Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

CHEMISTRY **9701/12**

Paper 1 Multiple Choice **May/June 2017**

1 hour

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

MODIFIED LANGUAGE

0202524632

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.

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Section A

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

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

1 In which species are the numbers of protons, neutrons and electrons **all** different?

A $^{19}_{9}F^{-}$ **B** $^{23}_{11}Na^{+}$ **C** $^{31}_{15}P$ **D** $^{32}_{16}S^{2-}$

2 Which would contain 9.03×10^{23} oxygen atoms?

A 0.25 mol aluminium oxide

B 0.75 mol sulfur dioxide

C 1.5 mol sulfur trioxide

D 3.0 mol water

3 In some fireworks there is a reaction between powdered aluminium and powdered barium nitrate. Heat is evolved, an unreactive gas is produced, and all nitrogen atoms are reduced.

What is the equation for this reaction?

A $2Al + Ba(NO_3)_2 \rightarrow Al_2O_3 + BaO + 2NO$

B $4Al + 4Ba(NO_3)_2 \rightarrow 2Al_2O_3 + 4Ba(NO_2)_2 + O_2$

C $10Al + 3Ba(NO_3)_2 \rightarrow 5Al_2O_3 + 3BaO + 3N_2$

D $10Al + 18Ba(NO_3)_2 \rightarrow 10Al(NO_3)_3 + 18BaO + 3N_2$

4 Which organic compound has the highest boiling point?

A $C(CH_3)_4$

B $CH_3CH_2CH_2CH_2CH_3$

C $CH_3COCH_2CH_3$

D $CH_3CH(OH)CH_2CH_3$

5 At a temperature of 2500 K and a pressure of 1.00×10^{-4} Pa a sample of 0.321 g of sulfur vapour has a volume of $2.08 \times 10^{6}\,m^3$.

What is the molecular formula of sulfur under these conditions?

A S **B** S_2 **C** S_4 **D** S_8

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6 Which reaction involves a decrease in the bond angle at a carbon atom?

A bromoethane refluxed with ethanolic sodium hydroxide

B complete combustion of methane in air

C ethanol heated with conc. H_2SO_4

D polymerisation of ethene

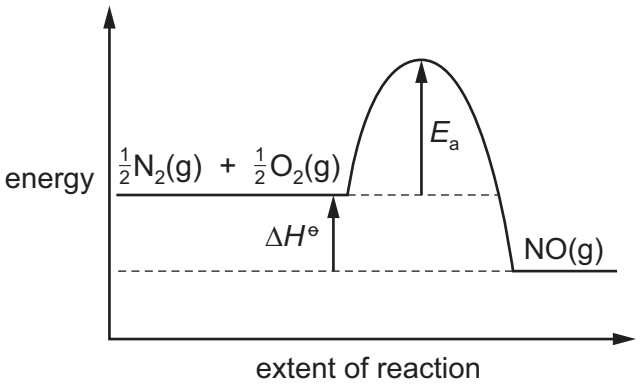
7 In the high temperatures of car engines, nitrogen reacts with oxygen to give nitrogen monoxide.

$$\tfrac{1}{2}N_2(g) + \tfrac{1}{2}O_2(g) \rightarrow NO(g) \qquad \Delta H^{\ominus} = +90\,kJ\,mol^{-1}$$

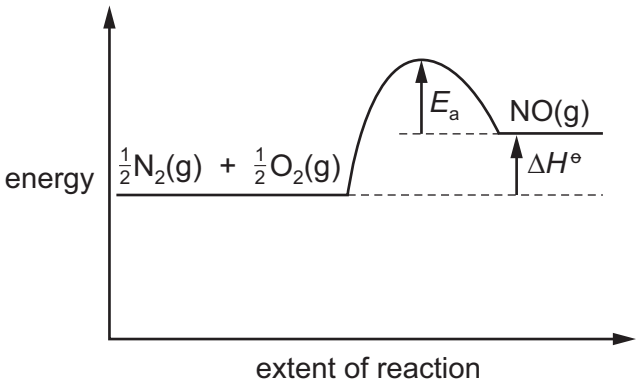
This reaction has activation energy E_a.

Which reaction pathway diagram could correctly represent this reaction?

A



B



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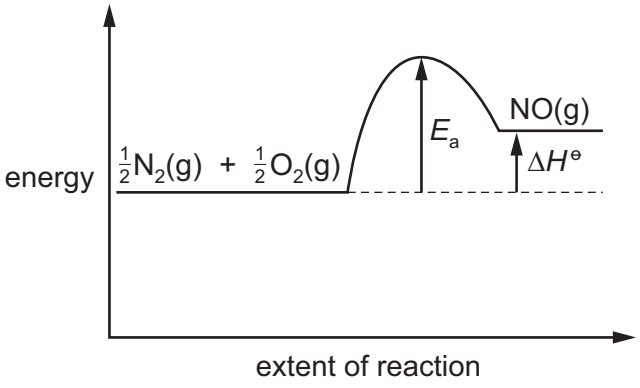
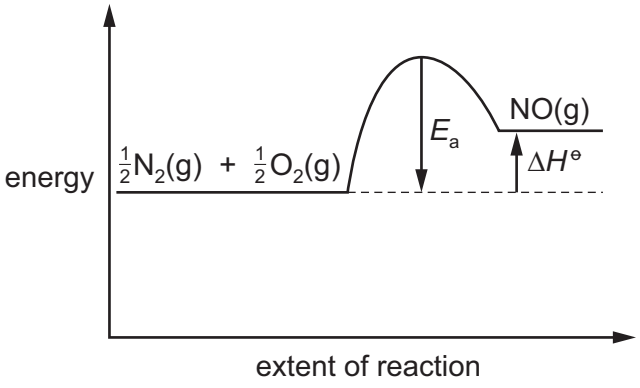


D



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[Turn over

8 A reaction sequence is shown.

$$SO_2 \xrightarrow{1} SO_3 \xrightarrow{2} H_2SO_4 \xrightarrow{3} H_2S \xrightarrow{4} SO_2$$

In each stage of this sequence the sulfur is oxidised, reduced or neither oxidised nor reduced.

Which row is correct?

	1	2	3	4
A	neither	oxidised	reduced	reduced
B	oxidised	neither	reduced	reduced
C	oxidised	neither	reduced	oxidised
D	oxidised	oxidised	reduced	oxidised

9 Hydrogen and carbon dioxide gases are mixed at 800 K. A reversible reaction takes place.

$$H_2(g) + CO_2(g) \rightleftharpoons H_2O(g) + CO(g)$$

At equilibrium, the partial pressures of H_2 and CO_2 are both 10.0 kPa. K_p is 0.288 at 800 K.

What is the partial pressure of CO in the equilibrium mixture?

A 5.37 kPa **B** 18.6 kPa **C** 28.8 kPa **D** 347 kPa

10 A reaction involved in the Contact process is shown.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g) \qquad \Delta H^{\ominus} = -197\,kJ\,mol^{-1}$$

The reaction is investigated at 200 kPa and 700 K and the value of the equilibrium constant, K_p, is found to be Y. The reaction is then investigated at 1000 kPa and 700 K and the value of K_p is found to be Z.

Which statement comparing Y and Z is correct?

A Y and Z are the same.

B Y is greater than Z.

C Z is 2.2 times greater than Y.

D Z is 5.0 times greater than Y.

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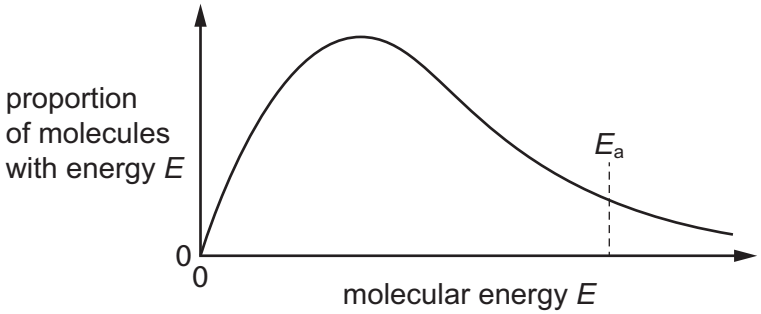
11 The Boltzmann distribution for the hydrogenation of an alkene at a particular temperature in the absence of a catalyst is shown.



Which row correctly describes the effects of adding nickel to the reaction vessel?

	the shape of the Boltzmann distribution	activation energy, E_a
A	changes	decreases
B	changes	increases
C	does not change	decreases
D	does not change	increases

12 The elements magnesium and sulfur each form doubly charged ions.

How do the atomic radii and ionic radii of these elements compare?

	atomic radius		ionic radius	atomic radius		ionic radius
A	Mg	>	Mg^{2+}	S	>	S^{2-}
B	Mg	>	Mg^{2+}	S	<	S^{2-}
C	Mg	<	Mg^{2+}	S	>	S^{2-}
D	Mg	<	Mg^{2+}	S	<	S^{2-}

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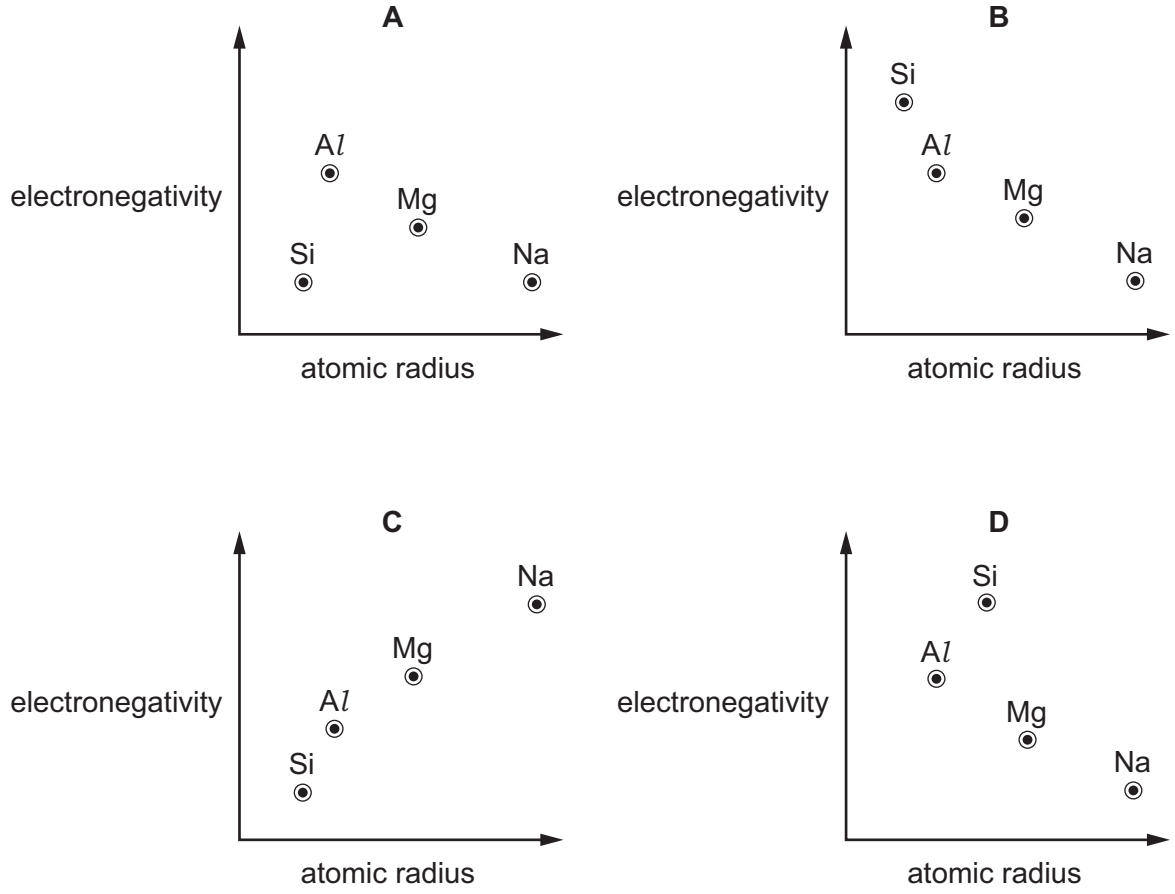
13 Which graph correctly shows relative electronegativity plotted against relative atomic radius for the elements Na, Mg, A*l* and Si?



14 Trends are seen in the physical and chemical properties of the elements of Group 2 and their compounds.

Which property shows a **decrease** from magnesium to barium?

A the rate of the reaction between the element and dilute hydrochloric acid

B the solubility of the hydroxides

C the solubility of the sulfates

D the temperature of decomposition of the carbonates

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15 Calcium oxide is added to water and the resulting mixture is filtered.

This filtrate is X.

When carbon dioxide is bubbled through filtrate X, a white precipitate is formed.

Which equation for this reaction of filtrate X with carbon dioxide is correct?

A $CaO + CO_2 \rightarrow CaCO_3$

B $Ca(OH)_2 + CO_2 \rightarrow CaO + H_2CO_3$

C $2CaO + H_2O + CO_2 \rightarrow CaCO_3 + Ca(OH)_2$

D $Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$

16 Element X reacts with cold, dilute, aqueous sodium hydroxide to form two different chlorine-containing products, Y and Z.

What are the oxidation states of chlorine in Y and Z?

	Y	Z
A	0	+1
B	0	+5
C	–1	+1
D	–1	+5

17 A powder is known to be either a single sodium halide or a mixture of two sodium halides. A sample of the powder was dissolved in water.

Aqueous silver nitrate was added, and a pale yellow precipitate was formed. When concentrated aqueous ammonia was then added, this precipitate partly dissolved leaving a darker yellow precipitate.

What might the powder be?

A sodium bromide only

B sodium iodide only

C a mixture of sodium chloride and sodium bromide

D a mixture of sodium chloride and sodium iodide

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18 The ammonium ion is formed by the following reaction.

$$NH_3 + H^+ \rightarrow NH_4^+$$

Which statement about the species involved in this reaction is correct?

A The ammonia molecule contains a dative covalent bond.

B The ammonium ion is a Brønsted-Lowry base as it has accepted a proton.

C The H–N–H bond angle changes from 107° in ammonia to 90° in the ammonium ion.

D The number of electrons surrounding each nitrogen atom does not change.

19 A chemist took 2.00 dm^3 of nitrogen gas, measured under room conditions, and reacted it with a large volume of hydrogen gas to produce ammonia. Only 15.0% of the nitrogen gas reacted to produce ammonia.

Which mass of ammonia was formed?

A 0.213 g **B** 0.425 g **C** 1.42 g **D** 2.83 g

20 A carbonyl compound **X** will react with HCN in the presence of NaCN to make a compound with M_r 85. Compound **X** does **not** react with Fehling's reagent.

What is **X**?

A butanal

B butanone

C propanal

D propanone

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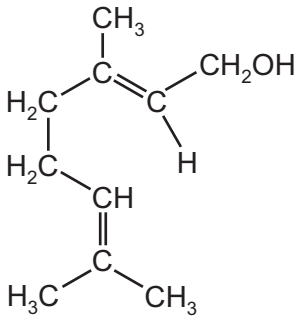
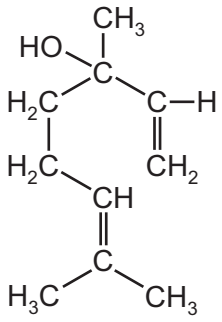
21 Geraniol and linalool are compounds found in some flower fragrances.



geraniol



linalool

Which statement is correct?

A They are chain isomers of each other.

B They are geometrical isomers of each other.

C They are optical isomers of each other.

D They are positional isomers of each other.

22 Which equation represents the initiation step of the substitution reaction between methane and chlorine?

A $CH_4 \rightarrow CH_3\bullet + H\bullet$

B $CH_4 \rightarrow CH_3^- + H^+$

C $Cl_2 \rightarrow 2Cl\bullet$

D $Cl_2 \rightarrow Cl^+ + Cl^-$

23 Aqueous sodium hydroxide reacts with 1-bromopropane to give propan-1-ol.

What should be included in a diagram of the first step in the mechanism?

A a curly arrow from a lone pair on the OH^- ion to the $C^{\delta+}$ atom of 1-bromopropane

B a curly arrow from the $C^{\delta+}$ atom of 1-bromopropane to the OH^- ion

C a curly arrow from the C–Br bond to the C atom

D the homolytic fission of the C–Br bond

24 A sample of 2.76 g of ethanol was mixed with an excess of aqueous acidified potassium dichromate(VI). The reaction mixture was then boiled under reflux for one hour. The required organic product was then collected by distillation.

The yield of product was 75.0%.

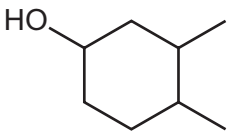
Which mass of product was collected?

A 1.26 g **B** 1.98 g **C** 2.07 g **D** 2.70 g

25 Compound X is a single, pure, optical isomer. X is heated with an excess of concentrated H_2SO_4. Only one organic product is formed.

What could X be?

A



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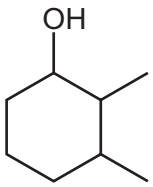

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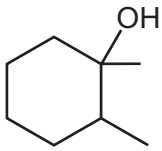

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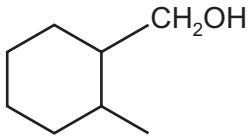

26 2-bromo-2-methylpropane undergoes nucleophilic substitution when heated under reflux with an aqueous solution of sodium hydroxide.

Which row is correct?

	mechanism for this reaction	reason
A	S_N1	the hydroxide ion is helped in its approach to the central carbon atom by the methyl groups
B	S_N1	the intermediate carbocation is stabilised by the inductive effect of the methyl groups
C	S_N2	the hydroxide ion is hindered in its approach to the central carbon atom by the methyl groups
D	S_N2	the intermediate carbocation is destabilised by the inductive effect of the methyl groups

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27 $H_2NNHC_6H_3(NO_2)_2$ is the structural formula of 2,4-DNPH.

Many, but not all, organic reactions need to be heated before reaction occurs.

Which reaction occurs at a good rate at room temperature (20 °C)?

A $C_{10}H_{22} \rightarrow C_8H_{18} + C_2H_4$

B $CH_3CH_2CH_2Br + NH_3 \rightarrow CH_3CH_2CH_2NH_2 + HBr$

C $CH_3CH_2OH + KBr \rightarrow CH_3CH_2Br + KOH$

D $(CH_3)_2CO + H_2NNHC_6H_3(NO_2)_2 \rightarrow (CH_3)_2C{=}NNHC_6H_3(NO_2)_2 + H_2O$

28 A carboxylic acid, P, has no possible chain isomers. It reacts with an alcohol, Q, that has only one positional isomer.

What could be the ester formed from a reaction between P and Q?

A butyl propanoate

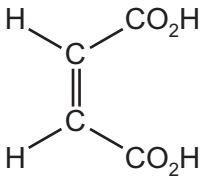
B ethyl butanoate

C pentyl ethanoate

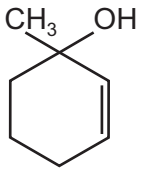
D propyl pentanoate

29 Which compound is chiral and reacts with Na_2CO_3 to give CO_2?

A



B



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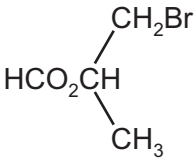

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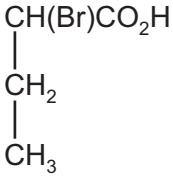

30 Which compound, when hydrolysed, gives propanoic acid and propan-2-ol?

A $CH_3CH_2CO_2CH_2CH(CH_3)CH_3$

B $(CH_3)_2CHCO_2CH_2CH_3$

C $CH_3CH_2CO_2CH(CH_3)CH_3$

D $CH_3CH_2CH_2CO_2CH(CH_3)CH_3$

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Section B

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

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

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

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

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

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

31 An isolated gaseous atom of element X has paired electrons in at least one of its 3d orbitals and has a filled 4s subshell.

What could be the identity of element X?

1 iron

2 gallium

3 copper

32 Which allotropes of carbon have a giant molecular structure?

1 buckminsterfullerene

2 diamond

3 graphite

33 Which statements about endothermic reactions are correct?

1 On the reaction pathway diagram the products of the reaction are lower than the reactants.

2 There is a net transfer of heat energy from the surroundings to the reacting system.

3 the total bond energies of the reactants > the total bond energies of the products

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34 The rate of chemical reactions can be increased by the addition of a suitable catalyst.

For which reactions can a heterogeneous catalyst be used?

1 $N_2 + 3H_2 \rightleftharpoons 2NH_3$

2 $2SO_2 + O_2 \rightleftharpoons 2SO_3$

3 $2NO + 2CO \rightleftharpoons N_2 + 2CO_2$

35 Which chlorides, when added to water, can produce a solution with a pH of less than 5?

1 $SiCl_4$

2 $AlCl_3$

3 $MgCl_2$

36 Acid rain continues to be a problem.

Which statements about acid rain are correct?

1 Acid rain is formed when oxides of nitrogen or oxides of sulfur react with water in the atmosphere.

2 Acid rain causes an increase in the concentration of heavy metal ions in water courses.

3 Nitrogen dioxide will catalyse the formation of SO_3 from SO_2 in the atmosphere.

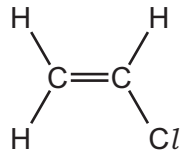
37 Which compounds contain a chiral centre?

1 2-hydroxybutanoic acid

2 3-hydroxybutanoic acid

3 4-hydroxybutanoic acid

38 The diagram shows the monomer used to make polyvinyl chloride, PVC.



Assuming that one particular molecule of the polymer forms from *n* molecules of the monomer (where *n* is many thousands), which statements are correct?

1 The relative molecular mass of this polymer molecule is approximately 62.5*n*.

2 There are *n* chiral carbon atoms in this polymer molecule.

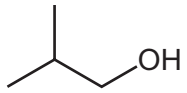
3 There are 5*n* σ bonds in one polymer molecule.

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 An organic compound, X, has the following skeletal formula.



X

Which statements about X are correct?

1 X is a primary alcohol.

2 X will dehydrate to give a single alkene.

3 X will undergo a substitution reaction with chloride ions.

40 2,2,4-trimethylpentanal is used in the manufacture of adhesives.

Which reagents would 2,2,4-trimethylpentanal react with?

1 2,4-dinitrophenylhydrazine reagent

2 Tollens' reagent

3 alkaline aqueous iodine

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