



Cambridge Assessment International Education

Cambridge International General Certificate of Secondary Education (9–1)

CHEMISTRY 0971/21

Paper 2 Multiple Choice (Extended) May/June 2019

45 minutes

Additional Materials: Multiple Choice Answer Sheet

Soft clean eraser

Soft pencil (type B or HB is recommended)

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

Do not use staples, paper clips, glue or correction fluid.

Write your name, centre number and candidate number on the Answer Sheet in the spaces provided unless this has been done for you.

DO **NOT** WRITE IN ANY BARCODES.

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 separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

Any rough working should be done in this booklet.

A copy of the Periodic Table is printed on page 16.

Electronic calculators may be used.

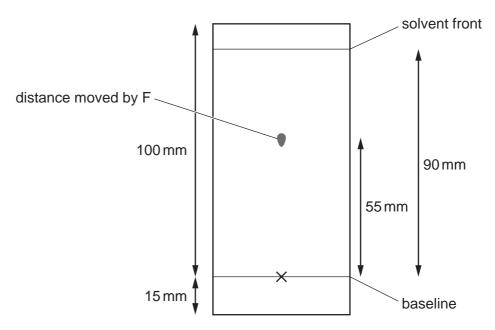


- **1** Which statement explains why ammonia gas, NH₃, diffuses at a faster rate than hydrogen chloride gas, HC*l*?
 - A Ammonia expands to occupy all of the space available.
 - **B** Ammonia has a smaller relative molecular mass than hydrogen chloride.
 - **C** Ammonia is an alkali and hydrogen chloride is an acid.
 - **D** Ammonia molecules diffuse in all directions at the same time.
- 2 2.00 g of powdered calcium carbonate is added to 50.0 cm³ of hydrochloric acid.

Which apparatus is used to measure the calcium carbonate and the hydrochloric acid?

	calcium carbonate	hydrochloric acid
Α	balance	burette
В	balance	thermometer
С	pipette	burette
D	pipette	thermometer

3 The measurements from a chromatography experiment using substance F are shown. The diagram is not drawn to scale.



What is the R_f value of F?

A 0.55

B 0.61

C 0.90

1.64

- 4 Which statement about an atom of fluorine, ¹⁹₉F, is correct?
 - A It contains more protons than neutrons.
 - **B** It contains a total of 28 protons, neutrons and electrons.
 - **C** Its isotopes contain different numbers of protons.
 - **D** Its nucleus contains 9 neutrons.
- 5 Which row describes the formation of single covalent bonds in methane?

Α	atoms share a pair of electrons	both atoms gain a noble gas electronic structure
В	atoms share a pair of electrons	both atoms have the same number of electrons in their outer shell
С	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

- 6 Which statement describes the structure of an ionic compound?
 - **A** It is a giant lattice of oppositely charged ions.
 - **B** It is a giant lattice of positive ions in a 'sea' of electrons.
 - **C** It is a giant molecule of oppositely charged ions.
 - **D** It is a simple molecule of oppositely charged ions.
- **7** Propane burns in oxygen.

$$C_3H_8 + xO_2 \rightarrow 3CO_2 + yH_2O$$

Which values of x and y balance the equation?

	Х	У
Α	5	4
В	7	4
С	10	8
D	13	8

4

8 A tablet contains 0.080 g of ascorbic acid ($M_r = 176$).

What is the concentration of ascorbic acid when one tablet is dissolved in 200 cm³ of water?

- **A** $9.1 \times 10^{-5} \,\text{mol/dm}^3$
- **B** $4.5 \times 10^{-4} \, \text{mol/dm}^3$
- **C** $9.1 \times 10^{-2} \,\text{mol/dm}^3$
- **D** $2.3 \times 10^{-3} \,\text{mol/dm}^3$
- **9** Which statement about the electrolysis of copper(II) sulfate solution using carbon electrodes is correct?
 - A A colourless gas is produced at the anode.
 - **B** A colourless gas is produced at the cathode.
 - **C** The colour of the electrolyte remains the same.
 - **D** The mass of both electrodes remains constant.
- **10** Aluminium metal is extracted from aluminium oxide by electrolysis.

Which ionic half-equation describes a reaction that occurs at the named electrode?

	ionic half-equation	electrode
Α	$2O^{2-} \rightarrow O_2 + 2e^-$	anode
В	$Al^{3+} + 3e^{-} \rightarrow Al$	anode
С	$20^{2-} \rightarrow O_2 + 4e^-$	cathode
D	$Al^{3+} + 3e^{-} \rightarrow Al$	cathode

- 11 Which statement about the hydrogen fuel cell is **not** correct?
 - **A** Chemical energy is converted into electrical energy.
 - B Hydrogen is oxidised.
 - **C** The reaction that takes place is endothermic.
 - **D** Water is the only product.

12 Nitrogen reacts with hydrogen to produce ammonia.

$$N_2 + 3H_2 \rightarrow 2NH_3$$

The reaction is exothermic. The bond energies are shown in the table.

bond	bond energy in kJ/mol
N≡N	945
H–H	436
N–H	390

What is the energy change for this reaction?

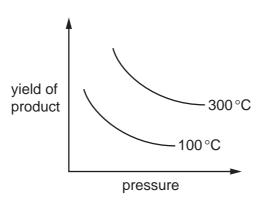
- **A** -1473 kJ/mol
- B -87 kJ/mol
- C 87 kJ/mol
- **D** 1473 kJ/mol
- **13** Which change in reaction conditions increases both the collision rate and the proportion of molecules with sufficient energy to react?
 - **A** addition of a catalyst
 - **B** increasing the concentration of a reactant
 - **C** increasing the surface area of a reactant
 - **D** increasing the temperature of the reaction
- 14 When blue-green crystals of nickel(II) sulfate are heated, water is produced and a yellow solid remains. When water is added to the yellow solid, the blue-green colour returns.

Which process describes these changes?

- A combustion
- **B** corrosion
- **C** neutralisation
- D reversible reaction

15 The graph shows how the yield of product in a reversible reaction changes as the temperature and pressure are changed.

All reactants and products are gases.



Which row is correct for this reversible reaction?

	side of reaction with fewer moles	forward reaction
Α	reactant	exothermic
В	reactant	endothermic
С	product	endothermic
D	product	exothermic

16 Which changes represent oxidation?

$$1 \quad 2I^- \rightarrow I_2 + 2e^-$$

2
$$Cr(VI) \rightarrow Cr(III)$$

3
$$Fe(II) \rightarrow Fe(III)$$

A 1 and 2

B 1 and 3

C 1 only

D 2 only

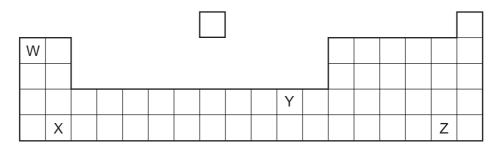
17 Nitrogen(I) oxide, N_2O , nitrogen(II) oxide, NO, and carbon monoxide, CO, are all non-metal oxides.

They do not react with acids or bases.

Which statement is correct?

- A They are acidic oxides.
- **B** They are amphoteric oxides.
- C They are basic oxides.
- **D** They are neutral oxides.

18 The positions of elements W, X, Y and Z in the Periodic Table are shown.



Which elements form basic oxides?

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

19 Ethanoic acid is a weak acid.

Hydrochloric acid is a strong acid.

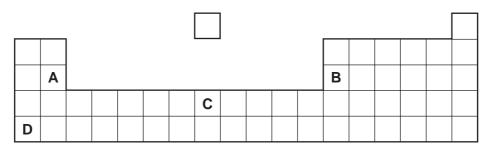
Which statements are correct?

- Ethanoic acid molecules are partially dissociated into ions.
- 1.0 mol/dm³ ethanoic acid has a higher pH than 1.0 mol/dm³ hydrochloric acid. 2
- Ethanoic acid is always more dilute than hydrochloric acid. 3
- Ethanoic acid is a proton acceptor.
- **A** 1 and 2
- 1 and 3
- **C** 2 and 4
- **D** 3 and 4

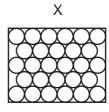
20 The properties of an element are shown.

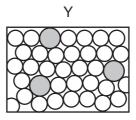
electrical conductivity	density	reaction with water
high	low	reacts violently with cold water

Which element has these properties?



- 21 Which statement about elements in Group I and Group VII of the Periodic Table is correct?
 - A Bromine reacts with potassium chloride to produce chlorine.
 - **B** lodine is a monoatomic non-metal.
 - **C** Lithium has a higher melting point than potassium.
 - **D** Sodium is more reactive with water than potassium.
- 22 Which statement about elements in Group VIII of the Periodic Table is correct?
 - A They all have a full outer shell of electrons.
 - **B** They all react with Group I elements to form ionic compounds.
 - **C** They are all diatomic molecules.
 - **D** They are all liquids at room temperature.
- 23 The diagrams show the structure of two substances used to make electrical conductors.





Which statement correctly describes X and Y?

- **A** X is a pure metal and Y is a compound.
- **B** X is a pure metal and Y is an alloy.
- **C** X is a solid and Y is a liquid.
- **D** X is harder and stronger than Y.

24 Three metal compounds, P, Q and R, are heated using a Bunsen burner.

The results are shown.

- P colourless gas produced, which relights a glowing splint
- Q colourless gas produced, which turns limewater milky
- R no reaction

Which row shows the identity of P, Q and R?

	Р	Q	R
Α	magnesium carbonate	potassium carbonate	potassium nitrate
В	magnesium carbonate	potassium nitrate	potassium carbonate
С	potassium nitrate	magnesium carbonate	potassium carbonate
D	potassium nitrate	potassium carbonate	magnesium carbonate

25 Zinc is extracted from its ore, zinc blende, using two chemical reactions.

1
$$2ZnS + 3O_2 \rightarrow 2ZnO + 2SO_2$$

2
$$2ZnO + C \rightarrow 2Zn + CO_2$$

Which substance is reduced in reactions 1 and 2?

	reaction 1	reaction 2
Α	O_2	С
В	O_2	ZnO
С	ZnS	С
D	ZnS	ZnO

26 Four metals, zinc, M, copper and magnesium, are reacted with aqueous solutions of their nitrates

The results are shown.

metal	magnesium nitrate	M nitrate	copper nitrate	zinc nitrate	
magnesium		✓	✓	✓	key
zinc	X	✓	✓		✓ = reacts
М	X		✓	X	x = no reaction
copper	×	X		X	

What is the order of reactivity of these four metals starting with the most reactive?

- **A** copper \rightarrow zinc \rightarrow M \rightarrow magnesium
- **B** copper \rightarrow M \rightarrow zinc \rightarrow magnesium
- **C** magnesium \rightarrow M \rightarrow zinc \rightarrow copper
- \mathbf{D} magnesium \rightarrow zinc \rightarrow M \rightarrow copper
- 27 Why is aluminium used to make containers for storing food?
 - A It conducts electricity.
 - **B** It has a high melting point.
 - C It is resistant to corrosion.
 - **D** It is strong.
- **28** Water can be treated by filtration then chlorination.

Which uses do **not** need water of this quality?

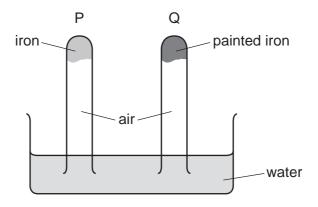
- 1 water for cooling in industry
- 2 water for washing clothes
- 3 water for drinking
- **A** 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

29 Oxides of nitrogen are formed in car engines and are a source of air pollution.

To decrease this pollution, catalytic converters are fitted to car exhausts.

What happens to the oxides of nitrogen in the catalytic converter?

- A combustion
- **B** cracking
- **C** oxidation
- **D** reduction
- **30** The diagram shows an experiment to investigate how paint affects the rusting of iron.



What happens to the water level in tubes P and Q?

	tube P	tube Q
Α	falls	rises
В	no change	rises
С	rises	falls
D	rises	no change

31 Ammonia is manufactured by the Haber Process.

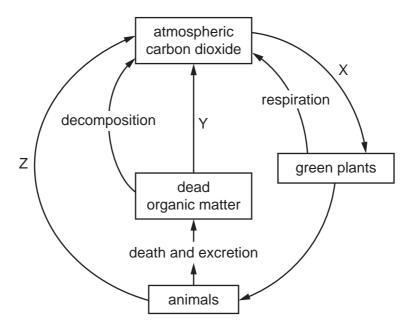
$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

The forward reaction is exothermic.

Which conditions maximise the yield of ammonia?

	pressure	temperature
Α	high	high
В	high	low
С	low	high
D	low	low

32 The carbon cycle is shown.



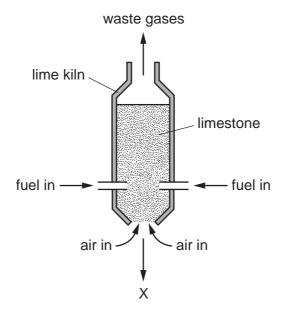
Which row describes processes X, Y and Z?

	Х	Y	Z
Α	respiration	combustion	photosynthesis
В	respiration	photosynthesis	combustion
С	photosynthesis	combustion	respiration
D	photosynthesis	respiration	combustion

33 Which row shows the conditions used in the Contact process?

	temperature /°C	pressure /atm	catalyst
Α	25	2	iron
В	25	200	iron
С	450	2	vanadium(V) oxide
D	450	200	vanadium(V) oxide

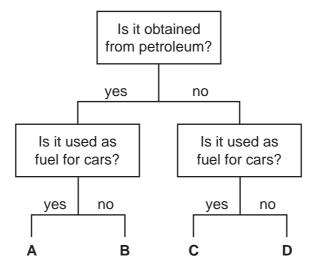
34 The diagram represents a lime kiln used to heat limestone to a very high temperature.



What leaves the kiln at X?

- A calcium carbonate
- B calcium hydroxide
- C calcium oxide
- D calcium sulfate

35 Which fuel could be gasoline?



14

- **36** Why is ethanol a member of the homologous series of alcohols but propane is **not**?
 - Ethanol has two carbon atoms per molecule but propane has three.
 - В Ethanol can be made from ethene but propane is obtained from petroleum.
 - **C** Ethanol is a liquid but propane is a gas.
 - Ethanol contains the same functional group as other alcohols but propane does not.
- 37 Chlorine reacts with methane.

Which statements are correct?

- 1 The reaction takes place in the dark.
- 2 The reaction of chlorine with methane forms chloromethane.
- Chloromethane reacts with chlorine to produce dichloromethane.
- The reaction of chlorine with methane is an addition reaction.
- **A** 1 and 2
- **B** 1 and 3
- **C** 2 and 3
- **D** 3 and 4

PMT

- 38 Which statements about aqueous ethanoic acid are correct?
 - Ethanoic acid contains the functional group -COOH. 1
 - Ethanoic acid reacts with carbonates to produce hydrogen.
 - 3 Ethanoic acid turns Universal Indicator paper blue.
 - 4 Ethanoic acid has a pH lower than pH 7.
 - **A** 1 and 2
- **B** 1 and 3
- C 1 and 4
- **D** 2 and 4

39 The structure of an ester is shown.

What is the name of the ester?

- Α ethyl propanoate
- **B** methyl propanoate
- C propyl ethanoate
- **D** propyl methanoate

40 The structure of a polymer is shown.



Which type of polymer is shown and by which process is it formed?

	type of polymer	formed by
Α	carbohydrate	addition polymerisation
В	carbohydrate	condensation polymerisation
С	polyester	addition polymerisation
D	polyester	condensation polymerisation

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 the Cambridge Assessment Group. Cambridge Assessment is the brand name of the University of Cambridge Local Examinations Syndicate (UCLES), which itself is a department of the University of Cambridge.

The Periodic Table of Elements

	=		a)	Ę	_	a)	E ~	_	_	uc (_	uo 1		d)	e +	<i>~</i>	_	е.			
	=	2	Ĭ	helii 4	1	Z	Dec 7	==	⋖	arg	8		kryp 8	25	×	xenon 131	88	~	rade			
	=				6	ட	fluorine 19	17	Cl	chlorine 35.5	35	ğ	bromine 80	53	_	iodine 127	85	Ą	astatine -			
	5				80	0	oxygen 16	16	S	sulfur 32	34	Se	selenium 79	52	<u>L</u>	tellurium 128	84	Ъ	molouium -	116	_	livermorium –
	>				7	z	nitrogen 14	15	۵	phosphorus 31	33	As	arsenic 75	51	Sp	antimony 122	83	<u>.</u>	bismuth 209			
	2				9	O	carbon 12	14	S	silicon 28	32	Ge	germanium 73	50	Sn	tin 119	82	Pb	lead 207	114	Εl	flerovium
	=				2	Δ	boron 11	13	Αl	aluminium 27	31	Ga	gallium 70	49	드	indium 115	84	11	thallium 204			
											30	Zu	zinc 65	48	В	cadmium 112	80	Нg	mercury 201	112	ű	copernicium -
											29	no	copper 64	47	Ag	silver 108	79	Αu	gold 197	111	Rg	roentgenium -
dr											28	z	nickel 59	46	Pq	palladium 106	78	莅	platinum 195	110	Ds	darmstadtium -
Group											27	ဝိ	cobalt 59	45	Rh	rhodium 103	77	<u>_</u>	iridium 192	109		meitnerium –
		-	ェ	hydrogen 1							26	Fe	iron 56	44	Ru	ruthenium 101	9/	SO	osmium 190	108	Hs	hassium -
]						25	Mn	manganese 55	43	ည	technetium -	75	Re	rhenium 186	107	Bh	bohrium –
											24	ပ်	chromium 52	42	Mo	nolybdenum 96	74	>	tungsten 184	106	Sg	seaborgium -
				Key	atomic number	atomic symbo	name relative atomic mass				23	>	vanadium 51	41	g	niobium 93	73	<u>n</u>	tantalum 181	105	op O	dubnium
			ato	aton	relativ				22	F	titanium 48	40	Zr	zirconium 91	72	士	hafnium 178	104	₩ ₩	utherfordium -		
								_			21	လွ	scandium 45	39	>	yttrium 89	57–71	lanthanoids		89–103	actinoids	
	=				4	Be	beryllium 9	12	Mg	magnesium 24	20	Ca	calcium 40	38	ഗ്	strontium 88	56	Ba	barium 137	88	Ra	radium -
	_				3		lithium 7					×	potassium 39	37	Rb	rubidium 85	55	Cs	caesium 133	87	亡	francium —

		ytterbium lutetium 173 175				
69	E	thulium 169	101	Md	mendelevium	
89	ы	erbium 167	100	Fn	fermium	
29	웃	holmium 165	66	Es	einsteinium	
99	ò	dysprosium 163	86	ŭ	californium	
65	Д	terbium 159	26	益	berkelium	
64	Gd	gadolinium 157	96	CB	curium	
63	Ш	europium 152	92	Am	americium	
62	Sm	samarium 150	94	Pu	plutonium	
61	Pm	promethium -	93	ď	neptunium	
09	PZ	neodymium 144	92	\supset	uranium 238	2007
59	P	praseodymium 141	91	Ра	protactinium 23.1	2
28	Ce	cerium 140	06	H	thorium 232	101
25	Гa	lanthanum 139	88	Ac	actinium	
	lanthanoids			actinoids		

The volume of one mole of any gas is $24\,\mathrm{dm^3}$ at room temperature and pressure (r.t.p.).