

CHEMISTRY

9701/11

Paper 1 Multiple Choice

May/June 2016

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.

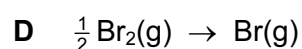
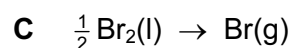
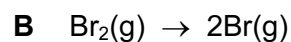
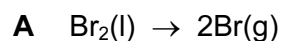
This document consists of **15** printed pages and **1** blank page.

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 Which equation shows the reaction that occurs during the standard enthalpy change of atomisation of bromine?



- 2 What is the correct number of bonds of each type in the Al_2Cl_6 molecule?

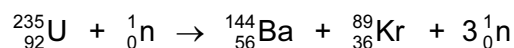
	covalent	co-ordinate (dative covalent)
A	6	1
B	6	2
C	7	0
D	7	1

- 3 Tetraethyl lead, $\text{Pb}(\text{C}_2\text{H}_5)_4$, has been used as a petrol additive.

What is the percentage by mass of carbon in tetraethyl lead?

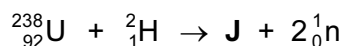
- A** 10.2 **B** 14.9 **C** 29.7 **D** 32.0

- 4 When nuclear reactions take place, the elements produced are different from the elements that reacted. Nuclear equations, such as the one below, are used to represent the changes that occur.



The nucleon (mass) number total is constant at 236 and the proton number total is constant at 92.

In another nuclear reaction, uranium-238 is reacted with deuterium atoms, ${}_1^2\text{H}$. An isotope of a new element, **J**, is formed as well as two neutrons.



What is isotope **J**?

- A** ${}_{92}^{238}\text{Np}$ **B** ${}_{92}^{238}\text{Pu}$ **C** ${}_{92}^{240}\text{Np}$ **D** ${}_{92}^{240}\text{Pu}$

- 5 Dicarbon monoxide, C_2O , is found in dust clouds in space. The structure of this molecule is $\text{C}=\text{C}=\text{O}$. The molecule contains no unpaired electrons.

How many lone pairs of electrons are present in a molecule of C_2O ?

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

- 6 A white powder is known to be a mixture of magnesium oxide and aluminium oxide.

100 cm^3 of 2 mol dm^{-3} $\text{NaOH}(\text{aq})$ is just sufficient to cause the aluminium oxide in x grams of the mixture to dissolve.

The reaction occurring is $\text{Al}_2\text{O}_3 + 2\text{OH}^- + 3\text{H}_2\text{O} \rightarrow 2\text{Al}(\text{OH})_4^-$.

800 cm^3 of 2 mol dm^{-3} $\text{HCl}(\text{aq})$ is just sufficient to cause **all** of the oxide in x grams of the mixture to dissolve.

The reactions occurring are $\text{Al}_2\text{O}_3 + 6\text{H}^+ \rightarrow 2\text{Al}^{3+} + 3\text{H}_2\text{O}$
and $\text{MgO} + 2\text{H}^+ \rightarrow \text{Mg}^{2+} + \text{H}_2\text{O}$.

How many moles of each oxide are present in x grams of the mixture?

	aluminium oxide	magnesium oxide
A	0.05	0.25
B	0.05	0.50
C	0.10	0.25
D	0.10	0.50

- 7 At room temperature and pressure, H_2O is a liquid and H_2S is a gas.

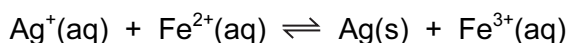
What is the reason for this difference?

- A** O has higher first and second ionisation energies than S.
- B** The covalent bond between O and H is stronger than the covalent bond between S and H.
- C** There is significant hydrogen bonding between H_2O molecules but not between H_2S molecules.
- D** The instantaneous dipole-induced dipole forces between H_2O molecules are stronger than the instantaneous dipole-induced dipole forces between H_2S molecules.
- 8 Gaseous phosphorus pentachloride can be decomposed into gaseous phosphorus trichloride and chlorine by heating. The table gives the bond energies.

bond	bond energy / kJ mol^{-1}
P-Cl (in both chlorides)	330
Cl-Cl	242

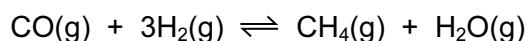
What is the enthalpy change for the decomposition of PCl_5 to PCl_3 and Cl_2 ?

- A** -418 kJ mol^{-1}
- B** -88 kJ mol^{-1}
- C** $+88 \text{ kJ mol}^{-1}$
- D** $+418 \text{ kJ mol}^{-1}$
- 9 An aqueous solution was prepared containing a mixture of 1.0 mol of AgNO_3 and 1.0 mol of FeSO_4 in 1.00 dm^3 of water. When equilibrium was established, there was 0.44 mol of $\text{Ag}^+(\text{aq})$ in the mixture.



What is the numerical value of K_c ?

- A** 0.62 **B** 1.40 **C** 1.62 **D** 2.89
- 10 The equation for the reaction between carbon monoxide and hydrogen is shown.



What are the units of K_p for this reaction?

- A** kPa **B** kPa^{-1} **C** kPa^2 **D** kPa^{-2}

- 11** Enzymes are biological catalysts. Many enzymes show specificity. An example of an enzyme which shows specificity is glucokinase. Glucokinase is involved in the metabolism of glucose.

What does specificity mean in this context?

- A** Glucokinase is most effective as a catalyst over a narrow pH range.
- B** Glucokinase is most effective as a catalyst over a narrow range of temperatures.
- C** Glucokinase only operates on a narrow range of substrate molecules.
- D** Glucokinase provides an alternative route for the reactions it catalyses.
- 12** Why is the ionic radius of a chloride ion larger than the ionic radius of a sodium ion?
- A** A chloride ion has one more occupied electron shell than a sodium ion.
- B** Chlorine has a higher proton number than sodium.
- C** Ionic radius increases regularly across the third period.
- D** Sodium is a metal, chlorine is a non-metal.
- 13** Elements D and E are both in Period 3. Element D has the smallest atomic radius in Period 3. There are only two elements in Period 3 which have a lower melting point than element E. Elements D and E react together to form compound L.

Which compound could be L?

- A** MgCl_2 **B** MgS **C** Na_2S **D** PCl_3
- 14** X and Y are both Group 2 metals.

X and Y both form hydroxide compounds, but X(OH)_2 is more soluble in water than Y(OH)_2 .

If a piece of metal Y is put into cold water a very slow reaction occurs, and only a very few, small hydrogen bubbles can be seen.

What could be the identities of X and Y?

	X	Y
A	barium	magnesium
B	barium	strontium
C	calcium	strontium
D	magnesium	calcium

- 15 The solids sodium chloride and sodium iodide both react with concentrated sulfuric acid at room temperature.

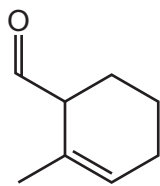
With NaCl , the products are NaHSO_4 and HCl .

With NaI , the products are NaHSO_4 , HI , I_2 , SO_2 , H_2O , S and H_2S .

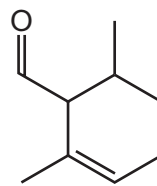
What is the best explanation for this difference in products?

- A Chloride ions will displace iodine from solution.
 - B Hydrogen chloride is more volatile than hydrogen iodide.
 - C Iodide ions are better reducing agents than chloride ions.
 - D Sulfuric acid is able to act as a dehydrating agent with NaI .
- 16 In some areas lime, $\text{Ca}(\text{OH})_2$, is added to soil to improve crop growth.
- Which statement correctly describes a reason why lime improves crop growth?
- A Lime acts as a catalyst which speeds up the release of nitrates into the soil.
 - B Lime is an effective pesticide and protects the plants from damage.
 - C Lime is used to reduce the acidity of the soil.
 - D Lime lowers the pH of the soil.
- 17 A piece of rock has a mass of 2.00 g. It contains calcium carbonate, but no other basic substances. It neutralises exactly 36.0 cm^3 of $0.500 \text{ mol dm}^{-3}$ hydrochloric acid.
- What is the percentage of calcium carbonate in the 2.00 g piece of rock?
- A 22.5% B 45.0% C 72.0% D 90.1%
- 18 Which statement about the ammonia molecule and/or the ammonium ion is correct?
- A Ammonia molecules are basic because they can donate H^+ ions.
 - B Ammonium ions are basic because they can accept H^+ ions.
 - C If ammonium ions are heated with $\text{NaOH}(\text{aq})$, ammonia molecules are formed.
 - D The bond angle in NH_4^+ is 2.5° less than the bond angle in NH_3 .
- 19 Which reaction **does not** contribute to the problem of acid rain?
- A the combustion of fossil fuels
 - B the oxidation of sulfur dioxide to sulfur trioxide catalysed by nitrogen dioxide
 - C the reaction between nitrogen monoxide and carbon monoxide in a catalytic converter
 - D the reaction of sulfur trioxide with water

20 The diagrams show two different compounds.



1



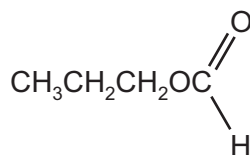
2

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 The structural formula of compound **X** is shown below.

compound **X**

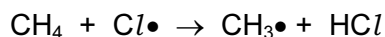
What is the name of compound **X** and how does its boiling point compare with that of butanoic acid?

	name of X	boiling point of X
A	methyl propanoate	higher than butanoic acid
B	methyl propanoate	lower than butanoic acid
C	propyl methanoate	higher than butanoic acid
D	propyl methanoate	lower than butanoic acid

22 Which pair of reagents will take part in a redox reaction?

- A $\text{CH}_3\text{CHCH}_2 + \text{Br}_2$
 B $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH} + \text{concentrated H}_3\text{PO}_4$
 C $\text{CH}_3\text{COCH}_3 + \text{HCN}$
 D $\text{HCO}_2\text{C}_2\text{H}_5 + \text{dilute H}_2\text{SO}_4$

23 The **first** propagation step in the reaction between methane and chlorine is shown.



How many different **first** propagation steps are possible in the reaction between pentane and chlorine?

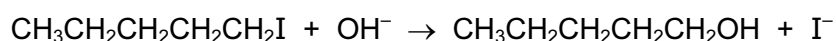
- A 2 B 3 C 4 D 5

24 Alcohol Y gives product Z after mild oxidation. Z gives a positive result with Tollens' reagent and with 2,4-dinitrophenylhydrazine reagent.

What could be the identity of alcohol Y?

- A butan-1-ol
 B butan-2-ol
 C butan-2,3-diol
 D 2-methylbutan-2-ol

25 A student prepares pentan-1-ol by the alkaline hydrolysis of 1-iodopentane. She gently warms the reaction mixture for 20 minutes.

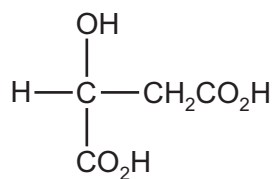


When the student uses 1-chloropentane to prepare the same alcohol she has to change the condition of the reaction.

Which change in condition should she use and what is the correct reason for its use?

	change in condition	reason
A	heat under reflux	C–Cl bond is more polar than the C–I bond
B	heat under reflux	C–Cl bond is stronger than the C–I bond
C	room temperature	C–Cl bond is more polar than the C–I bond
D	room temperature	C–Cl bond is shorter than the C–I bond

26 Malic acid is found in apples.

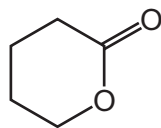


malic acid

Which reagent will react with all three –OH groups present in the malic acid molecule?

- A ethanol in the presence of concentrated sulfuric acid
- B potassium hydroxide
- C sodium
- D sodium carbonate

27 Cyclic esters are also known as lactones. *Delta* lactone is used as a solvent and in the manufacture of polyesters.



delta lactone

From which compound could *delta* lactone be made by a single reaction?

- A HOCH₂CH₂CH₂CH₂CHO
- B HOCH₂CH₂CH₂CH₂CO₂H
- C HOCH₂CH₂CH₂CH₂CH₂OH
- D HOCH₂CH₂CH₂CH₂CH₂CO₂H

28 Which reagent **cannot** be used to distinguish between ethanal and propanone?

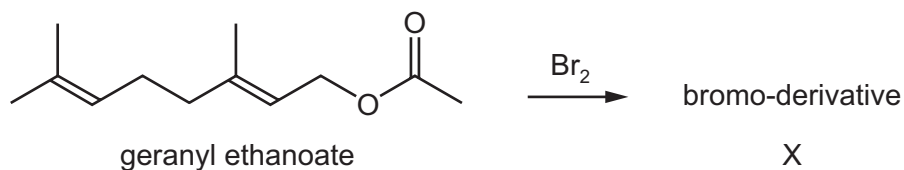
- A acidified sodium dichromate(VI) solution
- B alkaline aqueous iodine
- C cold acidified potassium manganate(VII) solution
- D Fehling's reagent

29 The ester $\text{CH}_3\text{CH}_2\text{CH}_2\text{CO}_2\text{CH}_2\text{CH}(\text{CH}_3)_2$ was hydrolysed under acidic conditions.

What are the organic products of this hydrolysis?

- A butanoic acid and 2-methylpropan-1-ol
- B butanoic acid and 2-methylpropan-2-ol
- C butan-1-ol and 2-methylpropanoic acid
- D propanoic acid and 2-methylpropan-1-ol

30 Geranyl ethanoate is present in ginger and cocoa, and is used in shampoos and soaps as a perfume. It reacts with an excess of bromine in an organic solvent to give X, a bromo-derivative.



Including geranyl ethanoate, how many cis-trans isomers are there of geranyl ethanoate, and how many chiral centres are there in X?

	cis-trans isomers	chiral centres in X
A	2	3
B	2	4
C	4	3
D	4	4

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 X is a particle with 18 electrons and 20 neutrons.

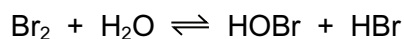
What could be the symbol of X?

- 1** ${}^{38}_{18}\text{Ar}$
- 2** ${}^{40}_{20}\text{Ca}^{2+}$
- 3** ${}^{39}_{19}\text{K}^{+}$

32 What are basic assumptions of the kinetic theory as applied to an ideal gas?

- 1** Gas particles are in continuous random motion.
- 2** Gas particles experience no intermolecular forces.
- 3** The volume of each gas particle is zero.

33 Bromine reacts with water.



Which oxidation states of bromine are present in the equilibrium mixture?

- 1** +3
- 2** 0
- 3** -1

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 little water is added to each of the following compounds and the mixture warmed.

For which compounds will an acidic gas be evolved?

- 1** aluminium chloride
- 2** silicon tetrachloride
- 3** phosphorous pentachloride

35 The element astatine, At, is below iodine in Group 17 of the Periodic Table.

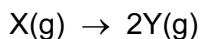
Which statements concerning At are likely to be correct?

- 1** It is a dark-coloured solid at room temperature.
- 2** It is a more powerful oxidising agent than iodine.
- 3** Its hydride is thermally stable.

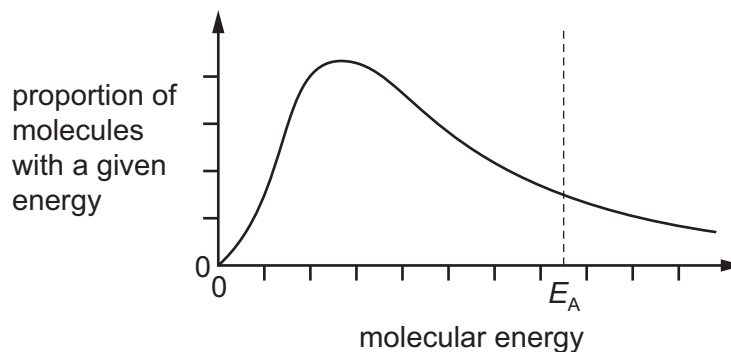
36 Which types of reaction can occur with 1-bromobutane?

- 1** elimination
- 2** hydrolysis
- 3** free radical substitution

37 The equation shows a gas phase reaction.

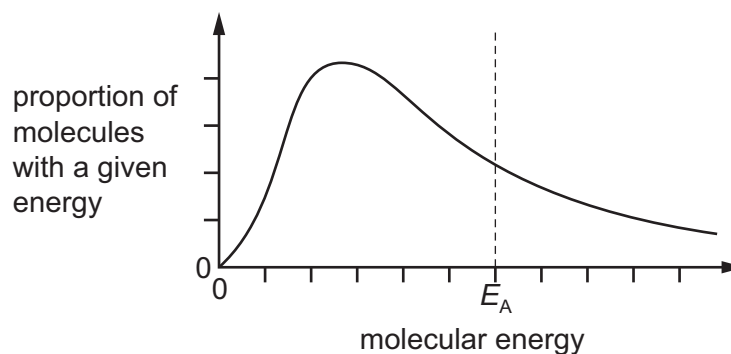


The diagram shows the Boltzmann distribution of a fixed mass of X(g) at temperature T in the absence of a catalyst. The line E_A indicates the activation energy.

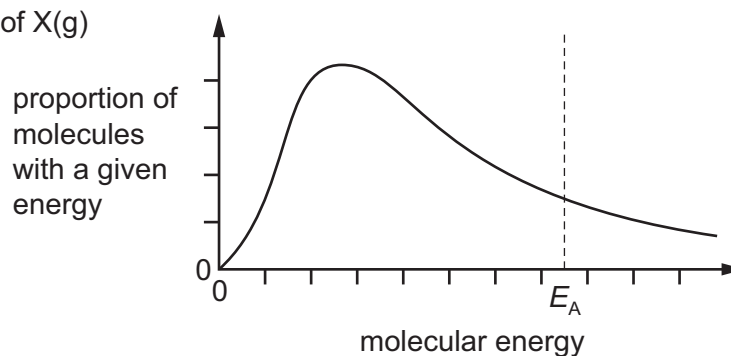


Which diagrams correctly show the effect of the following changes made separately and independently?

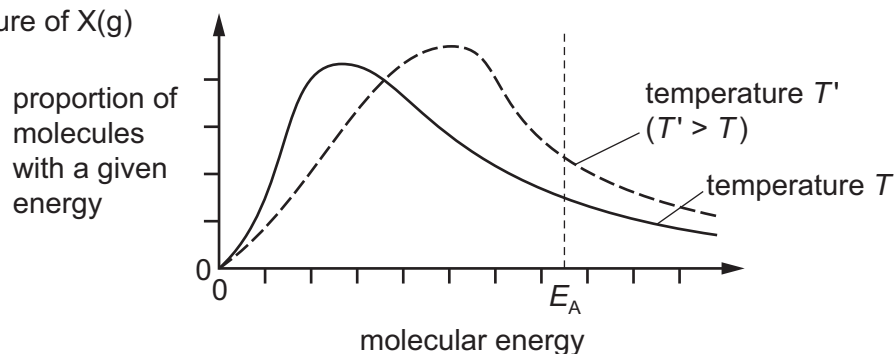
1 adding a catalyst



2 increasing the pressure of X(g)



3 increasing the temperature of X(g)

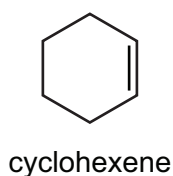


The responses **A** to **D** should be selected on the basis of

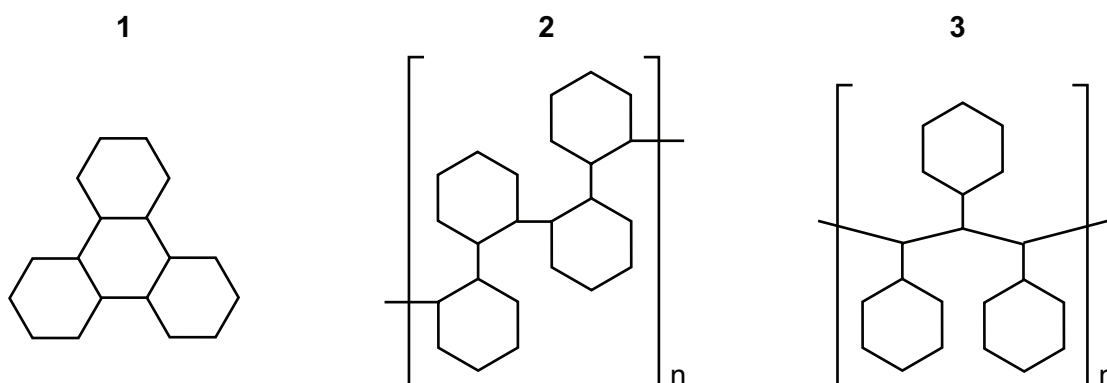
A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

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

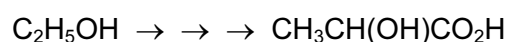
38 The diagram shows the structure of cyclohexene.



Which structures could be formed by addition reactions with cyclohexene as the only reactant?



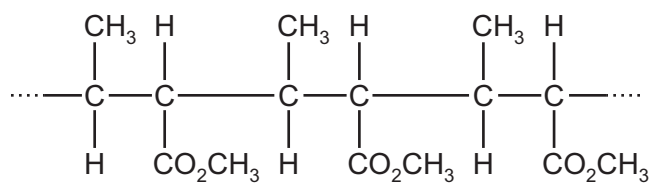
39 Several steps are involved in the synthesis of 2-hydroxypropanoic acid from ethanol.



Which statements concerning this synthesis are correct?

- 1** The chain length can be increased during a step involving reaction between HCN and an aldehyde.
- 2** The carboxyl group can be made by hydrolysis of a nitrile by boiling with NaOH(aq) and then acidifying.
- 3** The ethanol should be first oxidised by heating it under reflux with an excess of acidified potassium dichromate(VI).

40 The diagram shows the structure of an addition polymer, X.



Which reagents react with polymer X?

- 1 aqueous sulfuric acid
- 2 aqueous sodium hydroxide
- 3 sodium

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 International Examinations Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download at www.cie.org.uk after the live examination series.

Cambridge International Examinations is part of the Cambridge Assessment Group. Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.

CHEMISTRY

9701/12

Paper 1 Multiple Choice

May/June 2016

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.

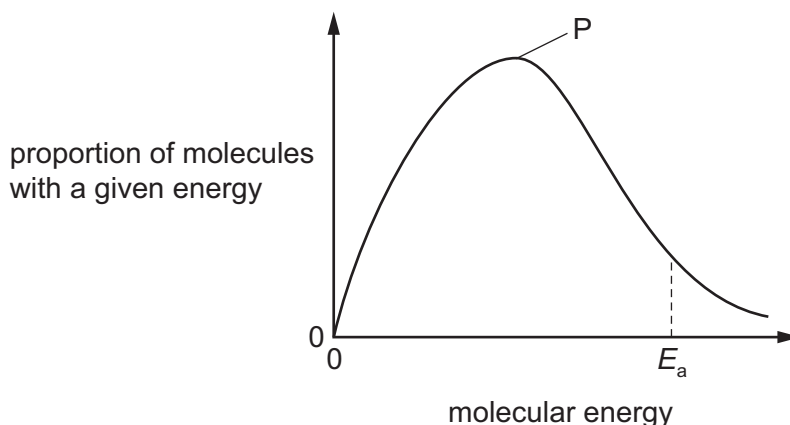
This document consists of **16** printed pages.

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 diagram shows the Boltzmann distribution of energies in 1 mole of a gas. The gas can take part in a reaction with an activation energy, E_a .



Which statement correctly describes the effect of an increase in temperature?

- A** Peak P will be higher and fewer molecules will have energy $> E_a$.
 - B** Peak P will be higher and more molecules will have energy $> E_a$.
 - C** Peak P will be lower and fewer molecules will have energy $> E_a$.
 - D** Peak P will be lower and more molecules will have energy $> E_a$.
- 2 Four electronic configurations are shown below. Three of these configurations belong to atoms of the elements chlorine, sodium and vanadium.

Which electronic configuration belongs to an atom of another element?

- A** $1s^2 2s^2 2p^6 3s^1$
- B** $1s^2 2s^2 2p^6 3s^2 3p^5$
- C** $1s^2 2s^2 2p^6 3s^2 3p^6 3d^3 4s^2$
- D** $1s^2 2s^2 2p^6 3s^2 3p^6 3d^6 4s^2$

- 3 Elements X and Y are in the same group of the Periodic Table.

The table shows the first six ionisation energies of X and Y in kJ mol^{-1} .

	1st	2nd	3rd	4th	5th	6th
X	800	1600	2400	4300	5400	10 400
Y	1000	1800	2700	4800	6000	12 300

What could be the identities of X and Y?

	X	Y
A	antimony, Sb	arsenic, As
B	arsenic, As	antimony, Sb
C	selenium, Se	tellurium, Te
D	tellurium, Te	selenium, Se

- 4 In China, the concentration of blood glucose, $\text{C}_6\text{H}_{12}\text{O}_6$, is measured in mmol/l . In Pakistan, the concentration of blood glucose is measured in mg/dl .

The unit l is a litre (1 dm^3). The unit dl is a decilitre (0.1 dm^3).

A blood glucose concentration of 18.5 mmol/l indicates a health problem.

What is 18.5 mmol/l converted to mg/dl ?

- A** 33.3 mg/dl **B** 178 mg/dl **C** 333 mg/dl **D** 3330 mg/dl

- 5 Each of the four species in this question are isolated and gaseous.

Which species is **not** planar?

- A** BF_3 **B** CH_3^+ **C** C_2H_4 **D** NH_3

- 6 Argon is a gas used to fill electric light bulbs.

Under which conditions of pressure and temperature will argon behave most like an ideal gas?

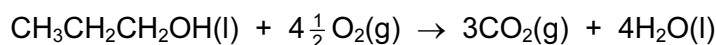
	pressure	temperature
A	high	high
B	high	low
C	low	high
D	low	low

- 7 0.10 g of the volatile liquid X formed 0.025 dm^3 of vapour at 100°C and atmospheric pressure.
1 mol of vapour occupies 22.4 dm^3 at 0°C and atmospheric pressure.

What is the relative molecular mass of X?

- A $\frac{0.025 \times 273 \times 22.4}{0.10 \times 373}$
B $\frac{0.025 \times 373 \times 22.4}{0.10 \times 273}$
C $\frac{0.10 \times 273 \times 22.4}{0.025 \times 373}$
D $\frac{0.10 \times 373 \times 22.4}{0.025 \times 273}$

- 8 The equation for the complete combustion of propan-1-ol is shown.

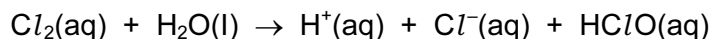


Standard enthalpy changes of formation are given.

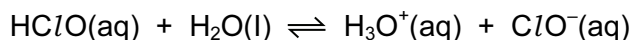
compound	$\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}(\text{l})$	$\text{CO}_2(\text{g})$	$\text{H}_2\text{O}(\text{l})$
$\Delta H_f^\ominus$	-303 kJ mol^{-1}	-394 kJ mol^{-1}	-286 kJ mol^{-1}

What is the standard enthalpy change of combustion of propan-1-ol, in kJ mol^{-1} ?

- A $-394 - 286 - 303$
B $303 - (4 \times 286) - (3 \times 394)$
C $394 + 286 - 303$
D $(3 \times 394) + (4 \times 286) + 303$
- 9 In the treatment of domestic water supplies, chlorine is added to the water to form HClO .



The HClO reacts further to give ClO^- ions.

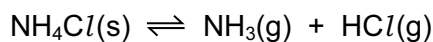


Both HClO and ClO^- kill bacteria by oxidation.

What is the change in oxidation number of chlorine when forming the ClO^- ion from aqueous chlorine?

- A -1 B 0 C +1 D +2

- 10 When solid ammonium chloride dissociates at a certain temperature in a 0.500 dm^3 container, ammonia and hydrogen chloride are formed.



The initial amount of ammonium chloride was 1.00 mol, and when the system had reached equilibrium there was 0.300 mol of ammonium chloride.

What is the numerical value of K_c for this reaction under these conditions?

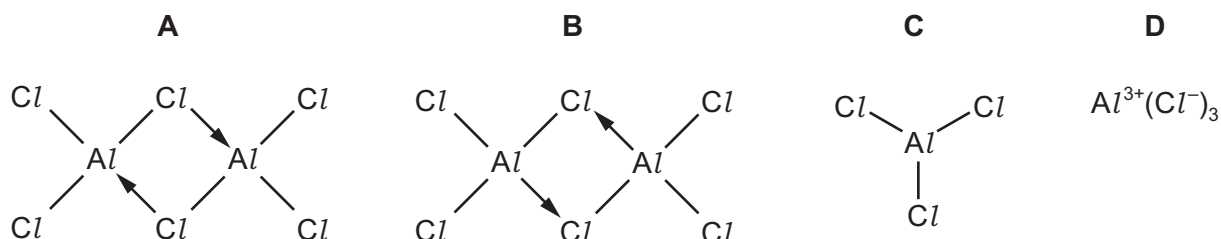
- A** 0.490 **B** 1.63 **C** 1.96 **D** 3.27
- 11 Which stage in the free radical substitution of ethane by chlorine has the lowest activation energy?
- A** $\text{Cl}_2 \rightarrow 2\text{Cl}\cdot$
- B** $\text{Cl}\cdot + \text{C}_2\text{H}_6 \rightarrow \text{C}_2\text{H}_5\cdot + \text{HCl}$
- C** $\text{C}_2\text{H}_5\cdot + \text{Cl}_2 \rightarrow \text{C}_2\text{H}_5\text{Cl} + \text{Cl}\cdot$
- D** $\text{Cl}\cdot + \text{C}_2\text{H}_5\cdot \rightarrow \text{C}_2\text{H}_5\text{Cl}$
- 12 Sodium and sulfur react together to form sodium sulfide, Na_2S .

How do the atomic radius and ionic radius of sodium compare with those of sulfur?

	atomic radius	ionic radius
A	sodium < sulfur	sodium > sulfur
B	sodium < sulfur	sodium < sulfur
C	sodium > sulfur	sodium > sulfur
D	sodium > sulfur	sodium < sulfur

- 13 Solid aluminium chloride sublimes at 178°C .

Which structure best represents the species in the vapour at this temperature?



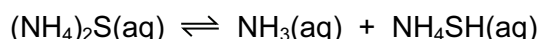
- 14** A 0.005 mol sample of anhydrous calcium carbonate was completely thermally decomposed to give 100 cm³ of gas measured at a certain temperature and pressure.

In a separate experiment carried out at the same temperature and pressure, a 0.005 mol sample of anhydrous calcium nitrate was completely thermally decomposed. The volume of gaseous products was measured.

What total volume of gaseous products was produced from the calcium nitrate?

- A** 50 cm³ **B** 100 cm³ **C** 200 cm³ **D** 250 cm³

- 15** Ammonia gas, NH₃, and hydrogen sulfide gas, H₂S, react together to form the salt ammonium sulfide, (NH₄)₂S. Ammonium sulfide dissolves in water to produce an orange alkaline solution.



The addition of NaOH(aq) to this solution produces a gas, **X**.

The addition of HCl(aq) to a separate portion of this solution produces a gas, **Y**.

What are the identities of **X** and **Y**?

	X	Y
A	H ₂ S	H ₂ S
B	H ₂ S	NH ₃
C	NH ₃	H ₂ S
D	NH ₃	NH ₃

- 16** A solid, **T**, was placed in an excess of the liquid **U**.

A colourless gas was given off and a white precipitate was seen. The precipitate was not **T**.

What could be the identities of **T** and **U**?

	T	U
A	BaCO ₃	H ₂ O
B	Ca	dilute H ₂ SO ₄
C	Mg	dilute H ₂ SO ₄
D	SrCO ₃	dilute HCl

- 17 Nitrogen(II) oxide, NO, nitrogen(IV) oxide, NO₂, carbon monoxide, CO, and unburnt hydrocarbons are present in the exhaust gases of internal combustion engines. When catalytic converters are used to remove these compounds from the exhaust gases, redox reactions occur.

What happens to each compound in the catalytic converter?

	NO	NO ₂	CO	hydrocarbons
A	oxidised	oxidised	reduced	oxidised
B	oxidised	oxidised	oxidised	oxidised
C	reduced	reduced	oxidised	oxidised
D	reduced	reduced	reduced	reduced

- 18 An excess of chlorine gas, Cl₂, is passed through 60 cm³ of cold aqueous 0.1 mol dm⁻³ sodium hydroxide. In a separate experiment an excess of chlorine gas is passed through 60 cm³ of hot aqueous 0.1 mol dm⁻³ sodium hydroxide until no further reaction takes place.

How much **more** sodium chloride will be produced by the reaction with hot NaOH than with cold NaOH?

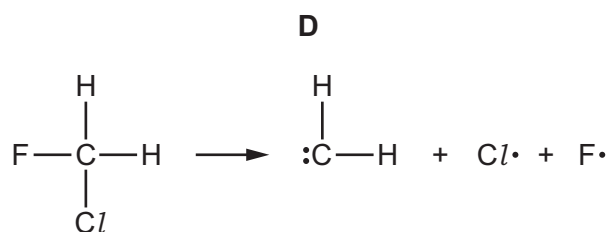
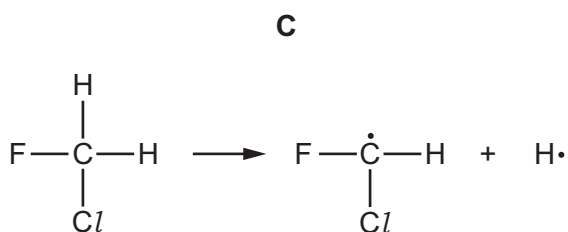
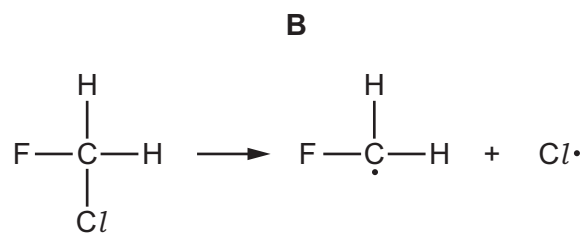
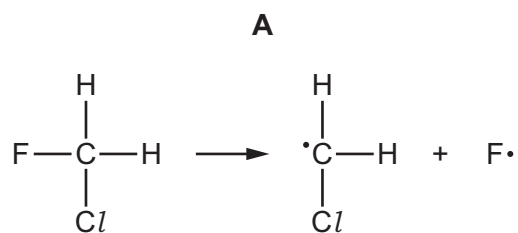
- A** 0.002 moles
B 0.003 moles
C 0.005 moles
D 0.006 moles
- 19 Fluorine and iodine are Group 17 elements. Their melting points are different due to differing strengths of van der Waals' forces between molecules.

Which row is correct?

	melting point	strength of van der Waals' forces between molecules
A	F ₂ > I ₂	F ₂ > I ₂
B	F ₂ > I ₂	F ₂ < I ₂
C	F ₂ < I ₂	F ₂ < I ₂
D	F ₂ < I ₂	F ₂ > I ₂

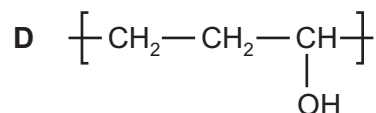
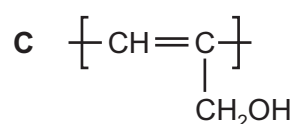
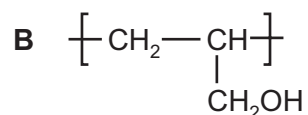
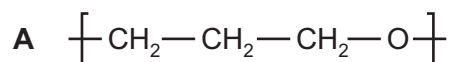
- 20 Chlorofluorocarbons damage the ozone layer by undergoing reactions with a free radical mechanism. The first stage of this is initiation.

Which equation is most likely to be the initiation stage when chlorofluoromethane is involved in such a reaction?



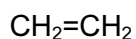
- 21 Synthetic resins can be made by polymerisation of a variety of monomers including prop-2-en-1-ol, $\text{CH}_2=\text{CHCH}_2\text{OH}$.

Which structure represents the repeat unit in poly(prop-2-en-1-ol)?

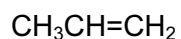


- 22 Oct-1-ene, $\text{CH}_3(\text{CH}_2)_5\text{CH}=\text{CH}_2$, can be thermally cracked.

Which combination of compounds W, X, Y and Z can be obtained by thermally cracking oct-1-ene?



W



X



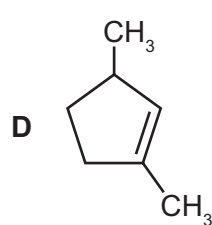
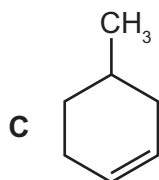
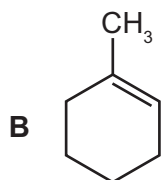
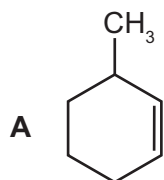
Y



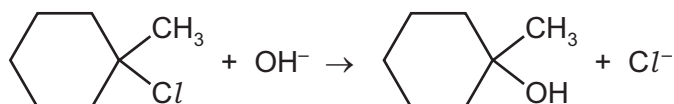
Z

- A W, X, Y and Z
 B W, X and Y only
 C W, X and Z only
 D W and X only
- 23 A cycloalkene with the molecular formula C_7H_{12} was oxidised by hot concentrated acidified MnO_4^- . The only organic product was 2-methylhexane-1,6-dioic acid.

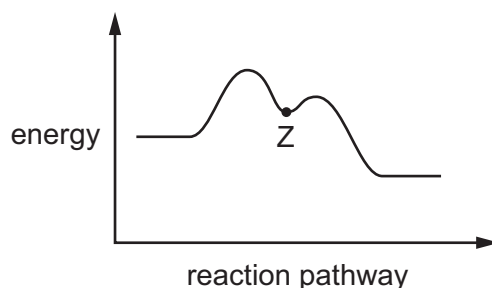
What is the identity of the cycloalkene?



- 24 1-chloro-1-methylcyclohexane is hydrolysed by heating with NaOH(aq) .



The reaction pathway is shown.

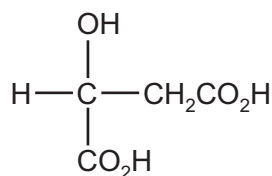


One carbon atom in 1-chloro-1-methylcyclohexane is bonded to three other carbon atoms.

What is the charge on this carbon atom at point Z?

- A δ^+ B $+$ C δ^- D $-$

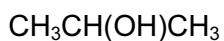
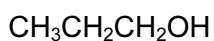
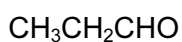
25 Malic acid is found in apples.



malic acid

Which reagent will react with only one of the –OH groups in the malic acid molecule?

- A** ethanoic acid in the presence of concentrated sulfuric acid
- B** sodium
- C** sodium hydrogen carbonate
- D** sodium hydroxide
- 26 Which organic compound would **not** give **either** a yellow precipitate when treated with alkaline aqueous iodine **or** an orange precipitate when treated with 2,4-dinitrophenylhydrazine reagent?
- A** propanal
- B** propan-1-ol
- C** propan-2-ol
- D** propanone
- 27 In which reaction is the organic compound oxidised?
- A** $\text{CH}_3\text{CH}_2\text{CH}_2\text{CHO} + \text{Tollens' reagent}$
- B** $\text{CH}_3\text{CH}_2\text{CH}_2\text{CHO} + \text{LiAlH}_4$
- C** $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH} + \text{concentrated H}_3\text{PO}_4$
- D** $\text{CH}_3\text{CO}_2\text{C}_2\text{H}_5 + \text{dilute H}_2\text{SO}_4$
- 28 How many of the following compounds produce a carboxylic acid on heating under reflux with an excess of hot acidified $\text{K}_2\text{Cr}_2\text{O}_7$?



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

- 29 How many isomeric esters, including structural isomers and stereoisomers, can be made with the molecular formula $C_5H_{10}O_2$, if methanoic acid is one of the two reactants used?

A 2 B 3 C 4 D 5

- 30 Compound X, $C_4H_8O_2$, has an unbranched carbon chain. An aqueous solution of X has an approximate pH of 3.

Compound Y, C_3H_8O , is a secondary alcohol.

X and Y are reacted together in the presence of a little concentrated sulfuric acid to form Z as the major organic product.

What is the structural formula of Z?

- A $(CH_3)_2CHCO_2CH_2CH_2CH_3$
B $CH_3(CH_2)_2CO_2CH(CH_3)_2$
C $CH_3(CH_2)_2CO_2(CH_2)_2CH_3$
D $(CH_3)_2CHCO_2CH(CH_3)_2$

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** In an experiment, 10 cm^3 of an organic compound, **J**, in the gaseous state was sparked with an excess of oxygen. 20 cm^3 of carbon dioxide and 5 cm^3 of nitrogen were obtained among the products. All gas volumes were measured at the same temperature and pressure.

What could be the identity of **J**?

- 1** $\text{C}_2\text{H}_6\text{N}_2$
- 2** $\text{C}_2\text{H}_3\text{N}$
- 3** $\text{C}_2\text{H}_7\text{N}$

- 32** Three elements, X, Y and Z, have electronic configurations as shown.

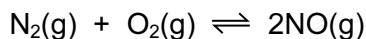
X	Y	Z
2,6	2,8,1	2,8,7

Which formulae represent compounds that conduct electricity in the liquid state?

- 1** YZ
- 2** Y_2X
- 3** Z_2X

- 33 In this question, all gases can be assumed to behave ideally.

A chemist heats a mixture of nitrogen and oxygen gases in a sealed container at a constant temperature until the mixture reaches a dynamic equilibrium containing $\text{N}_2(\text{g})$, $\text{O}_2(\text{g})$ and $\text{NO}(\text{g})$.



The chemist repeats the experiment at the same temperature using the same initial amounts of $\text{N}_2(\text{g})$ and $\text{O}_2(\text{g})$, but at a much higher pressure.

Which statements about the second experiment at higher pressure are correct?

- 1 At higher pressure, there are more particles per unit volume.
 - 2 The composition of the equilibrium mixture does not change.
 - 3 There are more collisions per second so equilibrium is reached faster.
- 34 An ethanol burner can be used to heat water. If appropriate measurements are taken, a value for the enthalpy of combustion of ethanol can be calculated. The equation

$$\text{heat transferred} = -mc\Delta T$$

is used as part of the calculation.

Which symbols are correctly described?

- 1 ΔT is the change in temperature of the water.
- 2 m is the mass of water used in the experiment.
- 3 c is the specific heat capacity of ethanol.

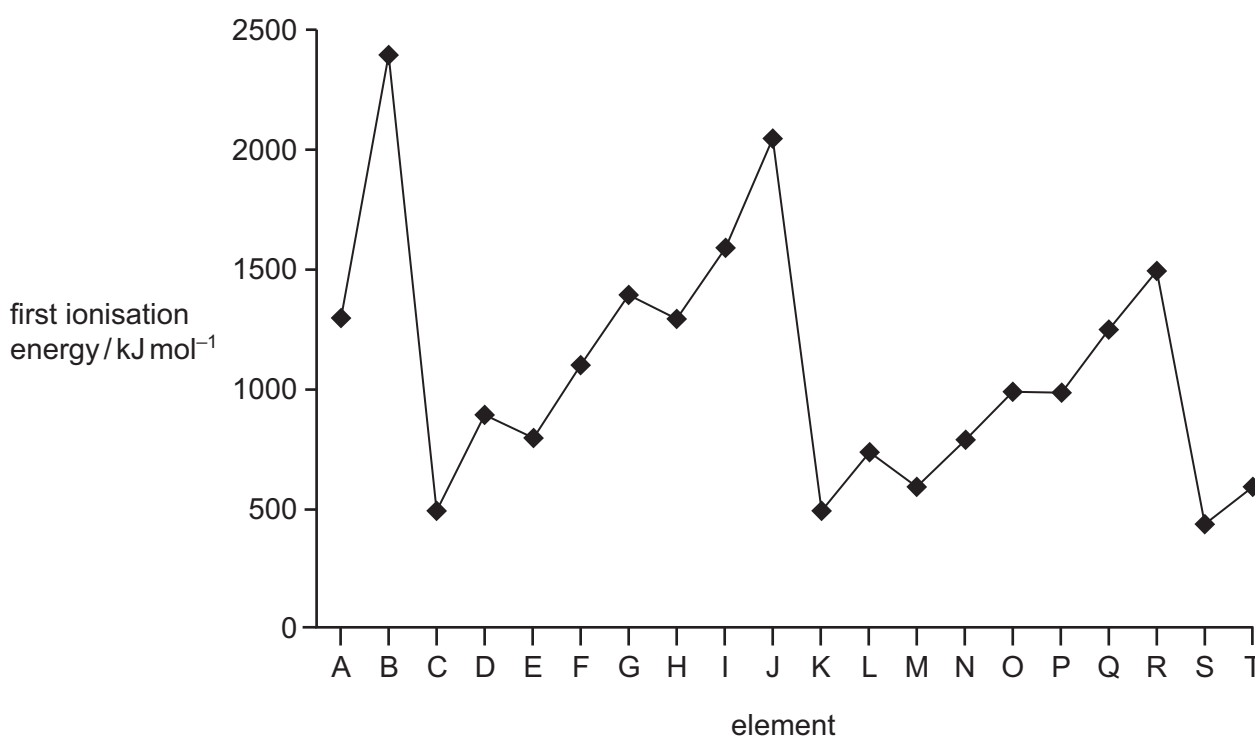
The responses **A** to **D** should be selected on the basis of

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.

- 35** The first ionisation energies of twenty successive elements in the Periodic Table are represented in the graph.

The letters given are not the normal symbols for these elements.



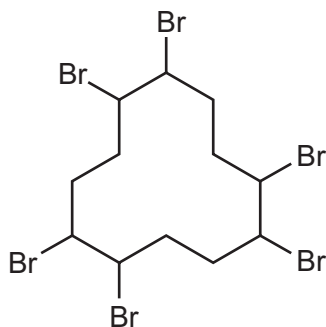
Which statements about this graph are correct?

- 1** Elements B, J and R are in Group 18 of the Periodic Table.
- 2** Atoms of elements D and L contain two electrons in their outer shells.
- 3** Atoms of elements G and O contain a half-filled p subshell.

- 36** Which properties increase in the sequence hydrogen chloride, hydrogen bromide and hydrogen iodide?

- 1** thermal stability
- 2** bond length
- 3** ease of oxidation

37 The diagram shows a compound used as a flame retardant.



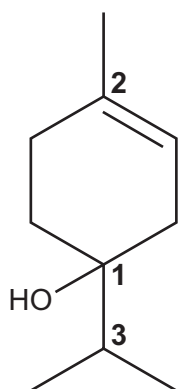
Which statements about this structure are correct?

- 1 The empirical formula is C_2H_3Br .
- 2 The C_{12} ring is not planar.
- 3 There are six chiral carbon atoms.

38 One of the active ingredients in tea-tree oil is terpinen-4-ol.

In the diagram of the skeletal formula of terpinen-4-ol, three of the carbon atoms are labelled **1**, **2** and **3**.

Which of the labelled carbon atoms are chiral?



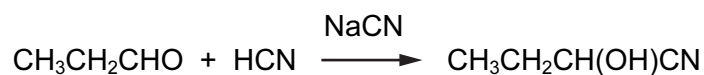
terpinen-4-ol

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.

- 39** Propanal reacts with hydrogen cyanide to form 2-hydroxybutanenitrile. A suitable catalyst for this reaction is sodium cyanide.



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

- 1** The sodium cyanide provides a stronger nucleophile than HCN.
 - 2** The reaction can be classified as nucleophilic substitution.
 - 3** The hydrogen cyanide molecule attacks the propanal molecule to form an intermediate ion.
- 40** Which syntheses will be successful?
- 1** $\text{CH}_3\text{CH}_2\text{CH}_3$ from $\text{CH}_3\text{CH}=\text{CH}_2 + \text{LiAlH}_4$
 - 2** $\text{CH}_3\text{CH}(\text{OH})\text{CH}_3$ from $\text{CH}_3\text{COCH}_3 + \text{NaBH}_4$
 - 3** $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$ from $\text{CH}_3\text{CH}_2\text{CHO} + \text{NaBH}_4$

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 International Examinations Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download at www.cie.org.uk after the live examination series.

Cambridge International Examinations is part of the Cambridge Assessment Group. Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.

CHEMISTRY

9701/13

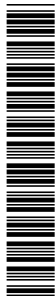
Paper 1 Multiple Choice

May/June 2016

1 hour

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

* 5 7 6 1 6 0 1 2 6 6 *



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 **15** printed pages and **1** blank page.



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 Enthalpy changes, ΔH , can be positive or negative.

Which row is correct?

	ΔH positive	ΔH negative
A	atomisation	bond breaking
B	bond breaking	neutralisation
C	bond making	combustion
D	combustion	bond making

- 2 What will make it more likely that a gas will approach ideal behaviour?

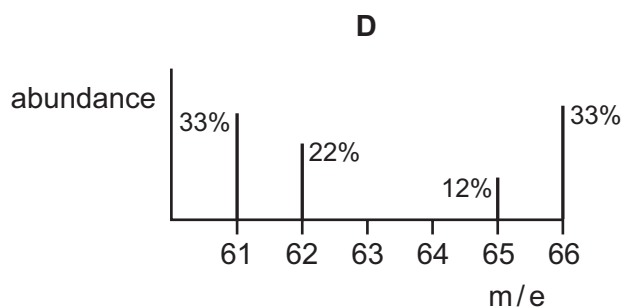
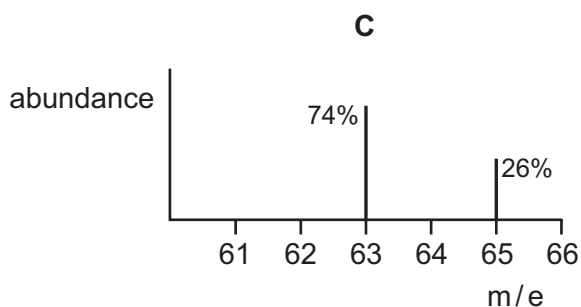
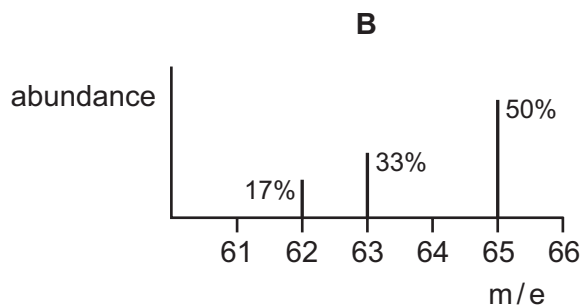
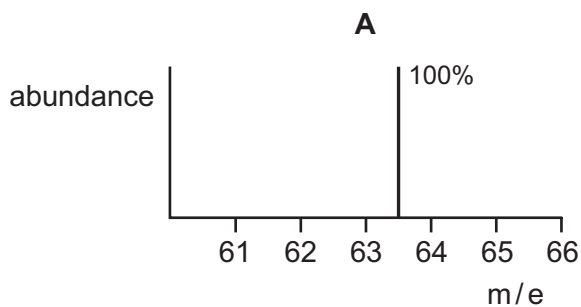
- A** higher pressure
- B** lower temperature
- C** more polar molecules
- D** weaker intermolecular forces

- 3 Which mass of urea, $\text{CO}(\text{NH}_2)_2$, contains the same mass of nitrogen as 101.1 g of potassium nitrate?

- A** 22 g **B** 30 g **C** 44 g **D** 60 g

- 4 The relative atomic mass of copper is 63.5.

Which chart is a correct mass spectrum that would lead to this value?



- 5 Which isolated gaseous atom has a total of five electrons occupying spherically shaped orbitals?

- A** boron
- B** fluorine
- C** sodium
- D** potassium

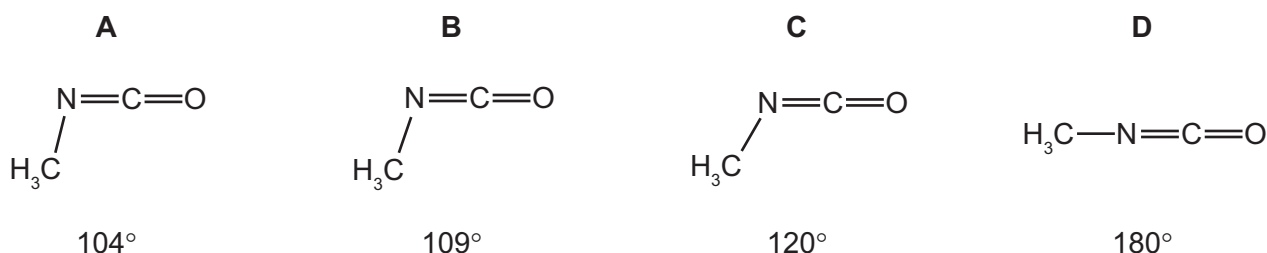
- 6 Carbon and silicon have the same outer electronic structure.

Why is a Si–Si bond weaker than a C–C bond?

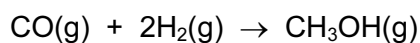
- A** Silicon atoms have a larger atomic radius than carbon atoms.
- B** Silicon has a greater nuclear charge than carbon.
- C** Silicon has a smaller first ionisation energy than carbon.
- D** Silicon is more metallic than carbon.

- 7 Methyl isocyanate, CH_3NCO , is a toxic liquid which is used in the manufacture of some pesticides.

What is the approximate angle between the bonds formed by the N atom in a molecule of methyl isocyanate?



- 8 Methanol may be prepared by the reaction between carbon monoxide and hydrogen.



The relevant average bond energies are given below.

$$E(\text{C}\equiv\text{O}) \quad 1077 \text{ kJ mol}^{-1}$$

$$E(\text{C}-\text{O}) \quad 360 \text{ kJ mol}^{-1}$$

$$E(\text{C}-\text{H}) \quad 410 \text{ kJ mol}^{-1}$$

$$E(\text{H}-\text{H}) \quad 436 \text{ kJ mol}^{-1}$$

$$E(\text{O}-\text{H}) \quad 460 \text{ kJ mol}^{-1}$$

What is the enthalpy change of this reaction?

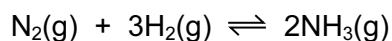
A -537 kJ mol^{-1}

B -101 kJ mol^{-1}

C $+101 \text{ kJ mol}^{-1}$

D $+537 \text{ kJ mol}^{-1}$

- 9 The equilibrium constant, K_c , for the reaction shown is $2 \text{ mol}^{-2} \text{ dm}^6$, at 600 K.

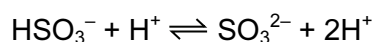
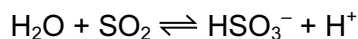


What is the concentration of NH_3 at equilibrium, at 600 K, when the equilibrium concentrations of N_2 and H_2 are both 2 mol dm^{-3} ?

A $\sqrt{8} \text{ mol dm}^{-3}$ B $\sqrt{16} \text{ mol dm}^{-3}$ C $\sqrt{32} \text{ mol dm}^{-3}$ D 32 mol dm^{-3}

- 10 Sulfur dioxide is used as a preservative in wine making.

The following equations describe the reactions that occur when sulfur dioxide dissolves in water.



Which statement about **these two reactions** is correct?

- A HSO_3^- acts as a base.
 - B SO_2 acts as an oxidising agent.
 - C SO_3^{2-} acts as an acid.
 - D SO_3^{2-} acts as a reducing agent.
- 11 Catalysts are an important feature of many industrial processes and biochemical reactions.

Which row correctly describes the effect of a catalyst on a reversible chemical reaction?

	position of equilibrium	effect on value of ΔH
A	moved to right	decreased
B	unaffected	decreased
C	unaffected	increased
D	unaffected	unaffected

- 12 The oxide and chloride of an element **X** are separately mixed with water. The two resulting solutions have the same effect on litmus.

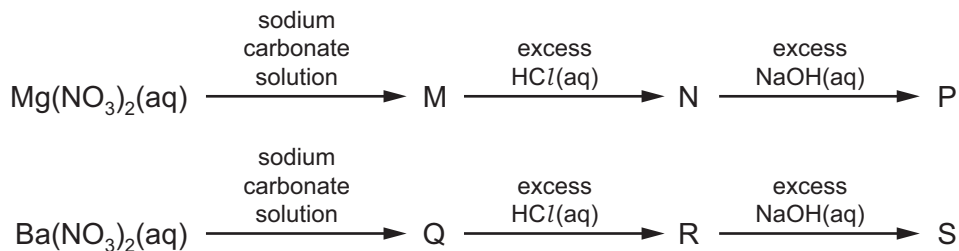
What could element **X** be?

- A Al
 - B Ca
 - C Na
 - D P
- 13 Each pair below consists of a sample of two separate elements. Each element is in its standard state at room temperature and pressure.

Which pair of elements has chemical bonds of the same type between their atoms?

- A aluminium and phosphorus
- B chlorine and argon
- C magnesium and silicon
- D sulfur and chlorine

- 14 Solutions of $\text{Mg}(\text{NO}_3)_2$ and $\text{Ba}(\text{NO}_3)_2$ separately undergo a series of reactions.



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

- 15 Anhydrous magnesium nitrate, $\text{Mg}(\text{NO}_3)_2$, will decompose when heated, giving a white solid and a mixture of two gases X and Y.

Y is oxygen.

What is the ratio $\frac{\text{mass of X released}}{\text{mass of Y released}}$?

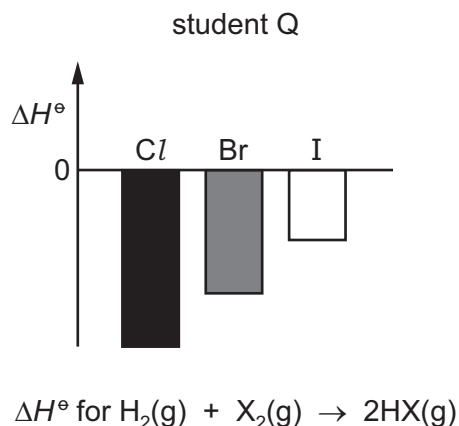
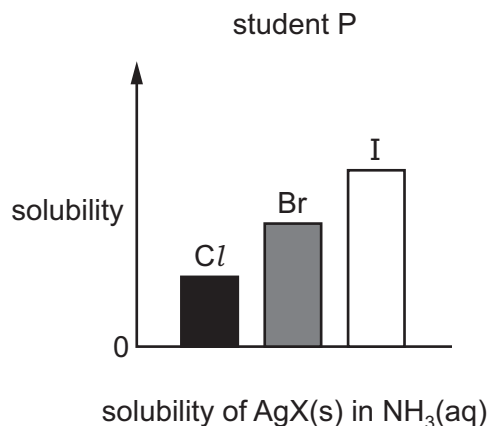
- A** $\frac{1}{0.174}$ **B** $\frac{1}{0.267}$ **C** $\frac{1}{0.348}$ **D** $\frac{1}{3.43}$

- 16 Steam is passed over heated magnesium to give compound J and hydrogen.

What is **not** a property of compound J?

- A** It has an M_r of 40.3.
B It is basic.
C It is a white solid.
D It is very soluble in water.

- 17 Two students, P and Q, were asked to draw bar charts to represent how some properties of the halogens and their compounds differ in magnitude. Their diagrams are shown. The bar charts show trends only and not actual values.



Which of the students have drawn bar charts which show the trends correctly?

- A** both P and Q
B P only
C Q only
D neither P nor Q
- 18 In a series of nine experiments to test the reactivity of the halogens, an aqueous solution of each halogen was added to an equal volume of an aqueous solution containing halide ions as shown in the table below.

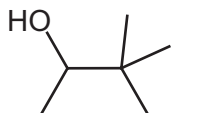
solution	sodium chloride (aq)	sodium bromide (aq)	sodium iodide (aq)
chlorine (aq)	experiment 1	experiment 2	experiment 3
bromine (aq)	experiment 4	experiment 5	experiment 6
iodine (aq)	experiment 7	experiment 8	experiment 9

The nine resulting mixtures were then shaken with hexane. The nine tubes were corked and left to stand so that the aqueous and organic solvents could separate into layers.

How many test-tubes contained a purple upper layer?

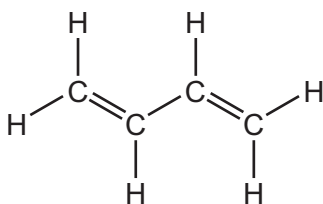
- A** 1 **B** 2 **C** 3 **D** 5
- 19 Which statement does **not** describe an effect of acid rain on the environment?
- A** Acid rain causes erosion of stone buildings.
B Acid rain causes ozone depletion.
C Acid rain increases the corrosion of some metals.
D Acid rain increases the leaching away of essential nutrients and minerals from soils.

20 What is the correct name of the molecule with the skeletal formula shown?



- A 1,2,2-trimethylbutan-3-ol
- B 2-ethyl-2-methylbutan-2-ol
- C 3,3-dimethylpentan-2-ol
- D 4-hydroxy-3,3-dimethylpentane

21 The diagram shows the structure of 1,3-butadiene.



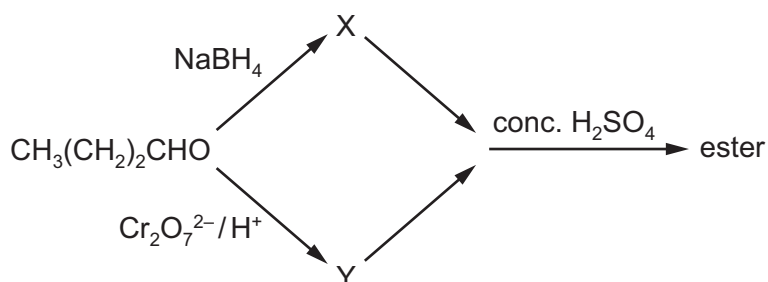
1,3-butadiene

The addition reaction between 1,3-butadiene 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

22 An ester with an aroma of pineapples can be synthesised in the laboratory from butanal using this reaction scheme.

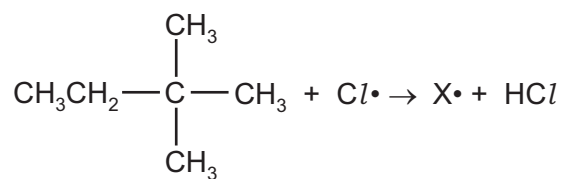


What is the structural formula of the **ester**?

- A $\text{CH}_3(\text{CH}_2)_2\text{CO}_2(\text{CH}_2)_2\text{CH}_3$
- B $\text{CH}_3(\text{CH}_2)_2\text{CO}_2(\text{CH}_2)_3\text{CH}_3$
- C $\text{CH}_3(\text{CH}_2)_3\text{CO}_2(\text{CH}_2)_2\text{CH}_3$
- D $\text{CH}_3(\text{CH}_2)_3\text{CO}_2(\text{CH}_2)_3\text{CH}_3$

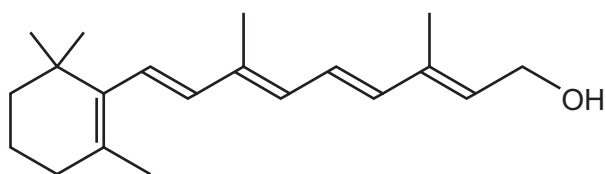
- 23** When heated with chlorine, the hydrocarbon 2,2-dimethylbutane undergoes free radical substitution.

In a propagation step a free radical $X\cdot$ is formed.



How many different structures of $X\cdot$ are possible?

- A** 2 **B** 3 **C** 4 **D** 5
- 24** Vitamin A contains retinol.



retinol

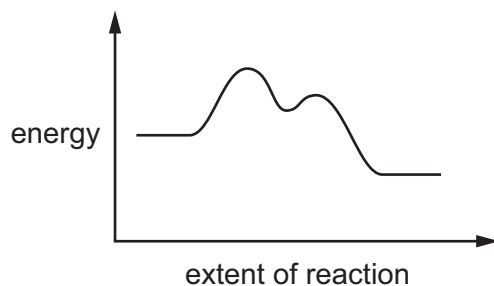
Under appropriate conditions, acidified $\text{KMnO}_4(\text{aq})$ can be used to break apart $\text{C}=\text{C}$ bonds.

After these bonds have been broken, further oxidation of the fragments may occur.

Under which conditions is the acidified $\text{KMnO}_4(\text{aq})$ used and what do the final oxidation products include?

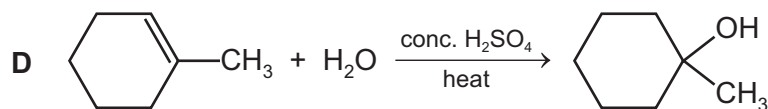
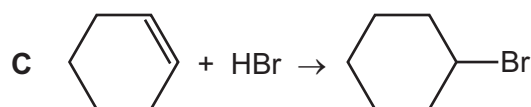
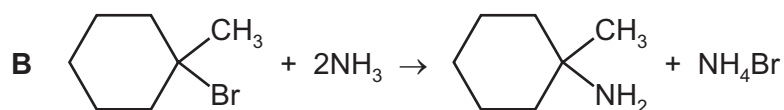
	conditions	final oxidation products
A	cold, dilute	aldehydes and carboxylic acids
B	cold, dilute	ketones and carboxylic acids
C	hot, concentrated	aldehydes and carboxylic acids
D	hot, concentrated	ketones and carboxylic acids

25 A reaction pathway diagram is shown.



The four reactions that follow are all exothermic.

Which reaction would **not** have such a pathway?



26 Which volume of oxygen, at room temperature and pressure, is needed for complete combustion of 1.0 mol of methylpropan-1-ol?

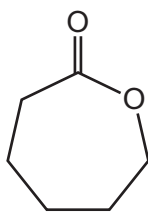
- A 108 dm³ B 144 dm³ C 156 dm³ D 288 dm³

27 An unknown organic compound reacts with sodium to give a combustible gas as one product but does **not** give a yellow precipitate with alkaline aqueous iodine.

What is a possible identity of the unknown organic compound?

- A propanal
B propan-1-ol
C propan-2-ol
D propanone

- 28 Which reaction will give 2-chloropropane in the best yield?
- A propane gas with chlorine gas in the presence of ultraviolet light
 - B propan-2-ol with dilute $\text{NaCl}(\text{aq})$
 - C propan-2-ol with $\text{SOCl}_2(\text{l})$
 - D propene with dilute $\text{HCl}(\text{aq})$
- 29 The ester, $\text{CH}_3\text{CH}_2\text{CO}_2\text{CH}_3$, is hydrolysed by boiling with aqueous sodium hydroxide. Which compound is one of the products?
- A ethanol
 - B propan-1-ol
 - C sodium methanoate
 - D sodium propanoate
- 30 Caprolactone is a cyclic ester. It is being used increasingly for the manufacture of specialist polymers.



caprolactone

From which compound could caprolactone be made by a single reaction?

- A $\text{OHCCH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CHO}$
- B $\text{HOCH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$
- C $\text{HOCH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CO}_2\text{H}$
- D $\text{HO}_2\text{CCH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CO}_2\text{H}$

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** Compound X is made from two elements. One element has the second highest value of first ionisation energy in its group and the other element has the third highest value of first ionisation energy in its group.

Which compounds could be compound X?

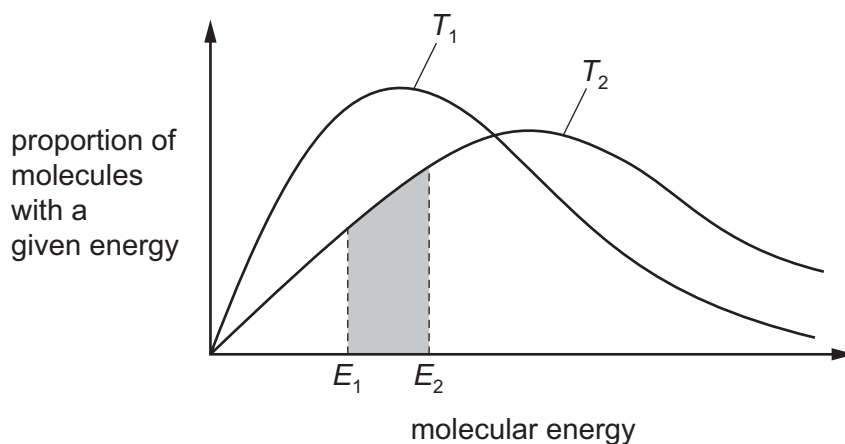
- 1** calcium chloride
- 2** magnesium bromide
- 3** potassium sulfide

- 32** Water has some unusual physical properties compared to other hydrides of Group 16 elements. Some of these properties are due to hydrogen bonds. These intermolecular forces are much stronger in water than they are in H₂S, for example.

Which statements are correct?

- 1** Hydrogen bonds cause the melting point of ice to be higher than expected.
- 2** Hydrogen bonds cause the surface tension of water to be higher than expected.
- 3** Hydrogen bonds cause the viscosity of water to be higher than expected.

- 33 The diagram shows the Boltzmann distribution of molecular energies in one mole of a gas at two temperatures, T_1 and T_2 .



Which statements are correct?

- 1 The shaded area represents the proportion of molecules with energies between E_1 and E_2 at temperature T_2 .
- 2 No particles have zero energy at either temperature.
- 3 T_2 is a lower temperature than T_1 .

- 34 When KClO_3 is heated, the following reaction occurs.



Which statements are correct?

- 1 The oxidation state of Cl in KClO_3 is +5.
- 2 The oxidation state of some Cl atoms decreases by 6.
- 3 The reaction involves disproportionation.

- 35 Why is the first ionisation energy of aluminium less than that of magnesium?

- 1 The outer electron in the aluminium atom is more shielded from the nuclear charge.
- 2 The outer electron in the aluminium atom is in a higher energy orbital.
- 3 The outer electron in the aluminium atom is further from the nucleus.

- 36 Ammonia is a colourless gas that is produced by the Haber process.

Which statements about ammonia are correct?

- 1 An ammonia molecule has three bond pairs and one lone pair of electrons.
- 2 If ammonia is bubbled into water the pH of the solution will increase.
- 3 Ammonia gas can be made by warming ammonium sulfate with aqueous hydrochloric acid.

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

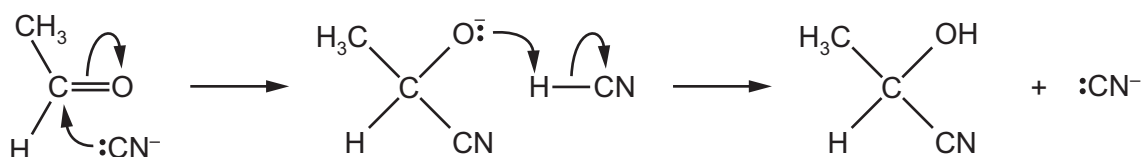
No other combination of statements is used as a correct response.

37 Halogenoalkanes show trends in their physical and chemical properties.

Which properties steadily increase from $\text{C}_2\text{H}_5\text{Cl}$ to $\text{C}_2\text{H}_5\text{Br}$ to $\text{C}_2\text{H}_5\text{I}$?

- 1** the polarity of the carbon-halogen bond
- 2** the boiling point of the halogenoalkane
- 3** the rate of reaction of the halogenoalkane with nucleophiles

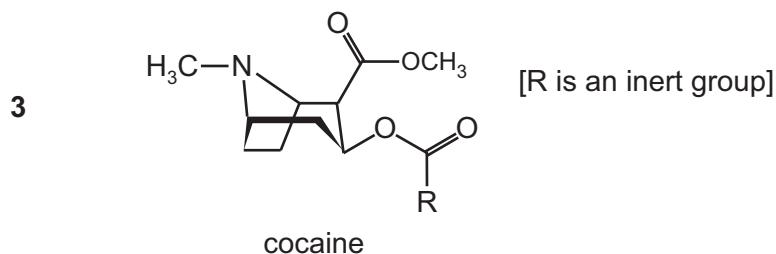
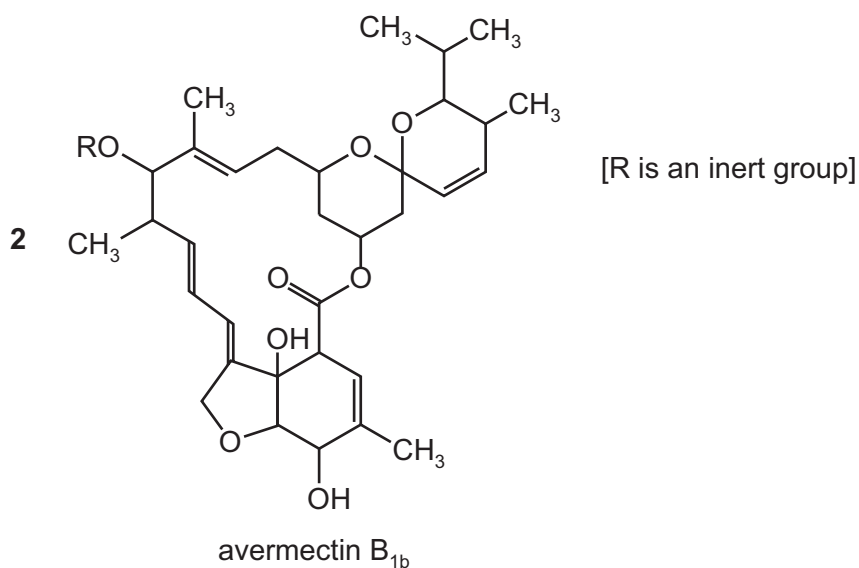
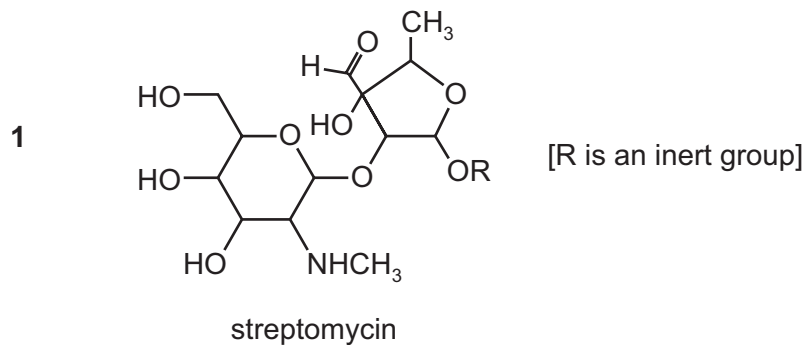
38 Ethanal and hydrogen cyanide react together to form a compound used in the production of acrylic fibres. The reaction mechanism involves cyanide ions.



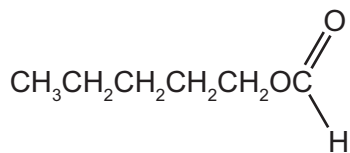
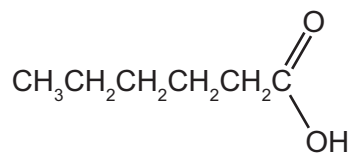
Which statements about this mechanism are correct?

- 1** CN^- acts as a catalyst.
- 2** CN^- is a nucleophile.
- 3** It is an addition reaction.

39 Which compounds will give an orange precipitate with 2,4-dinitrophenylhydrazine reagent?



40 The structural formulae of two compounds are shown below.



Which statements about these compounds are correct?

- 1 The two compounds are structural isomers of each other.
- 2 The empirical formula of both compounds is C₃H₆O.
- 3 Both compounds are carboxylic acids.

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 International Examinations Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download at www.cie.org.uk after the live examination series.

Cambridge International Examinations is part of the Cambridge Assessment Group. Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.