Cambridge International AS & A Level

Cambridge Assessment International Education
Cambridge International Advanced Subsidiary and Advanced Level

CHEMISTRY **9701/12**

Paper 1 Multiple Choice **February/March 2019**

1 hour

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

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.

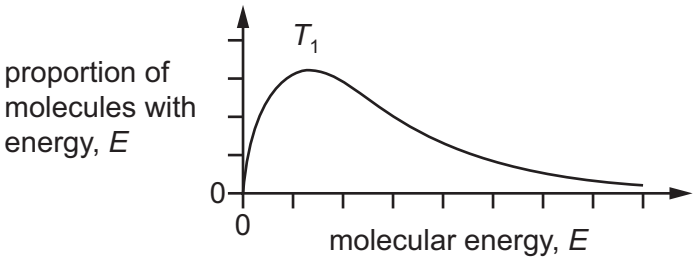
IB19 03_9701_12/3RP

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.

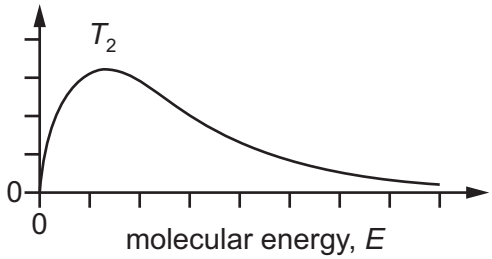
1 The Boltzmann distribution is shown for a sample of gas at an initial temperature, T_1.



The sample of gas was heated to temperature, T_2.

What is the correct distribution for the higher temperature, T_2?

A



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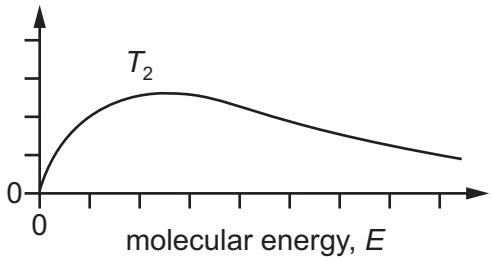
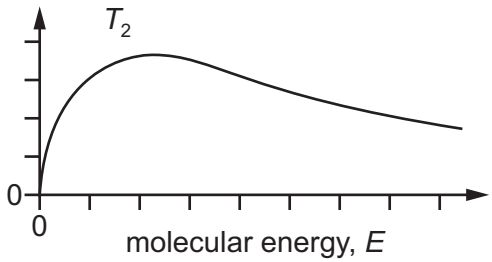


C



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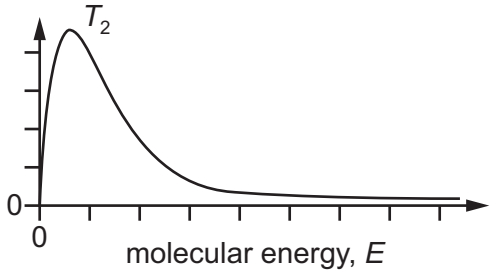


2 A 3.7 g sample of copper(II) carbonate is added to 25 cm^3 of 2.0 mol dm^{-3} hydrochloric acid.

Which volume of gas is produced under room conditions?

A 0.60 dm^3 **B** 0.72 dm^3 **C** 1.20 dm^3 **D** 2.40 dm^3

3 Which statement about a 3p orbital is correct?

A It can hold a maximum of 6 electrons.

B It has the highest energy of the orbitals with principal quantum number 3.

C It is at a higher energy level than a 3s orbital but has the same shape.

D It is occupied by one electron in an isolated phosphorus atom.

4 The eight species that follow all have covalent bonds.

In which pair do the species have different shapes from each other?

A $BeCl_2$ and CO_2

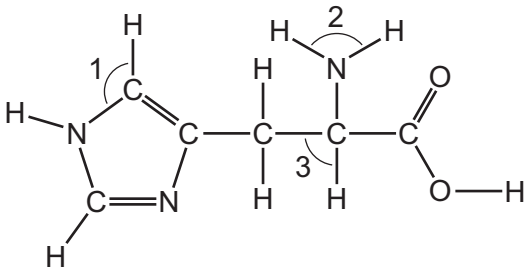
B CH_4 and NH_4^+

C NH_3 and BF_3

D SCl_2 and H_2O

5 Histidine is an amino acid.

histidine



What are the approximate bond angles 1, 2, and 3?

	1	2	3
A	109.5	107	90
B	120	107	109.5
C	120	120	90
D	120	120	109.5

[Turn over

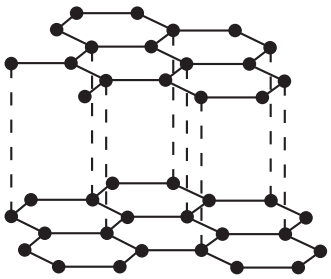
6 A sample of gas occupies 240 cm^3 at 37 °C and 100 kPa.

How many moles of gas are present in the sample?

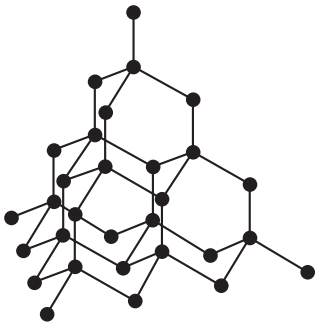
A 9.32×10^{-6} **B** 9.32×10^{-3} **C** 0.0781 **D** 78.1

7 P, Q and R represent three different structures of an element.

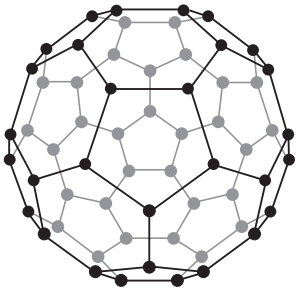
P



Q



R



Which structures are giant molecular?

A P, Q and R

B P and Q only

C P and R only

D Q and R only

8 The standard enthalpy changes of combustion of carbon, hydrogen and methanol are shown.

$$C(s) + O_2(g) \rightarrow CO_2(g) \qquad \Delta H_c^{\ominus} = -394\ kJ\ mol^{-1}$$

$$H_2(g) + \tfrac{1}{2}O_2(g) \rightarrow H_2O(l) \qquad \Delta H_c^{\ominus} = -286\ kJ\ mol^{-1}$$

$$CH_3OH(l) + 1\tfrac{1}{2}O_2(g) \rightarrow CO_2(g) + 2H_2O(l) \qquad \Delta H_c^{\ominus} = -726\ kJ\ mol^{-1}$$

Which expression gives the standard enthalpy change of formation of methanol in $kJ\ mol^{-1}$?

A –394 + (–286) – (–726)

B –394 + (–286 × 2) – 726

C –394 + (–286 × 2) – (–726)

D –726 – (–394) – (–286 × 2)

9 The equation for a chemical reaction is shown. All substances are in their standard states.

$$XeF_6 + 3H_2O \rightarrow XeO_3 + 6HF$$

Which statement describes the standard enthalpy change of reaction for this reaction?

A the enthalpy change when a total of one mole of products is produced

B the enthalpy change when a total of one mole of reactants is reacted

C the enthalpy change when one mole of water reacts

D the enthalpy change when six moles of hydrogen fluoride are produced

10 Acidified potassium manganate(VII) reacts with iron(II) ethanedioate, FeC_2O_4.

The reactions taking place are shown.

$$MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$$

$$Fe^{2+} \rightarrow Fe^{3+} + e^-$$

$$C_2O_4^{2-} \rightarrow 2CO_2 + 2e^-$$

How many moles of iron(II) ethanedioate react with **one** mole of potassium manganate(VII)?

A 0.60 **B** 1.67 **C** 2.50 **D** 5.00

11 When copper is added to a solution of silver ions, the following equilibrium is established.

$$Cu(s) + 2Ag^+(aq) \rightleftharpoons Cu^{2+}(aq) + 2Ag(s) \qquad K_c = 1.0 \times 10^5$$

What is the concentration of silver ions at equilibrium when $[Cu^{2+}] = 0.10\,mol\,dm^{-3}$?

A $5.0 \times 10^{-7}\,mol\,dm^{-3}$

B $5.0 \times 10^{-4}\,mol\,dm^{-3}$

C $1.0 \times 10^{-3}\,mol\,dm^{-3}$

D $1.0 \times 10^{2}\,mol\,dm^{-3}$

[Turn over

12 X, Y and Z are elements in Period 3 of the Periodic Table. The results of some experiments carried out with compounds of these elements are shown.

element	result of adding the oxide of the element to $H_2O(l)$	result of adding the chloride of the element to $H_2O(l)$	result of adding the oxide of the element to $HCl(aq)$
X	no reaction	hydrolyses	forms chloride salt
Y	forms hydroxide	dissolves	forms chloride salt
Z	forms acid	hydrolyses	hydrolyses

Which statement could be correct?

A X is Al and Y is Mg.

B X is Si and Y is Na.

C Y is Al and Z is P.

D Y is Na and Z is Al.

13 A solid Period 3 element, Q, is reacted with oxygen gas. Compound R is formed.

When R is added to water the pH decreases.

What could be the empirical formula of R?

A Q_2O_4 **B** Q_2O_5 **C** Q_4O_{10} **D** Q_5O_2

14 Metal T reacts with water to produce a colourless solution. A white precipitate is produced when this colourless solution is mixed with aqueous sulfuric acid.

What is metal T?

A barium

B magnesium

C potassium

D sodium

15 When calcium nitrate thermally decomposes, oxygen is one of the products.

Which volume of oxygen is produced under room conditions when 0.50 mol of calcium nitrate thermally decomposes?

A $6.0\,dm^3$ **B** $12.0\,dm^3$ **C** $18.0\,dm^3$ **D** $30.0\,dm^3$

16 L, M and N are Group 2 metals. L reacts more vigorously with dilute hydrochloric acid than N does. $M(OH)_2$ is more soluble than $N(OH)_2$.

What could be the identities of L, M and N?

	L	M	N
A	Ba	Ca	Sr
B	Ba	Sr	Ca
C	Ca	Ba	Sr
D	Sr	Ca	Ba

17 The table shows some reactions of a white compound, G.

test	observation
silver nitrate is added to a solution of G followed by aqueous ammonia	a precipitate is formed which does not dissolve when the ammonia is added
solid G is warmed with concentrated sulfuric acid	a mixture of gases is formed including hydrogen sulfide

What could be the identity of G?

A caesium chloride

B lithium bromide

C potassium sulfate

D sodium iodide

18 Under standard conditions, which statement is correct?

A Cl_2(aq) can oxidise Br^-(aq).

B Cl_2(aq) can reduce Br^-(aq).

C Cl^-(aq) can oxidise Br_2(aq).

D Cl^-(aq) can reduce Br_2(aq).

19 Ammonia, NH_3, and hydrazine, NH_2NH_2, are two compounds of nitrogen, N_2.

Which statement is correct?

A The N–N bond in NH_2NH_2 is polar.

B NH_3 and NH_2NH_2 have lone pairs of electrons but N_2 does not.

C The oxidation number of each nitrogen in NH_2NH_2 is +2.

D The reaction of nitrogen with hydrogen has a high activation energy.

[Turn over

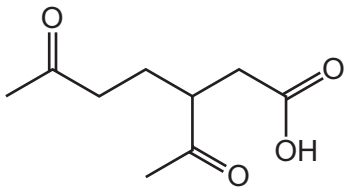
20 How many structural isomers are there of trichloropropane, $C_3H_5Cl_3$?

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

21 Compound L has the molecular formula $C_{10}H_{16}$.

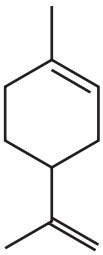
A sample of L reacted with an excess of hot, concentrated, acidified potassium manganate(VII). Compound M is produced.

M



What could be the structure of compound L?

A



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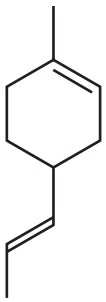

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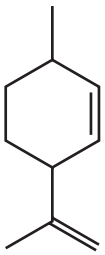

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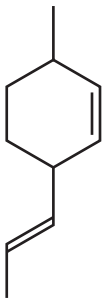


22 Many reactions take place in the engine and catalytic converter of a car.

Which pair of substances is produced **both** by the reactions in a car engine and in a catalytic converter?

A carbon dioxide and unburnt hydrocarbons

B carbon dioxide and water

C carbon monoxide and nitrogen

D carbon monoxide and unburnt hydrocarbons

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

2-bromopentane is heated with an excess of ethanolic sodium hydroxide.

How many different hydrocarbons are produced?

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

24 Bromopropane reacts with water as shown.

$$CH_3CH_2CH_2Br + H_2O \rightarrow CH_3CH_2CH_2OH + HBr$$

Which statement is correct?

A This is an elimination reaction.

B This is a hydrolysis reaction.

C This is a redox reaction.

D This reaction tends to proceed via the S_N1 mechanism.

25 Which product is formed when 3-methylpentane-1,3,4-triol is heated under reflux with an excess of acidified potassium dichromate(VI)?

A $HO_2CCH_2C(CH_3)(OH)COCH_3$

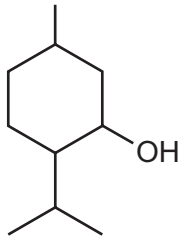
B $HO_2CCH_2COC(OH)(CH_3)_2$

C $OHCCH_2C(CH_3)(OH)COCH_3$

D $HO_2CCH_2CO(CH_3)COCH_3$

26 Menthol is a naturally occurring alcohol.

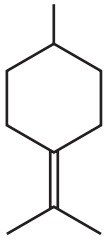
menthol



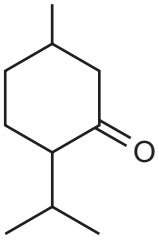
When menthol is heated with concentrated sulfuric acid it reacts. The products formed include compound T.

What could be the structure of compound T?

A



B



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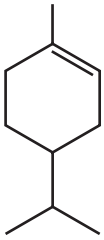

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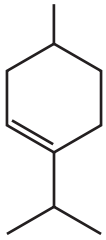


27 Structural isomerism only should be considered when answering this question.

All the isomeric alcohols with the molecular formula $C_5H_{12}O$ are added separately to warm alkaline aqueous iodine.

How many of the isomers give a yellow precipitate?

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

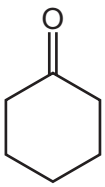
28 When compound X is heated with $Cr_2O_7^{2-}/H^+$, a colour change from orange to green is observed.

Two tests are carried out on the organic product of this reaction.

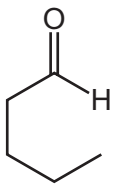
test	result
Tollens' reagent	no change
2,4-dinitrophenylhydrazine	orange precipitate

What could be compound X?

A



B



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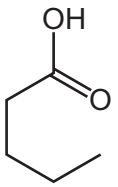

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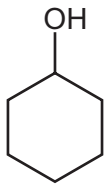
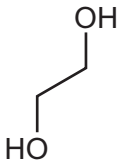


29 1 mole of each of the following four compounds is reacted separately with:

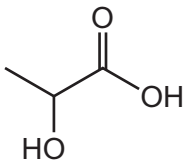
- an excess of sodium
- an excess of sodium carbonate.

Which compound produces the same volume of gas with each of the **two** reagents?

A



B



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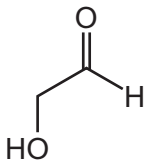

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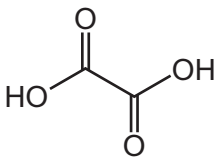


30 An infra-red spectrum shows a broad peak at 3000 cm^{-1} and a strong peak at 1710 cm^{-1}.

Which substance could have produced this spectrum?

A methyl propanoate

B propan-2-ol

C propanoic acid

D propanone

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 In an experiment, 10 cm^3 of an organic compound, J, in the gaseous state is reacted with an excess of oxygen. Steam, 20 cm^3 of carbon dioxide and 5 cm^3 of nitrogen are the only products.

All gas volumes were measured at the same temperature and pressure.

What could be the identity of J?

1 $C_2H_6N_2$

2 C_2H_3N

3 C_2H_7N

32 In which pairs do both species have the same number of unpaired electrons in p orbitals?

1 O and Cl^+

2 F^+ and Ga^-

3 N and Kr^{3+}

33 In which reactions is the underlined element or compound reduced?

1 $NaClO + H_2O_2 \rightarrow O_2 + NaCl + H_2O$

2 $2NH_3 + 2Li \rightarrow 2LiNH_2 + H_2$

3 $3CH_3CH_2OH + K_2Cr_2O_7 + 4H_2SO_4 \rightarrow 3CH_3CHO + Cr_2(SO_4)_3 + K_2SO_4 + 7H_2O$

34 Some polluting gases are removed from car exhaust fumes using a catalytic converter.

Platinum or palladium can be used as the catalyst. The reactions are faster when platinum is the catalyst than they are when palladium is the catalyst.

Which statements are correct?

1 Platinum acts as a heterogeneous catalyst in these reactions.

2 The palladium-catalysed reactions have higher activation energies than the platinum-catalysed reactions.

3 The platinum-catalysed reactions are more exothermic than the palladium-catalysed reactions.

35 Which statements about ceramics are correct?

1 Ceramics are good electrical conductors.

2 Ceramics are strong materials.

3 Ceramics have high melting points.

36 Which types of bonding are present in ammonium carbonate, $(NH_4)_2CO_3$?

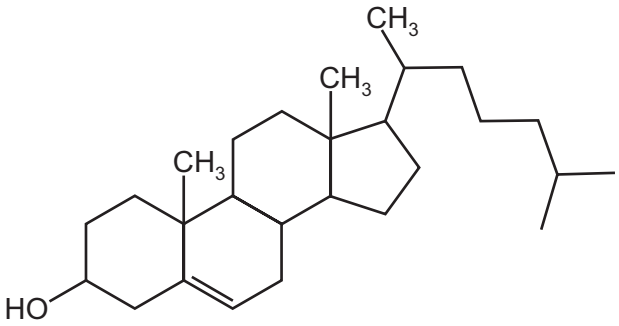
1 ionic

2 covalent

3 co-ordinate (dative covalent)

37 The diagram shows the structure of cholesterol.

cholesterol



Which statements about cholesterol are correct?

1 The molecule contains a secondary alcohol group.

2 The molecule contains two π bonds.

3 All carbon atoms in the four rings lie in the same plane.

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 Chlorine atoms in the upper atmosphere cause the breakdown of ozone.

$$Cl + O_3 \rightarrow O_2 + ClO$$

$$ClO + O \rightarrow Cl + O_2$$

Which statements about these chlorine atoms are correct?

1 The chlorine atoms act as catalysts.

2 The chlorine atoms are free radicals.

3 The chlorine atoms are formed by heterolytic fission of a covalent bond in chlorofluorocarbons.

39 The compounds listed are reacted with hydrogen cyanide.

Which compounds produce a molecule containing a chiral centre?

1 butanal

2 butanone

3 pentan-2-one

40 Carboxylic acids can be prepared from alcohols, nitriles or esters.

Which statements are correct?

1 Both primary and secondary alcohols can be oxidised to carboxylic acids.

2 Carboxylic acids can be made from nitriles by hydrolysis.

3 Ethyl propanoate gives propanoic acid when reacted with hydrochloric acid.

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