



CAMBRIDGE ASSESSMENT INTERNATIONAL EDUCATION

Cambridge IGCSE(9–1) · May/June 2023

SUBJECT	CLASS	TIME ALLOWED	MAXIMUM MARKS
Chemistry 0971/22 · Paper 2 Multiple Choice (extended)	IGCSE	45 minutes	40

Name: _____ Date: _____

You will need:

- Multiple choice answer sheet
- Soft clean eraser
- Soft pencil (type B or HB is recommended)

You must answer on the multiple choice answer sheet.

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.

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?

[1]

- 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]

- 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

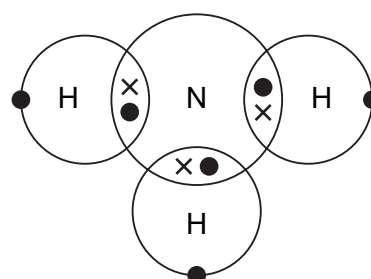
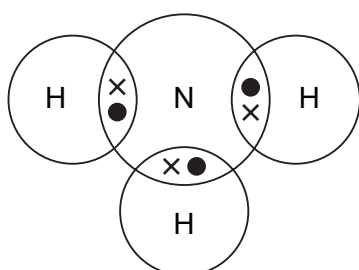
3 Ammonia, NH_3 , is a covalent molecule.

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

[1]

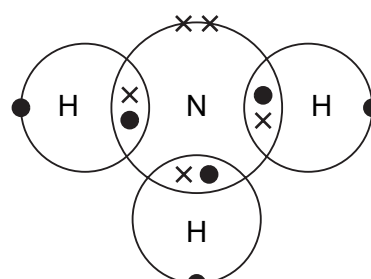
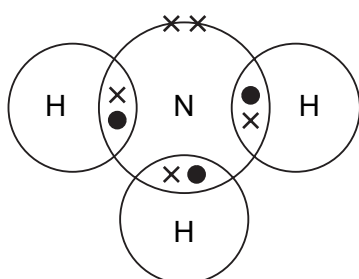
A

B



C

D



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

[1]

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]

- 1 anions
- 2 cations
- 3 electrons

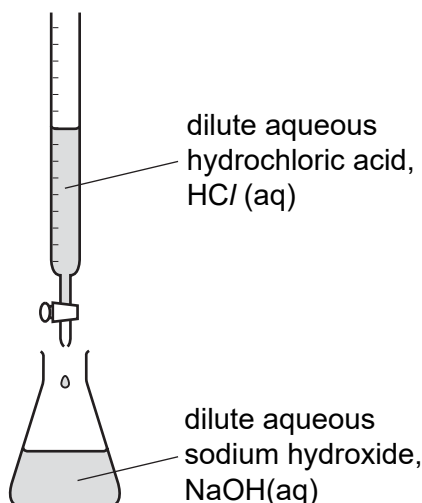
A 1 and 2

B 1 only

C 2 and 3

D 3 only

- 6 Which equation represents a chemical change? [1]
- A $\text{BaCl}_2(\text{s}) \rightarrow \text{BaCl}_2(\text{l})$
- B $\text{Ca}^{2+}(\text{aq}) + \text{SO}_4^{2-}(\text{aq}) \rightarrow \text{CaSO}_4(\text{s})$
- C $\text{KCl}(\text{s}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{K}^+(\text{aq}) + \text{Cl}^-(\text{aq})$
- D $\text{Na}^+(\text{aq}) + \text{NO}_3^-(\text{aq}) \rightarrow \text{NaNO}_3(\text{aq})$
- 7 Which sample contains the largest number of molecules? [1]
- A 16 g of methane, $\text{CH}_4(\text{g})$
- B 16 g of oxygen, $\text{O}_2(\text{g})$
- C 16 g of phosphorus, $\text{P}_4(\text{s})$
- D 16 dm^3 of methane at r.t.p., $\text{CH}_4(\text{g})$
- 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 ? [1]

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

key

✓ = needed

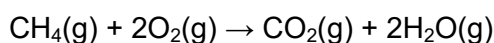
X = not needed



- 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? [1]
- A In experiment 1, the half-equation for the anode reaction is $4\text{OH}^- \rightarrow 2\text{H}_2\text{O} + \text{O}_2 + 4\text{e}^-$.
B In experiment 1, the half-equation for the cathode reaction is $2\text{H}^+ + 2\text{e}^- \rightarrow \text{H}_2$.
C In experiment 2, the half-equation for the anode reaction is $\text{Cu}^{2+} + 2\text{e}^- \rightarrow \text{Cu}$.
D In experiment 2, the half-equation for the cathode reaction is $4\text{OH}^- \rightarrow 2\text{H}_2\text{O} + \text{O}_2 + 4\text{e}^-$.
- 10 Which substance is **not** produced during the electrolysis of concentrated aqueous sodium chloride? [1]
- A chlorine
B hydrogen
C sodium
D sodium hydroxide

- 11 Methane burns in excess oxygen.

The equation is shown.



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? [1]

- 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 ? [1]
- 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?

[1]

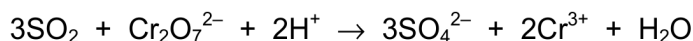
	temperature / °C	pressure / kPa	catalyst
A	300	200	iron
B	300	20 000	vanadium(V) oxide
C	450	200	vanadium(V) oxide
D	450	20 000	iron

- 14 Which reaction is reversible?

[1]

- 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.



What is oxidised and what is the oxidising agent?

[1]

	oxidised	oxidising agent
A	SO_2	$\text{Cr}_2\text{O}_7^{2-}$
B	SO_2	H^+
C	$\text{Cr}_2\text{O}_7^{2-}$	H^+
D	$\text{Cr}_2\text{O}_7^{2-}$	$\text{Cr}_2\text{O}_7^{2-}$

- 16 What is the definition of a strong acid?

[1]

- 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?

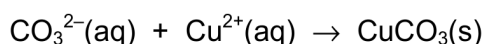
[1]

- 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.



How is pure copper(II) carbonate obtained from the reaction mixture? [1]

- 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? [1]

- 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? [1]

- 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? [1]

- 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? [1]

	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?

[1]

	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?

[1]

	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?

[1]

- 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?

[1]

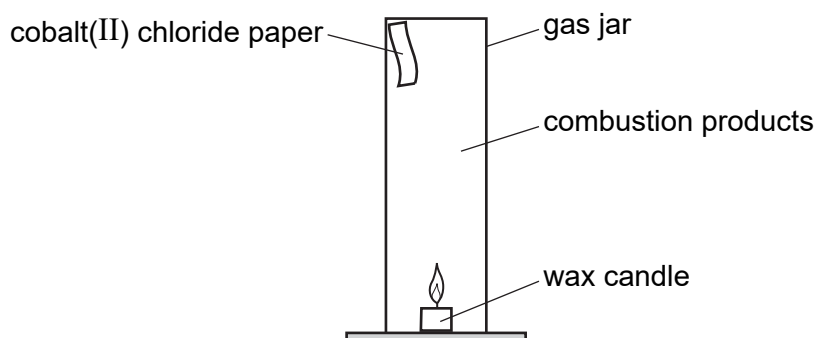
	P	Q	R	S
A	copper	sodium	potassium	iron
B	zinc	magnesium	calcium	iron
C	zinc	sodium	calcium	magnesium
D	iron	potassium	sodium	zinc

- 27 Which compound is formed when iron rusts? [1]
- 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? [1]
- 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? [1]

- 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? [1]
- 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? [1]
- A propane
B propanoic acid
C propanol
D propene

- 32 What are the products of the addition reactions of ethene with bromine and hydrogen? [1]

	bromine	hydrogen
A	$\text{CH}_2\text{BrCH}_2\text{Br}$	CH_3CH_3
B	$\text{CH}_2\text{BrCH}_2\text{Br}$	CH_2CH_2
C	$\text{CH}_3\text{CH}_2\text{Br}$	CH_3CH_3
D	$\text{CH}_3\text{CH}_2\text{Br}$	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? [1]

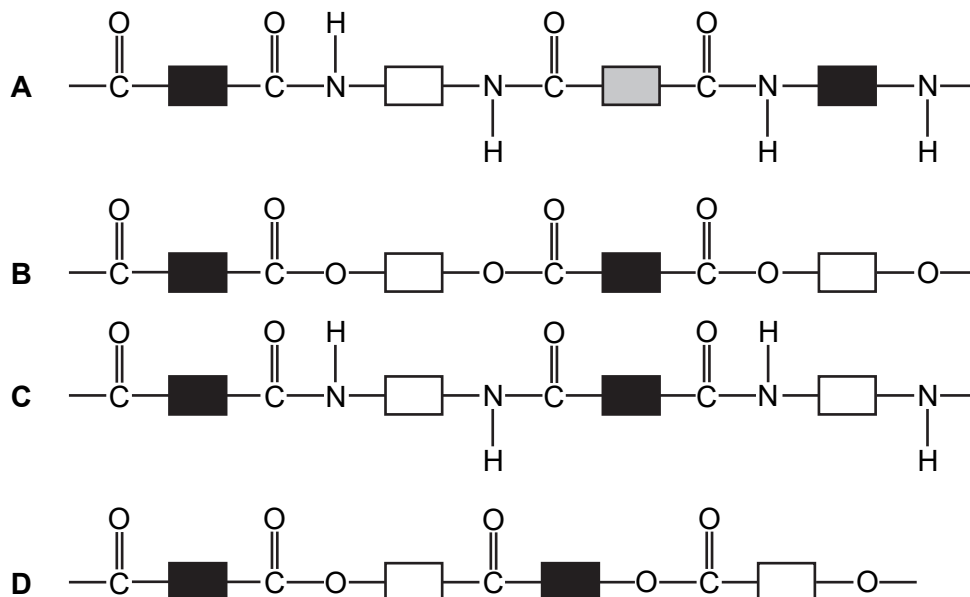
	from sugar by fermentation	from ethene and steam
A	ethanol needs to be purified	the process is continuous
B	it is a batch process	ethene comes from petroleum
C	the process is slow	the process is rapid
D	renewable resources are used	the ethanol produced is pure

- 34 Methanoic acid and propan-1-ol react to form an ester. What is the structural formula of the ester? [1]
- A $\text{HCOOCH}_2\text{CH}_2\text{CH}_3$
B $\text{CH}_3\text{CH}_2\text{COOCH}_3$
C $\text{CH}_3\text{COOCH}_2\text{CH}_3$
D $\text{CH}_3\text{CH}_2\text{CH}_2\text{COOH}$



35 What is the correct structure of PET?

[1]



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

Which equation represents a substitution reaction of ethane?

[1]

- A $\text{C}_2\text{H}_6 + \text{Cl}_2 \rightarrow \text{C}_2\text{H}_4 + 2\text{HCl}$
B $\text{C}_2\text{H}_6 + \text{Cl}_2 \rightarrow \text{C}_2\text{H}_5\text{Cl} + \text{HCl}$
C $\text{C}_2\text{H}_6 + \text{Cl}_2 \rightarrow \text{C}_2\text{H}_4\text{Cl}_2 + \text{H}_2$
D $\text{C}_2\text{H}_6 + \text{HCl} \rightarrow \text{C}_2\text{H}_5\text{Cl} + \text{H}_2$

37 Methane reacts with chlorine in substitution reactions.

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

[1]

- 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.

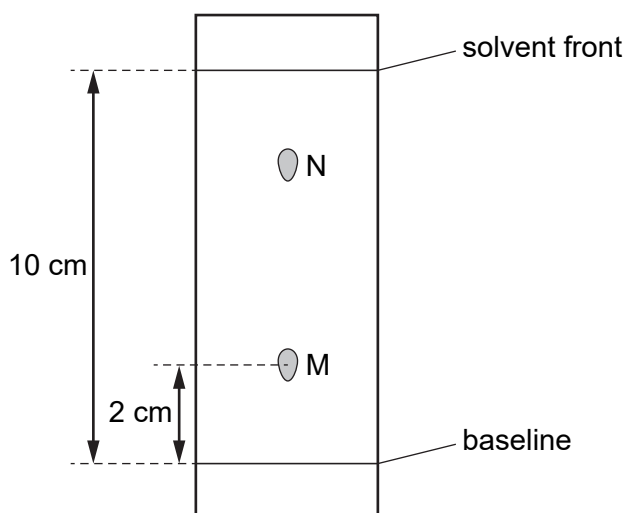
Which statement about the method is correct?

[1]

- 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?

[1]

	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?

[1]

A CaCO_3 **B** $(\text{NH}_4)_2\text{CO}_3$ **C** NH_4NO_3 **D** ZnCO_3

The Periodic Table of Elements

[illegible]

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	euroium	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.).



Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (UCLES) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest possible opportunity.

To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced online in the Cambridge Assessment International Education Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download at www.cambridgeinternational.org after the live examination series.

Cambridge Assessment International Education is part of Cambridge Assessment. Cambridge Assessment is the brand name of the University of Cambridge Local Examinations Syndicate (UCLES), which is a department of the University of Cambridge.