Cambridge Assessment International Education

Cambridge IGCSE™ (9–1)

CHEMISTRY **0971/22**

Paper 2 Multiple Choice (Extended) **May/June 2021**

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

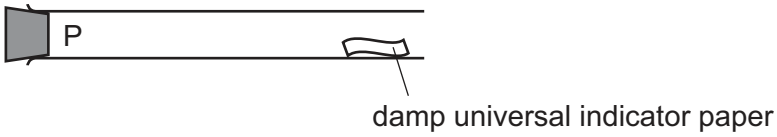
- There are **forty** questions on this paper. Answer **all** questions.
- For each question there are four possible answers **A**, **B**, **C** and **D**. Choose the **one** you consider correct and record your choice in soft pencil on the multiple choice answer sheet.
- Follow the instructions on the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

1 A gas is released at point P in the apparatus shown.



Which gas turns the damp universal indicator paper red most quickly?

A ammonia, NH_3

B chlorine, Cl_2

C hydrogen chloride, HCl

D sulfur dioxide, SO_2

2 A mixture of colourless compounds is separated using chromatography.

Which type of reagent is used to detect these compounds after separation?

A a dehydrating agent

B a locating agent

C an oxidising agent

D a reducing agent

3 Which statement about paper chromatography is correct?

A A solvent is needed to dissolve the paper.

B Paper chromatography separates mixtures of solvents.

C The solvent should cover the baseline.

D The baseline should be drawn in pencil.

4 Element X has 7 protons.

Element Y has 8 more protons than X.

Which statement about element Y is correct?

A Y has more electron shells than X.

B Y has more electrons in its outer shell than X.

C Y is in a different group of the Periodic Table from X.

D Y is in the same period of the Periodic Table as X.

5 A covalent molecule Q contains only six shared electrons.

What is Q?

A ammonia, NH_3

B chlorine, Cl_2

C methane, CH_4

D water, H_2O

6 Information about four substances E, F, G and H is shown.

	melting point / °C	electrical conductivity
E	1710	does not conduct when solid
F	3500	conducts when solid
G	120	does not conduct
H	801	conducts when molten

E, F, G and H are graphite, poly(ethene), sodium chloride and silicon(IV) oxide but not in that order.

What are E, F, G and H?

	E	F	G	H
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

7 Chemical compounds formed from a Group I element and a Group VII element contain ionic bonds.

How are the ionic bonds formed?

A Electrons are transferred from Group VII atoms to Group I atoms.

B Electrons are shared between Group I atoms and Group VII atoms.

C Electrons are lost by Group I atoms and Group VII atoms.

D Electrons are transferred from Group I atoms to Group VII atoms.

8 Some information about particles P, Q, R and S is shown.

	nucleon number	number of neutrons	number of electrons
P	12	6	6
Q	24	12	10
R	16	8	10
S	14	8	6

Which two particles are isotopes of the same element?

A P and Q **B** P and S **C** Q and R **D** R and S

9 Chlorine gas will react with iron metal.

Exactly 21.3 g of chlorine reacts with 11.2 g of iron.

How many iron atoms react with 30 molecules of chlorine?

A 10 **B** 15 **C** 20 **D** 30

10 In separate experiments, electricity was passed through concentrated aqueous sodium chloride and molten lead(II) bromide.

What would happen in **both** experiments?

A A halogen would be formed at the anode.

B A metal would be formed at the cathode.

C Hydrogen would be formed at the anode.

D Hydrogen would be formed at the cathode.

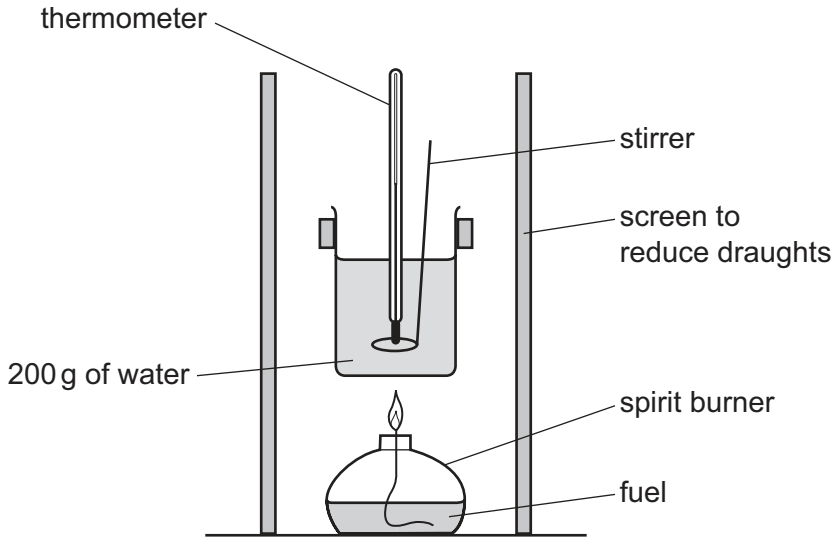
11 A reaction involving aluminium is shown.

$$xAl + yO_2 + 6H_2O \rightarrow xAl(OH)_3$$

Which values of x and y balance the equation?

	x	y
A	2	3
B	3	2
C	3	4
D	4	3

12 Four different fuels are used to heat a beaker of water, for the same amount of time, using the apparatus shown.



The initial temperature of the water and the temperature after heating by the fuel are recorded.

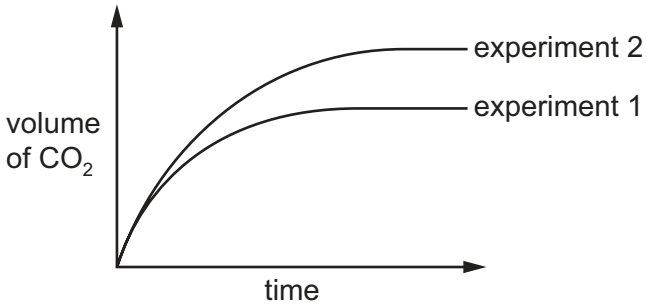
Which fuel releases the most heat energy?

	initial temperature / °C	temperature after heating / °C
A	17	46
B	24	52
C	26	61
D	30	62

13 An excess of calcium carbonate reacts with dilute hydrochloric acid. The volume of carbon dioxide produced is measured at regular time intervals. The results are shown as experiment 1.

The experiment is repeated with only **one** change to the reaction conditions.

The results are shown as experiment 2.



Which change is made in experiment 2?

A The concentration of the acid is increased.

B The volume of acid is increased.

C The mass of calcium carbonate is increased.

D The calcium carbonate is powdered.

14 When sulfur is heated it undergoes a .....1..... change as it melts.

Further heating causes the sulfur to undergo a .....2..... change and form sulfur dioxide.

Which words complete gaps 1 and 2?

	1	2
A	chemical	chemical
B	chemical	physical
C	physical	chemical
D	physical	physical

15 Four statements about the effect of increasing temperature on a reaction are shown.

1 The activation energy becomes lower.

2 The particles move faster.

3 There are more collisions between reacting particles per second.

4 There are more collisions which have energy greater than the activation energy.

Which statements are correct?

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

16 An example of a redox reaction is shown.

$$Zn + Cu^{2+} \rightarrow Zn^{2+} + Cu$$

Which statement about the reaction is correct?

A Zn is the oxidising agent and it oxidises Cu^{2+}.

B Zn is the oxidising agent and it reduces Cu^{2+}.

C Zn is the reducing agent and it oxidises Cu^{2+}.

D Zn is the reducing agent and it reduces Cu^{2+}.

17 When bismuth(III) chloride, $BiCl_3$, reacts with water, a white precipitate of bismuth(III) oxychloride, $BiOCl$, is formed. The equation for the reaction is shown.

$$BiCl_3(aq) + H_2O(l) \rightleftharpoons BiOCl(s) + 2H^+(aq) + 2Cl^-(aq)$$

The reaction is in equilibrium.

Which changes cause the white precipitate to dissolve?

1 adding acid

2 adding water

3 adding sodium chloride solution

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

18 Element X forms an oxide, XO, that neutralises sulfuric acid.

Which row describes X and XO?

	element X	nature of oxide, XO
A	metal	acidic
B	metal	basic
C	non-metal	acidic
D	non-metal	basic

19 Information about the solubility of salts is shown.

salt	solubility
chlorides	soluble (except for lead(II) chloride and silver chloride)
nitrates	soluble
sulfates	soluble (except for barium sulfate and lead(II) sulfate)

Aqueous solutions of which two compounds would produce a precipitate when added together?

A $Ba(NO_3)_2$ and $CaCl_2$

B $CuSO_4$ and $Zn(NO_3)_2$

C KCl and Na_2SO_4

D $Pb(NO_3)_2$ and $MgSO_4$

20 The equation shows the reaction between hydrogen and oxygen.

$$2\ H–H\ +\ O=O\ \rightarrow\ 2\ H–O–H$$

The bond energies are shown.

	bond energy in kJ / mol
H–H	436
O=O	495
O–H	463

Which row shows the energy change and the type of reaction?

	energy change in kJ / mol	type of reaction
A	441	exothermic
B	441	endothermic
C	485	exothermic
D	485	endothermic

21 Burning fossil fuels releases sulfur dioxide which leads to acid rain.

Which ion in the rain water causes it to be acidic?

A H^+ **B** OH^- **C** O^{2-} **D** SO_4^{2-}

22 Which statement about the trends shown by the elements of Period 3 in the Periodic Table is **not** correct?

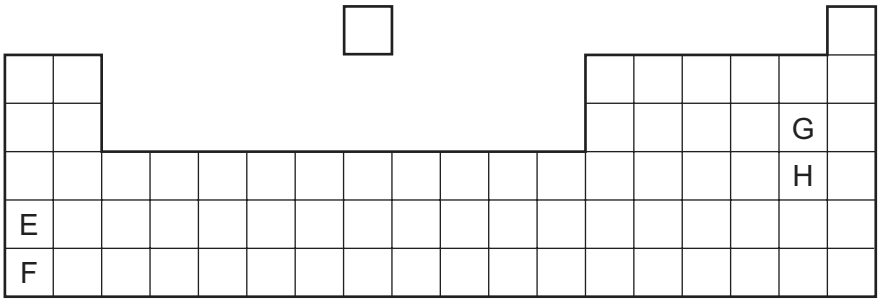
A The elements become less metallic across the period.

B The group number increases across the period.

C The number of electron shells increases across the period.

D The number of outer electrons increases across the period.

23 The diagram shows the positions of elements E, F, G and H in the Periodic Table.



Which statements about elements E, F, G and H are correct?

1 E has a higher density than F.

2 E has a higher melting point than F.

3 G has a darker colour than H.

4 G has a lower melting point than H.

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

24 When aqueous iodine is added to a solution of vanadium ions, V^{2+}, the V^{2+} ions each lose one electron.

Which property of transition elements is shown by this reaction?

A Transition elements have variable oxidation states.

B Transition elements form a stable 1+ ion.

C Transition elements are oxidising agents.

D Transition elements can act as catalysts.

25 A piece of aluminium is dropped into dilute hydrochloric acid.

No immediate reaction is observed.

Which statement explains this observation?

A Aluminium does not neutralise acids.

B Aluminium is a non-metal so does not react with acids.

C Aluminium is below hydrogen in the reactivity series.

D Aluminium is covered in an unreactive oxide layer.

26 Some metal nitrates and carbonates decompose when heated strongly.

Metal Q has a nitrate that decomposes to give a salt and a colourless gas only.

The carbonate of metal Q does not decompose when heated with a Bunsen burner.

What is metal Q?

A calcium

B copper

C sodium

D zinc

27 Aluminium is extracted from its ore by electrolysis.

Which equation represents the reaction that occurs at the anode during the electrolysis?

A $Al^{3+} + 3e^- \rightarrow Al$

B $Al^{3+} \rightarrow Al + 3e^-$

C $2O^{2-} \rightarrow O_2 + 4e^-$

D $2O^{2-} + 2e^- \rightarrow O_2$

28 Mild steel consists mostly of iron. Mild steel can be prevented from rusting by a process called galvanising.

Copper is not a very strong metal, however if it is mixed with a suitable metal a strong alloy called brass is produced.

Which statement is correct?

A Copper corrodes very quickly when wet and brass does not.

B Copper is mixed with zinc to produce brass.

C Galvanising mild steel changes it from a pure metal into an alloy.

D When a steel object is galvanised this means it is coated with a thin layer of tin.

29 Water is used for the irrigation of crops and for drinking water.

For which uses must water be chlorinated?

	irrigation	drinking
A	✓	✓
B	✓	✗
C	✗	✓
D	✗	✗

[Turn over

30 Which natural resource **cannot** provide a raw material for the manufacture of ammonia?

A air

B limestone

C petroleum

D water

31 Ammonia is made in the Haber process.

Which conditions are used in the Haber process?

	temperature / °C	pressure / atmospheres	catalyst used
A	450	200	iron
B	450	5	vanadium(V) oxide
C	200	450	iron
D	200	5	vanadium(V) oxide

32 Which process in the carbon cycle is responsible for removing carbon dioxide from the atmosphere?

A combustion

B decomposition

C photosynthesis

D respiration

33 The equations represent two reactions, P and Q, of lime (calcium oxide).

P $CaO + SiO_2 \rightarrow CaSiO_3$

Q $CaO + SO_2 \rightarrow CaSO_3$

In which processes do the reactions occur?

	P	Q
A	extraction of iron	extraction of iron
B	extraction of iron	flue gas desulfurisation
C	flue gas desulfurisation	extraction of iron
D	flue gas desulfurisation	flue gas desulfurisation

34 Which statement about ethanol is **not** correct?

A Ethanol can be made by fermentation.

B Ethanol is oxidised to make ethanoic acid.

C Ethanol reacts with oxygen exothermically, making it a good fuel.

D Ethanol reacts with propanoic acid to make propyl ethanoate.

35 Which pair of formulae represents two alkanes?

A CH_4 and C_8H_{18}

B C_2H_6 and C_5H_8

C C_3H_6 and C_5H_{12}

D $C_{10}H_8$ and C_4H_8

36 Which statement about alkanes is correct?

A They burn in oxygen.

B They contain carbon, hydrogen and oxygen atoms.

C They contain double bonds.

D They contain ionic bonds.

37 Which statements about ethanoic acid are correct?

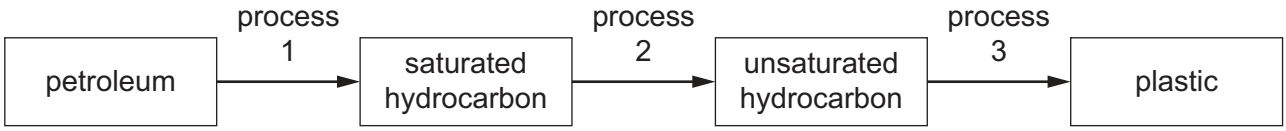
1 It is a strong acid.

2 It reacts with ethanol to form an ester.

3 It has the formula CH_3COOH.

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

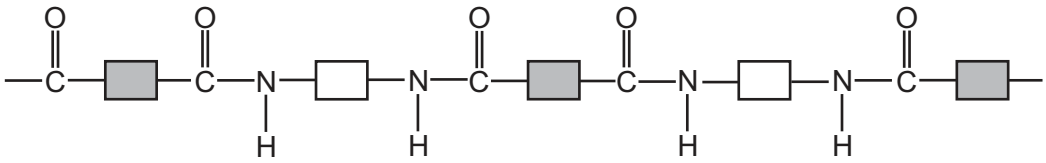
38 The flow chart shows how petroleum may be turned into a plastic.



What are processes 1, 2 and 3?

	process 1	process 2	process 3
A	cracking	fractional distillation	polymerisation
B	cracking	polymerisation	fractional distillation
C	fractional distillation	cracking	polymerisation
D	fractional distillation	polymerisation	cracking

39 The structure of a synthetic polymer is shown.



The structure shows that it is a .....1..... . It is formed by .....2..... polymerisation.

Which words complete gaps 1 and 2?

	1	2
A	polyamide	addition
B	polyamide	condensation
C	polyester	addition
D	polyester	condensation

40 Which substance is a natural polymer?

A ethene

B *Terylene*

C nylon

D protein

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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 –		114 Fl flerovium –		116 Lv livermorium –		

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.).