Cambridge International AS & A Level

Cambridge Assessment International Education
Cambridge International Advanced Subsidiary and Advanced Level

CHEMISTRY **9701/11**

Paper 1 Multiple Choice **May/June 2019**

1 hour

Additional Materials: Multiple Choice Answer Sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)
Data Booklet

* 1 9 8 4 2 6 7 0 2 7 *

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.
Electronic calculators may be used.

IB19 06_9701_11/4RP
© UCLES 2019

Section A

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

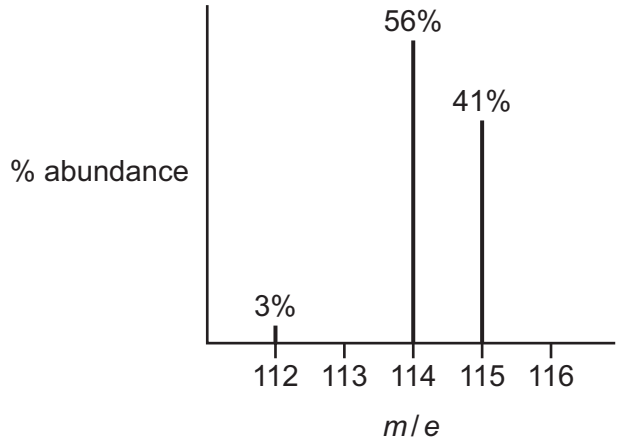
Use of the Data Booklet may be appropriate for some questions.

1 The temperature of a sample of an inert gas is increased.

What effect does this have on the number of molecules with the most probable energy and on the number of molecules with high energy?

	number of molecules with the most probable energy	number of molecules with high energy
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

2 A sample of element X is analysed using mass spectrometry. The mass spectrum obtained is shown.



What is the relative atomic mass of this sample of element X?

A 113.7 **B** 114.0 **C** 114.2 **D** 114.4

3 A washing powder contains sodium hydrogencarbonate, $NaHCO_3$, as one of the ingredients.

In a titration, a solution containing 1.00 g of this washing powder requires 7.15 cm^3 of 0.100 mol dm^{-3} sulfuric acid for complete reaction. The sodium hydrogencarbonate is the only ingredient that reacts with the acid.

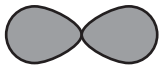
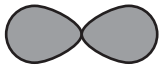
What is the percentage by mass of sodium hydrogencarbonate in the washing powder?

A 3.0% **B** 6.0% **C** 12.0% **D** 24.0%

© UCLES 2019

4 The outermost electron in an atom of neon occupies a particular orbital.

Which row shows the relative energy and shape of this orbital?

	energy of orbital relative to other occupied orbitals	shape of orbital
A	higher or equal	
B	higher or equal	
C	lower or equal	
D	lower or equal	

5 In which species is there a lone pair of electrons?

A CH_3 **B** CH_3^+ **C** CH_3^- **D** CH_4

6 When an evacuated tube of volume 400 cm^3 is filled with gas at 300 K and 101 kPa, the mass of the tube increases by 0.65 g.

Assume the gas behaves as an ideal gas.

What could be the identity of the gas?

A argon

B helium

C krypton

D neon

7 Under which conditions will nitrogen behave most like an ideal gas?

	temperature	pressure
A	low	high
B	high	low
C	low	low
D	high	high

© UCLES 2019

8 Two reactions and their enthalpy changes are shown.

$$2C(s) + 2H_2(g) \rightarrow C_2H_4(g) \qquad \Delta H^{\ominus} = +52.2\,kJ\,mol^{-1}$$

$$C_2H_2(g) + H_2(g) \rightarrow C_2H_4(g) \qquad \Delta H^{\ominus} = -175.8\,kJ\,mol^{-1}$$

These data can be used to calculate the enthalpy change for the reaction shown.

$$2C(s) + H_2(g) \rightarrow C_2H_2(g) \qquad \Delta H^{\ominus} = X$$

What is the value of X?

A $-228.0\,kJ\,mol^{-1}$

B $-123.6\,kJ\,mol^{-1}$

C $+123.6\,kJ\,mol^{-1}$

D $+228.0\,kJ\,mol^{-1}$

9 Ethanedioic acid, HO_2CCO_2H, can be oxidised by $KMnO_4$ in dilute sulfuric acid. The products of this reaction are carbon dioxide, water, potassium sulfate and manganese(II) sulfate.

In this reaction each ethanedioic acid molecule loses two electrons as it is oxidised. A half-equation for this process is shown.

$$HO_2CCO_2H \rightarrow 2CO_2 + 2H^+ + 2e^-$$

How many water molecules are produced when five ethanedioic acid molecules are oxidised by $KMnO_4$ in dilute sulfuric acid?

A 5 **B** 8 **C** 10 **D** 16

10 Hydrogen iodide gas decomposes reversibly producing iodine vapour and hydrogen.

$$2HI(g) \rightleftharpoons I_2(g) + H_2(g) \qquad \Delta H = +12\,kJ\,mol^{-1}$$

The position of the equilibrium for this reaction may be altered by changing the external conditions.

Which row correctly describes the change in position of equilibrium?

	effect of increasing the pressure	effect of increasing the temperature
A	moves to the right	moves to the right
B	moves to the right	moves to the left
C	no change	moves to the right
D	no change	moves to the left

© UCLES 2019

11 The reaction between sulfur dioxide and oxygen is reversible.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g) \qquad K_c = 280\,mol^{-1}\,dm^3 \text{ at } 1000\,K$$

In an equilibrium mixture at 1000 K the sulfur trioxide concentration is 6.00 mol dm^{-3}.

The sulfur dioxide concentration is twice the oxygen concentration.

What is the sulfur dioxide concentration?

A 0.175 mol dm^{-3}

B 0.254 mol dm^{-3}

C 0.318 mol dm^{-3}

D 0.636 mol dm^{-3}

12 1.15 g of a metallic element needs 300 cm^3 of oxygen for complete reaction, under room conditions, to form an oxide which contains O^{2-} ions.

What could be the identity of this metallic element?

A calcium

B magnesium

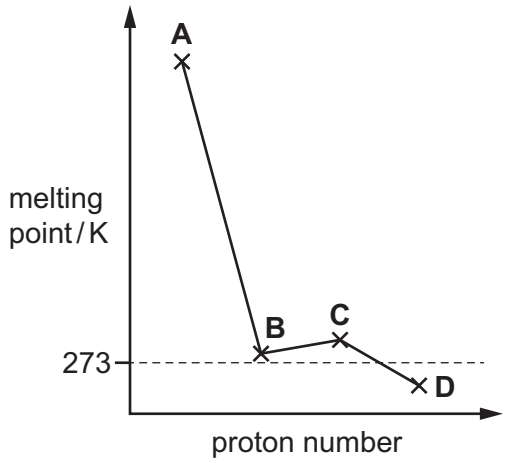
C potassium

D sodium

13 The relative melting points of four consecutive elements in the Periodic Table are shown in the graph.

The elements all have proton numbers less than 20.

Which element is in Group 16?



14 Substance X reacts with water. A gas is given off and the pH of the solution increases. The solution is then reacted with sulfuric acid and a white precipitate forms.

What could be substance X?

A barium

B barium oxide

C magnesium

D magnesium oxide

15 Solutions of $0.1\,mol\,dm^{-3}$ $Mg(NO_3)_2$ and $0.1\,mol\,dm^{-3}$ $Ba(NO_3)_2$ separately undergo a series of reactions using pure reagents.

$$Mg(NO_3)_2(aq) \xrightarrow{\text{sodium carbonate solution}} M \xrightarrow{\text{excess HC}\mathit{l}\text{(aq) then boil}} N \xrightarrow{\text{excess NaOH(aq)}} P$$

$$Ba(NO_3)_2(aq) \xrightarrow{\text{sodium carbonate solution}} Q \xrightarrow{\text{excess HC}\mathit{l}\text{(aq) then boil}} R \xrightarrow{\text{excess NaOH(aq)}} S$$

M, N and P are magnesium compounds.

Q, R and S are barium compounds.

How many of M, N, P, Q, R and S are white precipitates?

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

16 Concentrated sulfuric acid is added to separate solid samples of sodium chloride, sodium bromide and sodium iodide.

With which samples does sulfuric acid act as an oxidising agent?

A sodium chloride only

B sodium chloride and sodium bromide

C sodium bromide and sodium iodide

D sodium iodide only

17 The reaction of bromine with warm NaOH(aq) produces products with the same oxidation numbers, in the same ratios, as the reaction of chlorine with hot NaOH(aq).

In one reaction between bromine and warm NaOH(aq), 30.2 g of a product containing sodium, bromine and oxygen is produced.

Which mass of NaOH has reacted?

A 8.00 g **B** 10.2 g **C** 20.3 g **D** 48.0 g

© UCLES 2019

18 At 550 °C nitrogen dioxide reacts with unburnt hydrocarbon fragments such as CH_3 in the catalytic converter of a motor vehicle.

$$4CH_3 + 7NO_2 \rightarrow 3\tfrac{1}{2}N_2 + 4CO_2 + 6H_2O$$

Which row gives the energy change for this reaction and a possible reason for it?

	energy change of reaction	reason why the reaction is endothermic or exothermic
A	endothermic	chemical energy is converted to heat energy
B	endothermic	the N≡N bond energy is very high
C	exothermic	CO_2 and H_2O have negative $\Delta H_f^{\ominus}$ values
D	exothermic	double bonds are broken in NO_2

19 Which statement is correct?

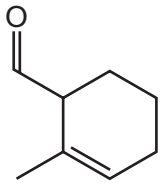
A Ammonia reacts with alkalis to form the ammonium ion.

B Ammonium chloride contains ionic, covalent and co-ordinate bonds.

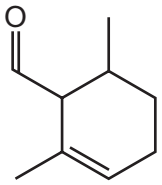
C The ammonium ion reacts with acids to produce ammonia.

D The bond angle in the ammonium ion is approximately 107°.

20 The diagrams show two different compounds.



1



2

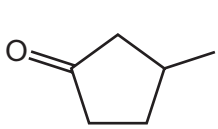
What is

- the total number of structural isomers, including compound 2, that could be formed by adding a second methyl group to the ring of compound 1,
- the number of π electrons in each compound?

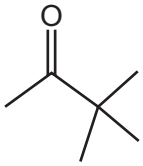
	number of isomers	number of π electrons
A	3	2
B	3	4
C	5	2
D	5	4

21 Which compound has the molecular formula $C_6H_{10}O$?

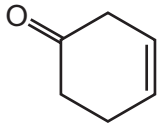
A



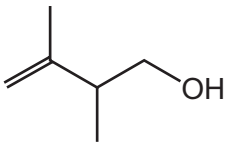
B



C



D



22 What is the structural formula of the major product when hydrogen bromide reacts with 2-methylbut-2-ene?

A $CH_2BrCH(CH_3)CH_2CH_3$

B $(CH_3)_2CBrCH_2CH_3$

C $(CH_3)_2CHCHBrCH_3$

D $(CH_3)_2CHCH_2CH_2Br$

23 Which reaction is most likely to involve the formation of a positively charged intermediate?

A 1-bromopentane and warm dilute NaOH(aq)

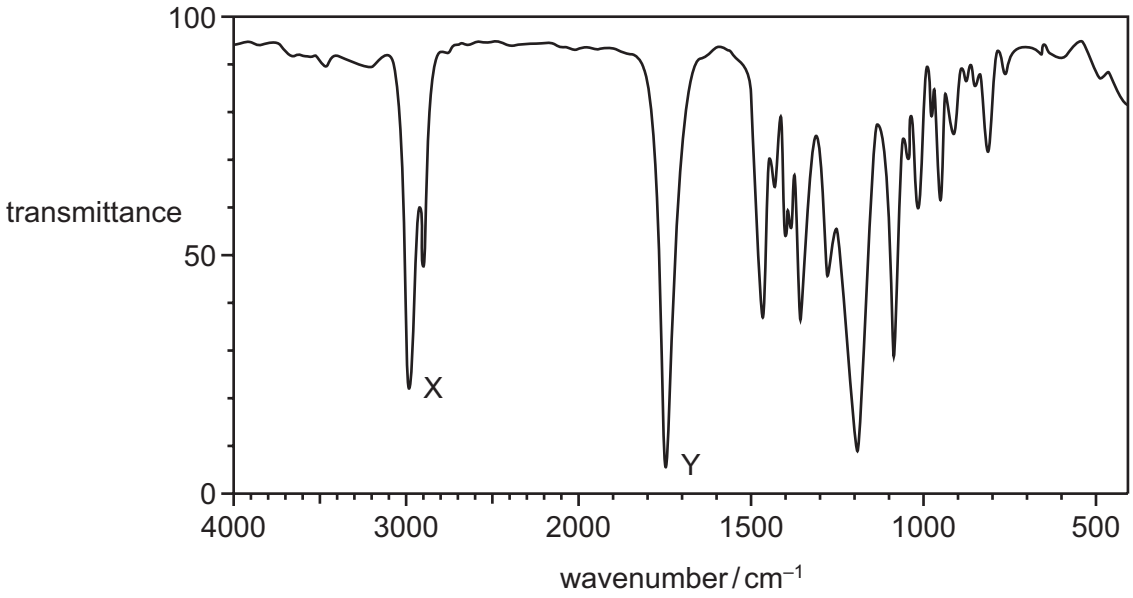
B 1-bromo-2,2-dimethylpropane and warm dilute NaOH(aq)

C 1-bromo-3-methylbutane and warm dilute NaOH(aq)

D 2-bromo-2-methylbutane and warm dilute NaOH(aq)

© UCLES 2019

24 The infra-red spectrum of a substance with empirical formula C_2H_4O is shown.

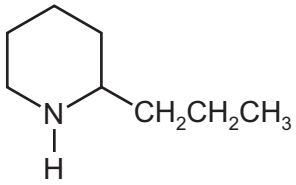


Which bonds are responsible for peak X and peak Y?

	peak X	peak Y
A	C–H	C=C
B	C–H	C=O
C	O–H	C=C
D	O–H	C=O

25 The structure of coniine is shown.

coniine



Coniine can be synthesised by reacting ammonia with a dibromo compound, X.

$$NH_3 + C_8H_{16}Br_2 \rightarrow \text{coniine} + 2HBr$$
$$\text{X}$$

What is the name of compound X?

A 1,1-dibromo-2-propylcyclopentane

B 1,2-dibromo-2-propylcyclopentane

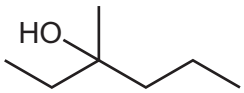
C 1,4-dibromooctane

D 1,5-dibromooctane

26 Structural isomerism and stereoisomerism should be considered when answering this question.

3-methylhexan-3-ol reacts with hot, concentrated sulfuric acid to form several isomeric compounds with the molecular formula C_7H_{14}.

3-methylhexan-3-ol



How many isomeric compounds could be formed in this reaction?

A 3 **B** 4 **C** 5 **D** 6

27 An organic compound T undergoes the following reactions.

- T is oxidised by hot, acidified potassium manganate(VII).
- T reacts with sodium to give hydrogen.

What could be compound T?

A $CH_3CH_2CH(OH)CH_3$

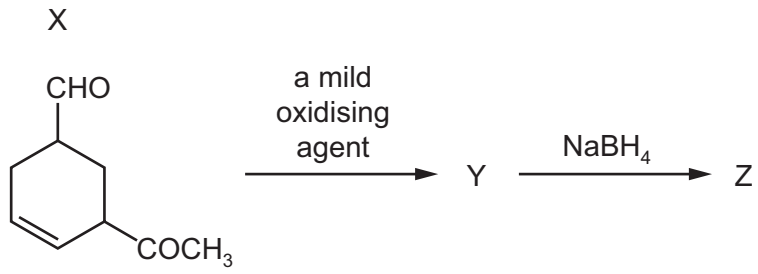
B $CH_3CH_2CH_2CHO$

C $(CH_3)_3COH$

D $CH_3CH_2COCH_3$

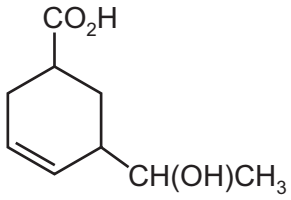
© UCLES 2019

28 Compound X is treated with two reagents successively, forming compound Z.

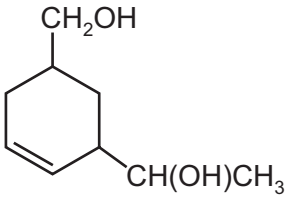


What could be Z?

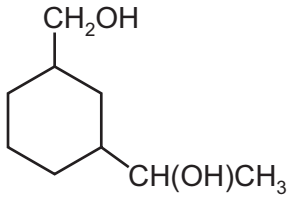
A



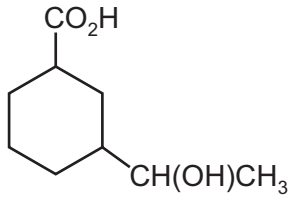
B



C



D



29 Which reagent may be used to distinguish between propanone and ethanol?

A 2,4-dinitrophenylhydrazine

B bromine water

C Fehling's reagent

D Tollens' reagent

30 Which compound is chiral?

A 1-chloro-3-methylbutane

B 2-chloro-2-methylbutane

C 2-chloro-3-methylbutane

D 3-chloropentane

© UCLES 2019

[Turn over

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 An atom of calcium-48 can form a 2+ ion.

Which statements about this ion are correct?

1 It has 20 protons.

2 It has 28 neutrons.

3 It has 22 electrons.

32 Four elements, W, X, Y and Z, have electronic configurations as shown.

W	X	Y	Z
2,4	2,6	2,8,2	2,8,8,1

Which formulae represent compounds that have boiling points below room temperature?

1 WX_2

2 YX

3 Z_2X

33 Which statements about enthalpy changes are correct?

1 The enthalpy change of atomisation is always positive.

2 The enthalpy change when a C–C bond is broken is positive.

3 The enthalpy change of neutralisation of a weak acid is always negative.

© UCLES 2019

34 Vanadium and pepsin can both act as catalysts. Vanadium is a metal. Pepsin is an enzyme.

Which statements are correct for **both** vanadium and pepsin?

1 They will speed up any chemical reaction.

2 They can lower the activation energy for a reaction.

3 They are not used up when they act as catalysts.

35 Which oxides, when placed in cold water for one day, will react with the water?

1 MgO

2 Al_2O_3

3 SiO_2

36 A mixture of magnesium carbonate and magnesium nitrate is heated strongly in a hard-glass test-tube.

Which gases are formed?

1 carbon dioxide

2 nitrogen dioxide

3 oxygen

37 Which statements about poly(alkene)s are correct?

1 Poly(alkene)s do not react with $Br_2(aq)$ in the dark.

2 Disposal of poly(alkene)s by combustion can produce harmful products.

3 Poly(alkene)s do not readily biodegrade.

© UCLES 2019

[Turn over

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

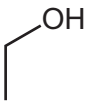
A	B	C	D
1, **2** and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

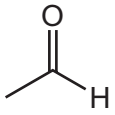
No other combination of statements is used as a correct response.

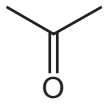
38 Compound Y

- reacts with alkaline aqueous iodine to form a yellow precipitate
- changes the colour of warm, acidified potassium dichromate(VI) solution.

What could be compound Y?

1 

2 

3 

39 Carboxylic acids can be made by several different reactions.

Which statements are correct?

1 The acid hydrolysis of CH_3CH_2CN will make ethanoic acid.

2 The oxidation of $CH_3CH_2CH_2CH_2OH$ will make butanoic acid.

3 The oxidation of CH_3CH_2CHO will make propanoic acid.

40 Carboxylic acids react with alcohols to produce esters.

Carboxylic acid X forms **one** ester only with molecular formula $C_5H_{10}O_2$.

What could X be?

1 ethanoic acid

2 propanoic acid

3 butanoic acid

© UCLES 2019

BLANK PAGE

BLANK PAGE

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.

© UCLES 2019