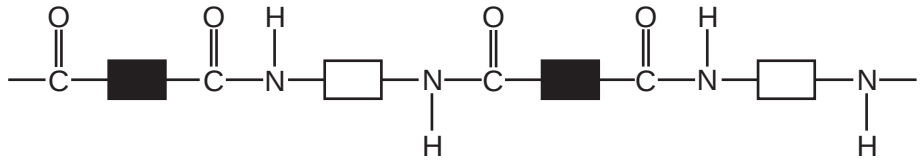

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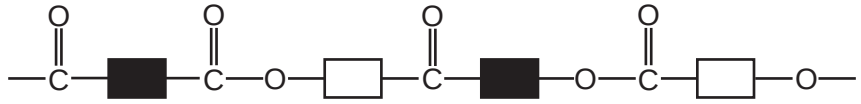


36 Alkanes undergo substitution reactions in the presence of UV light.

Which equation represents a substitution reaction of ethane?

A $C_2H_6 + Cl_2 \rightarrow C_2H_4 + 2HCl$

B $C_2H_6 + Cl_2 \rightarrow C_2H_5Cl + HCl$

C $C_2H_6 + Cl_2 \rightarrow C_2H_4Cl_2 + H_2$

D $C_2H_6 + HCl \rightarrow C_2H_5Cl + H_2$

37 Methane reacts with chlorine in substitution reactions.

How many different products, containing a single carbon atom, can be made during the reactions?

A 2 **B** 3 **C** 4 **D** 5

38 Rock salt is a mixture of salt and sand.

The method used to separate the sand from the salt is listed.

step 1 Crush the rock salt, add to warm water and stir.

step 2 Pour the mixture through a filter paper held in a funnel.

step 3 Evaporate the water to crystallise the salt.

Which statement about the method is correct?

A The filtrate in step 2 is pure water.

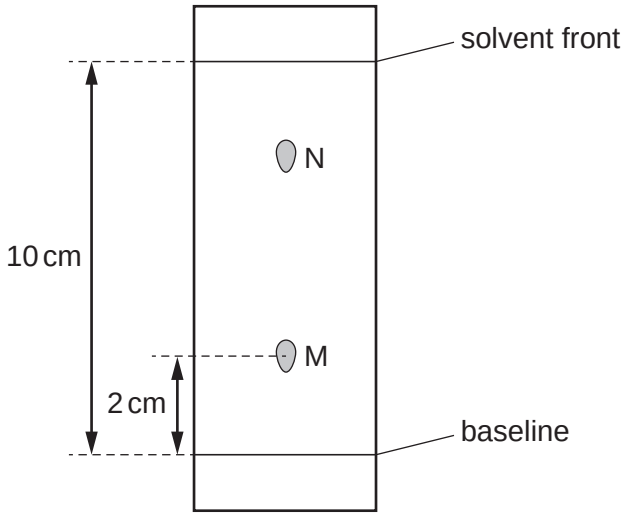
B The residue in step 2 is pure crystals of salt.

C The solute is salt.

D The solvent is a mixture of salt and water.

39 Two compounds, M and N, are dissolved in water and separated by chromatography.

The results are shown.



What is the R_f value of M and which compound is most soluble in water?

	R_f value of M	most soluble compound
A	0.2	M
B	0.2	N
C	5.0	M
D	5.0	N

40 When acid is added to salt X, a gas is produced which turns limewater milky.

When sodium hydroxide is added to salt X, a gas is produced which turns litmus paper blue.

What is X?

A $CaCO_3$ **B** $(NH_4)_2CO_3$ **C** NH_4NO_3 **D** $ZnCO_3$

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.).