Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

CHEMISTRY **9701/12**

Paper 1 Multiple Choice **October/November 2014**

1 hour

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

5984535004

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.

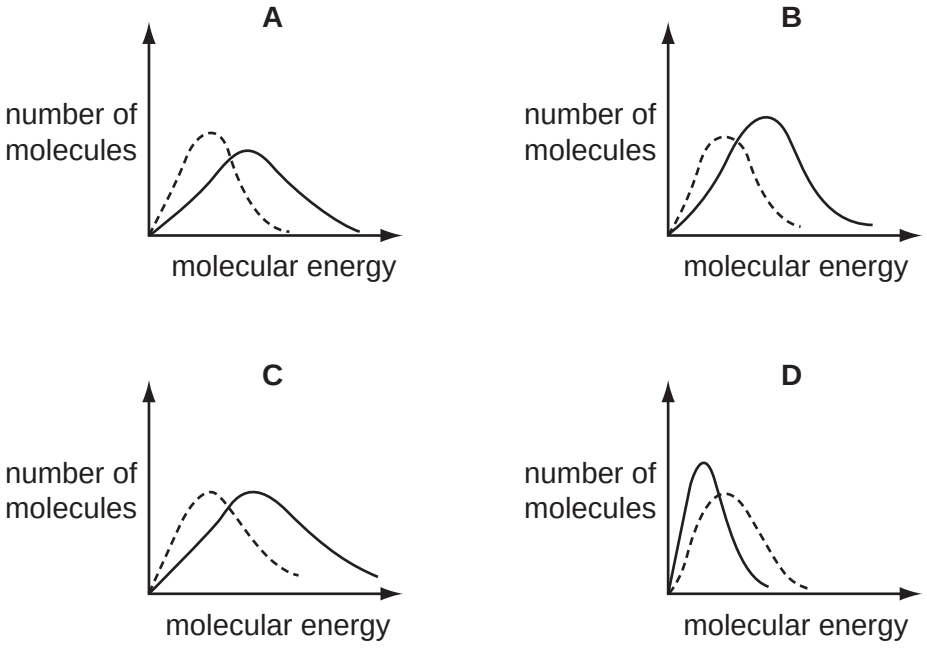
This document consists of **13** printed pages and **3** blank pages.

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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.

1 Which solid-line curve most accurately represents the distribution of molecular energies in a gas at 500 K if the dotted-line curve represents the corresponding distribution for the same gas at 300 K?



2 In which reaction does hydrogen behave as an oxidising agent?

A $H_2 + Cl_2 \rightarrow 2HCl$

B $C_2H_4 + H_2 \rightarrow C_2H_6$

C $N_2 + 3H_2 \rightarrow 2NH_3$

D $2Na + H_2 \rightarrow 2NaH$

3 Ethanol is increasingly being used as a fuel for cars.

The standard enthalpy change of formation of carbon dioxide is $-393\,kJ\,mol^{-1}$.
The standard enthalpy change of formation of water is $-286\,kJ\,mol^{-1}$.
The standard enthalpy change of formation of ethanol is $-277\,kJ\,mol^{-1}$.

What is the standard enthalpy change of combustion of ethanol?

A $-1921\,kJ\,mol^{-1}$

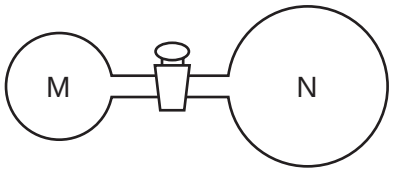
B $-1367\,kJ\,mol^{-1}$

C $-956\,kJ\,mol^{-1}$

D $-402\,kJ\,mol^{-1}$

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4 Two glass vessels M and N are connected by a closed valve.



M contains helium at 20 °C at a pressure of 1×10^5 Pa. N has been evacuated, and has three times the volume of M. In an experiment, the valve is opened and the temperature of the whole apparatus is raised to 100 °C.

What is the final pressure in the system?

A 3.18×10^4 Pa

B 4.24×10^4 Pa

C 1.25×10^5 Pa

D 5.09×10^5 Pa

5 The table shows the physical properties of four substances.

Which substance could be hydrogen chloride?

	melting point / °C	electrical conductivity of solid	electrical conductivity of liquid	electrical conductivity of aqueous solution
A	–119	poor	poor	insoluble
B	–115	poor	poor	good
C	–50	poor	poor	poor
D	993	poor	good	good

6 Aluminium carbide, Al_4C_3, reacts readily with aqueous sodium hydroxide. The two products of the reaction are $NaAlO_2$ and a hydrocarbon. Water molecules are also involved as reactants.

What is the formula of the hydrocarbon?

A CH_4 **B** C_2H_6 **C** C_3H_8 **D** C_6H_{12}

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7 In an experiment to calculate the enthalpy change of combustion of a fuel, 1.5 g (0.0326 mol) of the fuel was used to heat 200 g of water. The temperature of the water rose from 25 °C to 55 °C. The specific heat capacity of water is $4.18\,J\,g^{-1}\,K^{-1}$.

There is significant heat loss in this experiment. Therefore, the experimental value for the enthalpy change of combustion, ΔH_c, of the fuel will be different from the theoretical value.

Using the information above, what is the experimental value for the enthalpy change of combustion, ΔH_c, of the fuel?

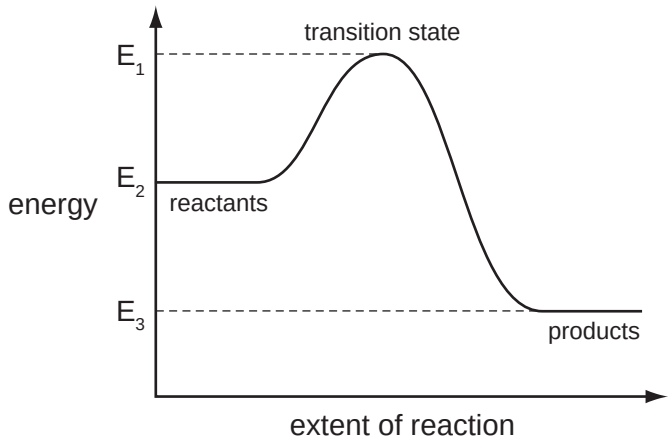
A $-1410\,kJ\,mol^{-1}$

B $-769\,kJ\,mol^{-1}$

C $-30.7\,kJ\,mol^{-1}$

D $-16.7\,kJ\,mol^{-1}$

8 The reaction pathway diagram below illustrates the energies of the reactants, the products and the transition state of a reaction.



Which expression represents the activation energy of the forward reaction?

A $E_1 - E_2$ **B** $E_2 - E_1$ **C** $E_2 - E_3$ **D** $E_3 - E_2$

9 Methylpropan-1-ol and butan-1-ol are structural isomers. Methylpropan-1-ol has a lower boiling point.

Which statement explains why the boiling point of methylpropan-1-ol is lower than that of butan-1-ol?

A Methylpropan-1-ol cannot form hydrogen bonds.

B Methylpropan-1-ol has weaker covalent bonds than butan-1-ol.

C Methylpropan-1-ol has weaker van der Waals' forces than butan-1-ol.

D Methylpropan-1-ol molecules have more surface area than butan-1-ol molecules.

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10 Which row correctly describes the electrodes used in the electrolysis cell for the production of aluminium?

	anode	cathode
A	carbon	carbon
B	carbon	steel
C	steel	carbon
D	steel	steel

11 For which equation is the enthalpy change correctly described as an enthalpy change of formation?

A $C(g) + O_2(g) \rightarrow CO_2(g)$

B $C(s) + \frac{1}{2}O_2(g) \rightarrow CO(g)$

C $2N(g) + 4O(g) \rightarrow N_2O_4(g)$

D $2NO(g) + O_2(g) \rightarrow 2NO_2(g)$

12 Element **X**, in Period 3, has the following properties.

- Its oxide has a giant structure.
- It forms covalent bonds with chlorine.
- Its oxide will neutralise $HCl(aq)$.

What is element **X**?

A Mg **B** Al **C** Si **D** P

13 Which property is **not** associated with the element sodium?

A It can react with cold water to form hydrogen.

B It forms a basic oxide.

C It forms a neutral chloride.

D It is an oxidising agent.

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14 *Use of the Data Booklet is relevant to this question.*

Sir Humphrey Davy discovered boron, calcium, magnesium and sodium.

Which of these elements has the **second** smallest atomic radius in its group and the **third** lowest first ionisation energy in its period?

A boron

B calcium

C magnesium

D sodium

15 *Use of the Data Booklet is relevant to this question.*

A sample of potassium oxide, K_2O, is dissolved in 250 cm^3 of distilled water. 25.0 cm^3 of this solution is titrated against sulfuric acid of concentration 2.00 mol dm^{-3}. 15.0 cm^3 of this sulfuric acid is needed for complete neutralisation.

Which mass of potassium oxide was originally dissolved in 250 cm^3 of distilled water?

A 2.83 g **B** 28.3 g **C** 47.1 g **D** 56.6 g

16 Chlorine gas reacts with cold aqueous sodium hydroxide. It can also react with hot aqueous sodium hydroxide.

What are the oxidation numbers of chlorine in the products of these reactions?

	cold aqueous sodium hydroxide	hot aqueous sodium hydroxide
A	–1, +1	–1, +5
B	–1, +1	+1, +6
C	–1, +2	–1, +5
D	–1, +2	+1, +6

17 Under standard conditions, which statement is correct?

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

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

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

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

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18 Total removal of the pollutant sulfur dioxide, SO_2, is difficult. The quantities emitted from furnace chimneys can be lowered by using desulfurisation plants. The gases are reacted with calcium hydroxide to remove the SO_2.

What is the main product formed **initially**?

A $Ca(HSO_4)_2$ **B** CaS **C** $CaSO_3$ **D** $CaSO_4$

19 Which oxide does **not** react with cold dilute sodium hydroxide to produce a salt?

A Al_2O_3 **B** P_4O_{10} **C** SO_2 **D** SiO_2

20 Which row correctly describes the reaction between propene and bromine, $Br_2(l)$?

	reaction mechanism	organic product
A	electrophilic addition	$CH_3CHBrCH_2Br$
B	electrophilic addition	$CH_3CH_2CH_2Br$
C	nucleophilic substitution	$CH_3CH_2CH_2Br$
D	nucleophilic substitution	$CH_3CHBrCH_2Br$

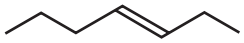
21 *Use of the Data Booklet is relevant to this question.*

Which compound has an M_r of 84 and will react with HBr to give a product with an M_r of 164.9?

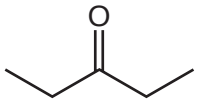
A



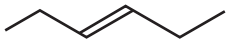
B



C



D



22 1,1-dichloropropane reacts with aqueous sodium hydroxide in a series of steps to give propanal.

$$CH_3CH_2CHCl_2 \xrightarrow{NaOH(aq)} CH_3CH_2CHO$$

Which term describes the first step of this reaction?

A addition

B elimination

C oxidation

D substitution

23 Considering **only** structural isomers, what is the number of alcohols of each type with the formula $C_5H_{12}O$?

	primary	secondary	tertiary
A	3	3	2
B	4	2	2
C	4	3	1
D	5	2	1

24 Lactic acid, $CH_3CH(OH)CO_2H$, causes pain when it builds up in muscles.

Which reagent reacts with **both** of the –OH groups in lactic acid?

A acidified potassium dichromate(VI)

B ethanol

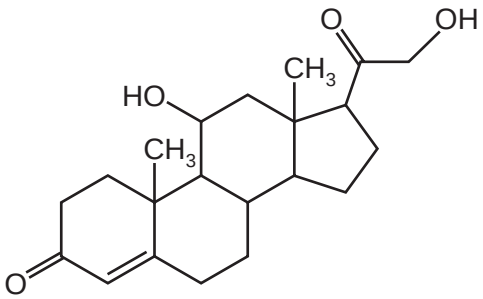
C sodium

D sodium hydroxide

25 In the hydrolysis of bromoethane by aqueous sodium hydroxide, what is the nature of the attacking group and of the leaving group?

	attacking group	leaving group
A	electrophile	electrophile
B	electrophile	nucleophile
C	nucleophile	electrophile
D	nucleophile	nucleophile

26 Corticosterone is a hormone involved in the metabolism of carbohydrates and proteins.



corticosterone

How many chiral centres are there in one molecule of corticosterone?

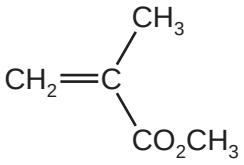
A 5 **B** 6 **C** 7 **D** 8

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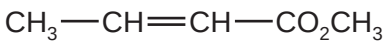
27 Methyl methylpropenoate is the monomer used to make *Perspex*.

Which diagram correctly shows methyl methylpropenoate?

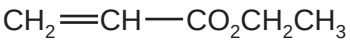
A



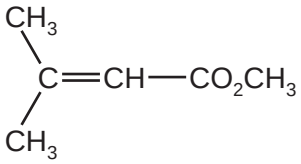
B



C



D



28 The ester $CH_3CH_2CH_2CO_2CH_3$ is responsible for the aroma of apples.

When this ester is hydrolysed by acid in the stomach, what is the empirical formula of the organic acid produced?

A CH_2O **B** CH_4O **C** C_2H_4O **D** $C_3H_6O_2$

29 Which equation correctly represents the balanced equation for the complete combustion of a hydrocarbon with the formula C_xH_y?

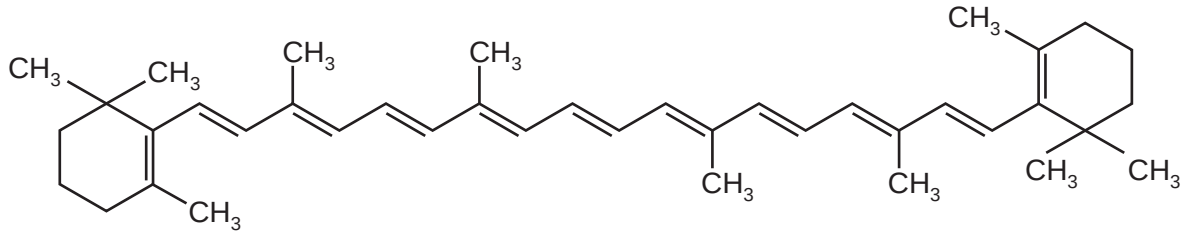
A $C_xH_y + (x + \frac{y}{2})O_2 \rightarrow xCO_2 + \frac{y}{2}H_2O$

B $C_xH_y + (x + \frac{y}{4})O_2 \rightarrow xCO_2 + yH_2O$

C $C_xH_y + (x + \frac{y}{4})O_2 \rightarrow xCO_2 + \frac{y}{4}H_2O$

D $C_xH_y + (x + \frac{y}{4})O_2 \rightarrow xCO_2 + \frac{y}{2}H_2O$

30 β-carotene is responsible for the orange colour of carrots.



β-carotene

β-carotene is oxidised by hot, concentrated, acidified $KMnO_4$.

When an individual molecule of β-carotene is oxidised in this way, many product molecules are formed.

How many of these product molecules contain a ketone functional group?

A 4 **B** 6 **C** 9 **D** 11

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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.

31 *Use of the Data Booklet is relevant to this question.*

Which ions contain one or more unpaired electrons?

1 Cu^{2+}

2 Mn^{3+}

3 V^{3+}

32 *Use of the Data Booklet is relevant to this question.*

The bond energy of the Br – O bond is 235 kJ mol^{-1}.

Which reactions are exothermic?

1 $OH\bullet + HBr \rightarrow H_2 + BrO\bullet$

2 $OH\bullet + HBr \rightarrow H_2O + Br\bullet$

3 $H\bullet + HBr \rightarrow H_2 + Br\bullet$

33 A reversible reaction is catalysed.

Which statements about the effects of the catalyst on this system are correct?

1 The catalyst alters the mechanism of the reaction.

2 The catalyst reduces the activation energy for both the forward and the backward reaction.

3 The catalyst alters the composition of the equilibrium mixture.

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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.

34 A student borrowed a friend's chemistry notes and copied out the notes in the box below.

Which statements are correct?

A gas behaves **less** like an ideal gas when the gas

1 is at low pressure.

2 is at low temperature.

3 can be easily liquefied.

35 On being heated, hydrogen iodide breaks down more quickly than hydrogen chloride.

Which statements explain this faster rate?

1 The HI bond is weaker than the HC*l* bond.

2 The reaction of the breakdown of HI has a smaller activation energy than that of HC*l*.

3 The breakdown of HI is more exothermic than that of HC*l*.

36 Which statements about calcium oxide are correct?

1 It reacts with cold water.

2 It is produced when calcium nitrate is heated.

3 It can be reduced by heating with magnesium.

37 Propanal will react with hydrogen cyanide to form 2-hydroxybutanenitrile. A suitable catalyst for this reaction is sodium cyanide.

$$CH_3CH_2CHO + HCN \overset{NaCN}{\rightleftharpoons} CH_3CH_2CH(OH)CN$$

Which statements about the reaction of propanal with hydrogen cyanide are correct?

1 The CN^- ion attacks the propanal molecule to form an intermediate ion.

2 The product of the reaction has a chiral carbon atom.

3 The CN^- ion is a stronger electrophile than the HCN molecule.

38 **X** is an organic compound that gives a precipitate with aqueous silver nitrate. This precipitate remains undissolved when concentrated aqueous ammonia is added.

What is a possible identity for **X**?

1 iodomethane

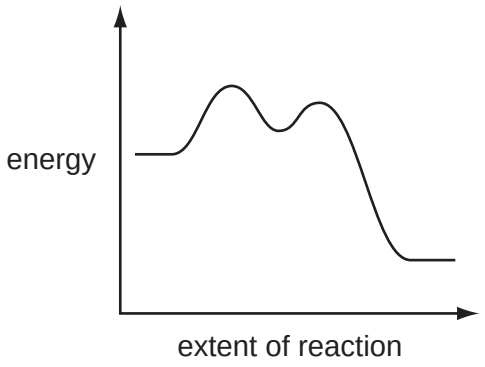
2 2-bromobutane

3 2-chlorobutane

39 For which mixtures of reagents are the colour changes described correctly?

	reagents	colour change
1	pentanal + hot, acidified potassium dichromate(VI)	orange to green
2	pentan-2-one + warm Fehling's reagent	no change
3	cyclohexane + cold, acidified potassium manganate(VII)	purple to colourless

40 A reaction pathway diagram is shown.



Which reactions would have this profile?

1 $(CH_3)_3CBr + NaOH \rightarrow (CH_3)_3COH + NaBr$

2 $CH_3CH_2Br + NaOH \rightarrow CH_3CH_2OH + NaBr$

3 $(CH_3)_3CCH_2CH_2Cl + 2NH_3 \rightarrow (CH_3)_3CCH_2CH_2NH_2 + NH_4Cl$

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