Cambridge Assessment International Education

Cambridge International AS & A Level

CHEMISTRY **9701/12**

Paper 1 Multiple Choice **May/June 2020**

1 hour

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)
Data booklet

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. A mark will not be deducted for a wrong answer.
- Any rough working should be done on this question paper.

This document has **16** pages. Blank pages are indicated.

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Section A

For each question there are four possible answers **A**, **B**, **C** and **D**. Choose the **one** you consider to be correct.

Use of the Data Booklet may be appropriate for some questions.

1 In which carbon allotrope are all electrons localised?

A buckminsterfullerene

B diamond

C graphite

D graphene

2 A copper ore contains 3.00% of copper carbonate, $CuCO_3$, by mass.

Which mass of copper would be obtained from 1 tonne of the ore?

A 1.91 kg **B** 3.71 kg **C** 15.4 kg **D** 58.4 kg

3 The catalysed formation of ammonia by the Haber process can be represented by the equation shown.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \qquad \Delta H = -92\,kJ\,mol^{-1}$$

Which change in conditions will increase both the rate of formation and the equilibrium yield of ammonia?

A decrease in the temperature

B increase in the temperature

C increase in the pressure

D increase in the surface area of the catalyst

4 Solid sulfur consists of S_8 molecules.

Which equation represents the standard enthalpy of atomisation of sulfur?

A $\frac{1}{8}S_8(s) \rightarrow S(g)$

B $\frac{1}{8}S_8(g) \rightarrow S(g)$

C $S_8(s) \rightarrow 8S(g)$

D $S_8(g) \rightarrow 8S(g)$

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5 In this question you should use changes in oxidation numbers to balance a chemical equation.

The following reaction occurs when MnO_2 is warmed with dilute H_2SO_4.

$$a\ MnO_2 + b\ H^+ \rightarrow c\ Mn^{2+} + d\ MnO_4^- + e\ H_2O$$

What is the ratio of c : d in the correctly balanced equation?

A 1 : 1 **B** 1 : 2 **C** 2 : 3 **D** 3 : 2

6 In this question you should assume air contains 21% oxygen.

What is the minimum volume of air required to ensure complete combustion of 10 cm^3 of butane gas, under room conditions?

A 14 cm^3 **B** 27 cm^3 **C** 65 cm^3 **D** 310 cm^3

7 When aqueous bromine is shaken with cyclohexane and allowed to stand, two layers form. The top cyclohexane layer is coloured and the bottom aqueous layer is almost colourless.

What is the most likely explanation for this observation?

A Bromine is reduced to bromide ions in the bottom layer.

B Bromine molecules are non-polar.

C Bromine reacts with water but cannot react with cyclohexane.

D The product of the reaction between bromine and cyclohexane is coloured.

8 In which change are **only** temporary dipole-induced dipole forces overcome?

A $C_2H_5OH(l) \rightarrow C_2H_5OH(g)$

B $H_2O(s) \rightarrow H_2O(l)$

C $O_2(s) \rightarrow O_2(l)$

D $C_4H_{10}(l) \rightarrow C_4H_{10}(s)$

9 The complete combustion of 2 moles of an alkane produces 400 dm^3 of carbon dioxide measured at 301 K and 1×10^5 Pa. Carbon dioxide can be assumed to behave as an ideal gas under these conditions.

What is the formula of the alkane?

A C_8H_{18} **B** $C_{16}H_{34}$ **C** $C_{20}H_{42}$ **D** $C_{40}H_{82}$

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10 In which reaction does an element undergo the largest change in oxidation number?

A $Cl_2 + 2OH^- \rightarrow OCl^- + Cl^- + H_2O$

B $3Cl_2 + 6OH^- \rightarrow ClO_3^- + 5Cl^- + 3H_2O$

C $Cr_2O_7^{2-} + 6Fe^{2+} + 14H^+ \rightarrow 2Cr^{3+} + 6Fe^{3+} + 7H_2O$

D $3MnO_4^{2-} + 4H^+ \rightarrow MnO_2 + 2MnO_4^- + 2H_2O$

11 PCl_5 decomposes as shown.

$$PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$$

1.0 mol of $PCl_5(g)$, 1.0 mol of $PCl_3(g)$ and 1.0 mol of $Cl_2(g)$ are placed in a container of volume 1 dm^3 at 250 °C and allowed to reach equilibrium.

At this temperature, the equilibrium mixture contains 1.8 moles of PCl_3.

What is the value of K_c at 250 °C?

A 1 **B** 1.8 **C** 9 **D** 16.2

12 The fifth to eighth ionisation energies of four elements in Period 3 of the Periodic Table are shown.

Which row refers to chlorine?

	ionisation energies / kJ mol^{-1}			
	fifth	sixth	seventh	eighth
A	6280	21 200	25 900	30 500
B	6990	8 490	27 100	31 700
C	6540	9 330	11 000	33 600
D	7240	8 790	12 000	13 800

13 Magnesium nitrate, $Mg(NO_3)_2$, decomposes when heated to give a white solid and a mixture of gases. One of the gases released is an oxide of nitrogen, X.

7.4 g of anhydrous magnesium nitrate is heated until no further reaction takes place.

What mass of X is produced?

A 1.5 g **B** 2.3 g **C** 3.0 g **D** 4.6 g

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14 Which statement explains why iodine is less volatile than chlorine?

A Chlorine is more electronegative than iodine and so has more repulsion between its molecules.

B The greater number of electrons in iodine leads to larger temporary dipole-induced dipole forces.

C The I–I bond energy is smaller than the C*l*–C*l* bond energy.

D The iodine molecules have stronger permanent dipole-permanent dipole forces.

15 Ammonium carbonate is a crystalline solid. On gentle warming a reaction occurs, forming ammonia as one product.

How are the carbonate ions behaving during this reaction?

A Brønsted-Lowry acid

B Brønsted-Lowry base

C oxidising agent

D reducing agent

16 One molecule of an oxide of element Z reacts with six molecules of water to produce an acidic compound.

What is element Z?

A aluminium

B phosphorus

C silicon

D sulfur

17 Which property shows an **increase** from magnesium to barium?

A the first ionisation energy of the elements

B the oxidising power of the metals

C the solubility of the hydroxides

D the solubility of the sulfates

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18 A test-tube of HBr(g) and a separate test-tube of HI(g) are heated to the same temperature.

Which combination of observations is possible?

	test-tube of HBr(g)	test-tube of HI(g)
A	a brown vapour appears	no change
B	a purple vapour appears	no change
C	no change	a brown vapour appears
D	no change	a purple vapour appears

19 Most modern cars are fitted with catalytic converters in the exhaust system.

Which three gases are removed by a catalytic converter?

A carbon monoxide, hydrocarbons, nitrogen oxides

B carbon monoxide, carbon dioxide, nitrogen oxides

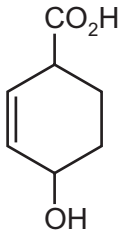
C carbon monoxide, nitrogen oxides, sulfur dioxide

D hydrocarbons, nitrogen oxides, sulfur dioxide

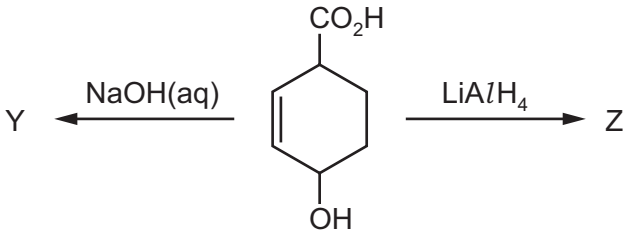
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20 Compound X is shown.

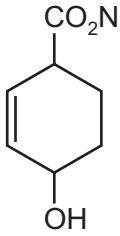
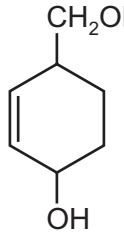
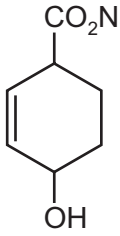
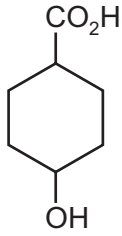
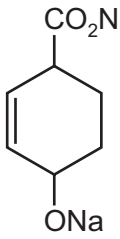
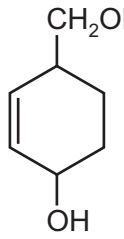
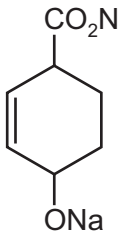
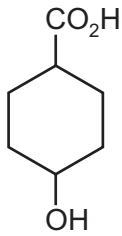
compound X



X is treated separately with NaOH(aq) and LiAlH$_4$ to give Y and Z.



What are Y and Z?

	Y	Z
A		
B		
C		
D		

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[Turn over

21 The table shows the molecular formulae of three molecules P, Q and R. None of the molecules are cyclic.

molecule	molecular formula
P	CH_4O
Q	CH_2O_2
R	CH_2O

Which molecules show a strong absorption between 1610 cm^{-1} and 1750 cm^{-1} in their infra-red spectra?

A Q only **B** R only **C** Q and R only **D** P, Q and R

22 Which row correctly shows the type of mechanism of each of the two reactions?

	C_2H_5Br + KCN	CH_3COCH_3 + HCN
A	electrophilic substitution	electrophilic addition
B	electrophilic substitution	nucleophilic addition
C	nucleophilic substitution	electrophilic addition
D	nucleophilic substitution	nucleophilic addition

23 Ester X is shown.

ester X

$CH_3CO_2(CH_2)_7CH_3$

Ester X is hydrolysed using aqueous sodium hydroxide.

What is the molecular formula of one of the products?

A $C_2H_4O_2$ **B** $C_2H_3O_2Na$ **C** $C_8H_{16}O$ **D** $C_8H_{17}O_2Na$

24 Which reagent could be used to distinguish between propane-1,2-diol and ethane-1,2-diol?

A alkaline aqueous iodine

B aqueous acidified dichromate(VI)

C ethanol and a few drops of concentrated sulfuric acid

D sodium metal

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25 Which substance forms propanoic acid as one of the products when it reacts with hot concentrated acidified potassium manganate(VII)?

A but-1-ene

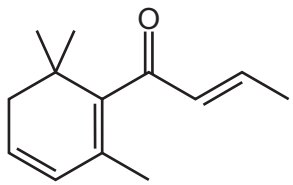
B but-2-ene

C 2-methylpropene

D 2-methylbut-1-ene

26 The structure of damascenone is shown.

damascenone



Including damascenone, how many stereoisomers exist with this structural formula?

A 1 **B** 2 **C** 4 **D** 8

27 How many isomeric esters have the molecular formula $C_4H_8O_2$?

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

28 Ethene reacts with aqueous bromine to give two products, CH_2BrCH_2Br and CH_2BrCH_2OH.

Which statement about these products is correct?

A Both products are obtained in this reaction by nucleophilic substitution.

B Both products are obtained in this reaction by nucleophilic addition.

C Both products can be hydrolysed to form the same organic compound.

D Both products can form hydrogen bonds with water.

29 PVC is used as a packaging material.

What holds the different polymer strands together in a piece of solid PVC?

A covalent bonds

B hydrogen bonds

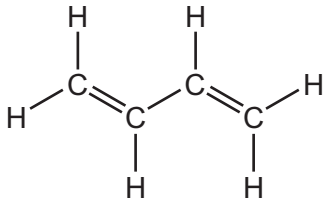
C ionic bonds

D van der Waals' forces

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30 The diagram shows the structure of buta-1,3-diene.

buta-1,3-diene



The addition reaction between buta-1,3-diene and two molecules of hydrogen bromide can produce three structurally isomeric products.

How many of these products have at least one chiral centre?

A 0 **B** 1 **C** 2 **D** 3

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Section B

For each of the questions in this section, one or more of the three numbered statements **1** to **3** may be correct.

Decide whether each of the statements is or is not correct (you may find it helpful to put a tick against the statements that you consider to be correct).

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, **2** and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

Use of the *Data Booklet* may be appropriate for some questions.

31 Scientists are trying to synthesise a new element with proton number 119. The element is predicted to be a Group 1 element in Period 8 of the Periodic Table.

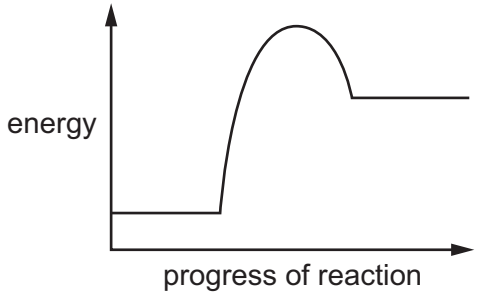
Which predictions are likely to be correct about this element?

1 The outermost occupied orbital of one atom of this element will be an s orbital.

2 The atomic radius will be the largest of the seven elements in Group 1.

3 It will have a greater first ionisation energy than element 118.

32 Which reactions would have the reaction profile shown?



1 $NaOH + HCl \rightarrow NaCl + H_2O$

2 $CaCO_3 \rightarrow CaO + CO_2$

3 $2MgO \rightarrow 2Mg + O_2$

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, **2** and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

33 Which factors can lead to an increase in the rate of a reaction?

1 a lower activation energy

2 an increase in temperature

3 an increase in the concentration of a reactant

34 Sodium and fluorine are both reactive elements. Two atoms are described.

	F	Na
atomic number	9	11
nucleon number	19	23

Which statements about these two atoms, and the ions they can form, are correct?

1 One Na atom has two more protons than one F^- ion.

2 One Na atom has two more neutrons than one F atom.

3 One Na^+ ion has the same number of electrons as one F^- ion.

35 In the atmosphere, which transformations can involve sulfur dioxide as either a reagent or a catalyst?

1 NO_2 to NO

2 NO to NO_2

3 CO to CO_2

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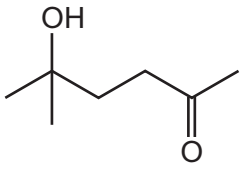
36 The bond .....P..... of the HBr molecule is .....Q..... than that of the HI molecule.

Which pairs of words correctly complete the above sentence?

	P	Q
1	energy	greater
2	length	less
3	polarity	greater

37 Compound X has the structure shown.

compound X



Which statements about compound X are correct?

1 X will decolourise cold, acidified $KMnO_4(aq)$.

2 X gives an orange precipitate with 2,4-DNPH reagent.

3 X does not react with Tollens' reagent.

38 Propanal reacts with hydrogen cyanide.

Which absorptions are present in the infra-red spectrum of the product?

1 a weak absorption in the range 2200–2250 cm^{-1}

2 a strong absorption in the range 3200–3600 cm^{-1}

3 a strong absorption in the range 1040–1300 cm^{-1}

39 Which alcohols **cannot** be dehydrated to form alkenes?

1 CH_3OH

2 $(CH_3)_3COH$

3 $CH_3CH(OH)CH_3$

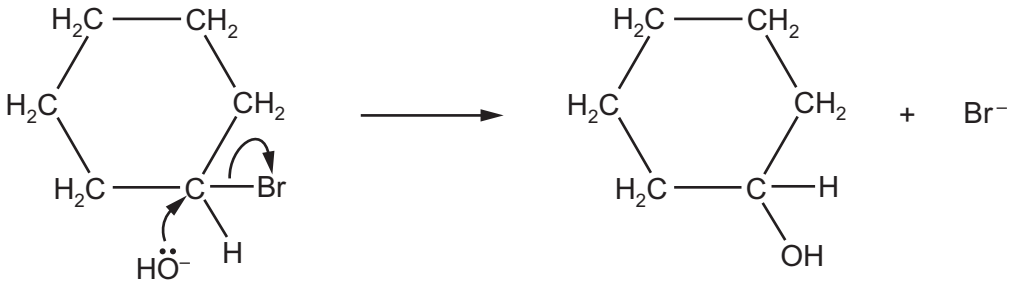
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The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, **2** and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

40 A reaction mechanism is shown.



Which statements about this reaction are correct?

1 Heterolytic bond fission occurs.

2 It is a substitution reaction.

3 OH^- behaves as an electrophile.

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