Cambridge International AS & A Level

**Cambridge International Examinations**
Cambridge International Advanced Subsidiary and Advanced Level

**CHEMISTRY** **9701/11**

Paper 1 Multiple Choice **October/November 2017**

**1 hour**

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

* 3 2 8 6 3 0 1 7 9 3 *

**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.

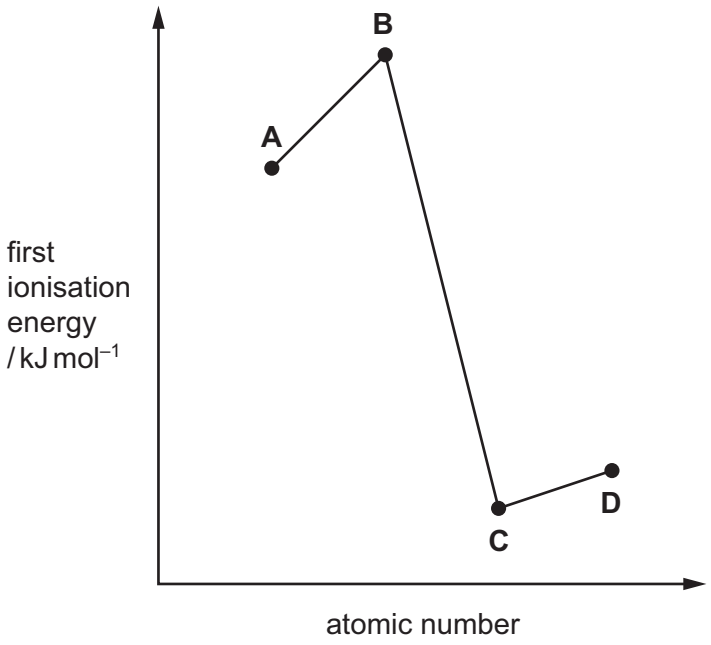
**1** Which formula represents the empirical formula of a compound?

**A** $C_2H_4O$ **B** $C_2H_4O_2$ **C** $C_6H_{12}$ **D** $H_2O_2$

**2** The relative first ionisation energies of four elements with consecutive atomic numbers below 20 are shown on the graph.

One of the elements reacts with hydrogen to form a covalent compound with formula HX.

Which element could be X?




**3** In which structure are three atoms bonded together in a straight line?

**A** poly(ethene), $-(CH_2CH_2)_n-$

**B** propane, $C_3H_8$

**C** silicon tetrachloride, $SiCl_4$

**D** sulfur hexafluoride, $SF_6$

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**4** In the sodium chloride lattice the number of chloride ions that surround each sodium ion is called the *co-ordination number* of the sodium ions.

What are the co-ordination numbers of the sodium ions and the chloride ions in the sodium chloride lattice?

| | sodium ions | chloride ions |
|---|---|---|
| **A** | 4 | 6 |
| **B** | 6 | 4 |
| **C** | 6 | 6 |
| **D** | 8 | 6 |

**5** A fluorescent light tube has an internal volume of 400 $cm^3$ and an internal pressure of 200 kPa.

It is filled with 0.03 moles of an ideal gas.

What is the temperature of the gas inside the fluorescent light tube?

**A** $3.21 \times 10^{-1}$ K

**B** $3.21 \times 10^{2}$ K

**C** $3.21 \times 10^{5}$ K

**D** $3.21 \times 10^{8}$ K

**6** One of the reactions in a lead / acid cell is shown.

$$Pb(s) + PbO_2(s) + 4H^+(aq) + 2SO_4^{2-}(aq) \rightarrow 2PbSO_4(s) + 2H_2O(l)$$

Which statement about this reaction is correct?

**A** Lead is both oxidised and reduced.

**B** Lead is neither oxidised nor reduced.

**C** Lead is oxidised only.

**D** Lead is reduced only.

**7** Iodine and propanone react according to the following equation.

$$I_2(aq) + CH_3COCH_3(aq) \rightarrow CH_3COCH_2I(aq) + HI(aq)$$

If the concentration of propanone is increased, keeping the total reaction volume constant, the rate of the reaction also increases.

What could be the reason for this?

**A** A greater proportion of collisions is successful at the higher concentration.

**B** The particles are further apart at the higher concentration.

**C** The particles have more energy at the higher concentration.

**D** There are more collisions between reactant particles per second at the higher concentration.

**8** Sulfur can be oxidised in two ways.

$$S(s) + O_2(g) \rightarrow SO_2(g) \qquad \Delta H^{\ominus} = -296.5\,kJ\,mol^{-1}$$

$$2S(s) + 3O_2(g) \rightarrow 2SO_3(g) \qquad \Delta H^{\ominus} = -791.4\,kJ\,mol^{-1}$$

Sulfur trioxide can be made from sulfur dioxide and oxygen.

$$2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$$

What is the standard enthalpy change for this reaction?

**A** $-1384.4\,kJ\,mol^{-1}$

**B** $-989.8\,kJ\,mol^{-1}$

**C** $-494.9\,kJ\,mol^{-1}$

**D** $-198.4\,kJ\,mol^{-1}$

**9** Hydrogen iodide dissociates into hydrogen and iodine.

$$2HI(g) \rightleftharpoons H_2(g) + I_2(g)$$

In an experiment, $b$ mol of hydrogen iodide were put into a sealed vessel at pressure p. At equilibrium, $x$ mol of the hydrogen iodide had dissociated.

Which expression for $K_p$ is correct?

**A** $\dfrac{x^2}{(b-x)^2}$ **B** $\dfrac{x^2p^2}{(b-x)^2}$ **C** $\dfrac{x^2p^2}{4b(b-x)}$ **D** $\dfrac{x^2}{4(b-x)^2}$

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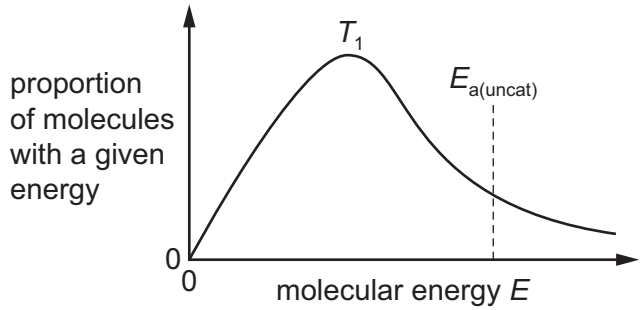
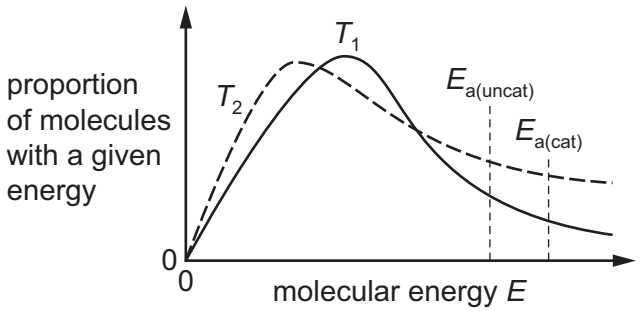
**10** The diagram shows the distribution of molecular energies in a sample of gas at a temperature $T_1$. The activation energy for an uncatalysed reaction of this gas, $E_{a(uncat)}$, is shown.

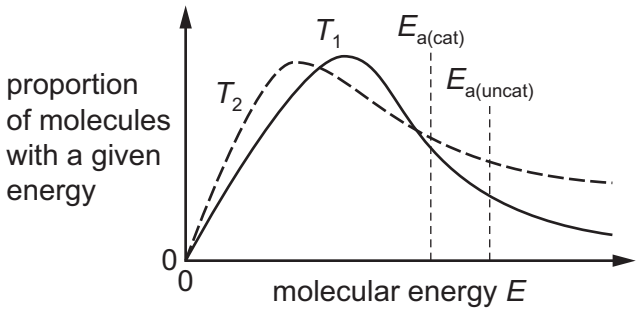



Which diagram correctly shows the new distribution and new activation energy, $E_{a(cat)}$, when the temperature is increased to $T_2$, and a catalyst is used that increases the rate of the reaction?

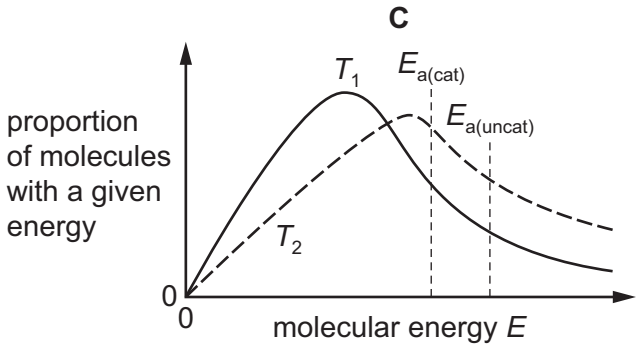
**A**



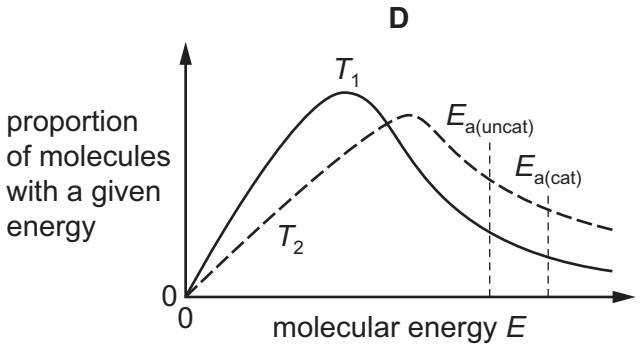

**B**




**C**




**D**




**11** 200 g of water are at 25 °C.

The water is heated to 75 °C by burning 2 g of ethanol.

What is the amount of energy transferred to the water?

**A** 0.418 kJ **B** 10.4 kJ **C** 41.8 kJ **D** 62.7 kJ

**12** The elements C$l$, Mg, Si and S are all in Period 3.

What is the correct sequence of the melting points of these elements, from lowest to highest?

| | lowest melting point → | | | highest melting point |
|---|---|---|---|---|
| **A** | C$l$ | S | Mg | Si |
| **B** | C$l$ | S | Si | Mg |
| **C** | Mg | Si | S | C$l$ |
| **D** | Si | Mg | S | C$l$ |

**13** An element Y reacts according to the following sequence.

$$Y \xrightarrow{\text{burns in } O_2} \text{white solid} \xrightarrow{HCl(aq)} \text{solution} \xrightarrow{NaOH(aq)} \text{white precipitate} \xrightarrow{\text{an excess of } NaOH(aq)} \text{solution}$$

What could be element Y?

**A** A$l$ **B** Ca **C** Mg **D** P

**14** Which compound would most usually be added to soil to reduce its acidity?

**A** aluminium hydroxide

**B** calcium hydroxide

**C** magnesium hydroxide

**D** sodium hydroxide

**15** The mineral dolomite is a mixture of magnesium carbonate and calcium carbonate.

An aqueous reagent, X, was added to a small sample of dolomite. Effervescence was seen and a white solid, Y, was formed.

What could be the correct identity of reagent X and solid Y?

| | reagent X | solid Y |
|---|---|---|
| **A** | hydrochloric acid | calcium chloride |
| **B** | hydrochloric acid | magnesium chloride |
| **C** | sulfuric acid | calcium sulfate |
| **D** | sulfuric acid | magnesium sulfate |

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**16** Which fertiliser contains the greatest percentage of nitrogen by mass?

**A** ammonium nitrate, $NH_4NO_3$

**B** ammonium sulfate, $(NH_4)_2SO_4$

**C** diammonium hydrogen phosphate, $(NH_4)_2HPO_4$

**D** urea, $CO(NH_2)_2$

**17** 71.0 g of chlorine, $Cl_2$, react with an excess of sodium hydroxide solution at a particular temperature. The reaction produces exactly 35.5 g of product **X**.

What is product **X**?

**A** $H_2O$ **B** $NaCl$ **C** $NaClO$ **D** $NaClO_3$

**18** Compound Q is a white crystalline solid which dissolves easily in water. When concentrated sulfuric acid is added to a dry sample of Q steamy white fumes are formed which, when passed through aqueous silver nitrate solution, form a white precipitate. This precipitate is soluble in dilute ammonia solution.

What could be the identity of compound Q?

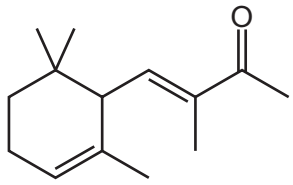
**A** $AgCl$ **B** NaBr **C** $NaCl$ **D** $PbBr_2$

**19** The strengths of the covalent bonds within halogen molecules, and the van der Waals' forces between halogen molecules, vary going down Group 17 from chlorine to bromine to iodine.

Which row shows these correctly?

| | strength of covalent bonds | strength of van der Waals' forces |
|---|---|---|
| **A** | decreases | decreases |
| **B** | decreases | increases |
| **C** | increases | decreases |
| **D** | increases | increases |

**20** The structural formula of compound Q is shown.

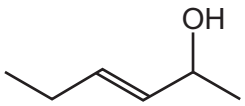



Q

How many stereoisomers exist with this structural formula?

**A** 1 **B** 2 **C** 4 **D** 8

**21** What is the name of compound **X**?




compound **X**

**A** *trans*-2-hydroxyhex-3-ene

**B** *trans*-2-hydroxyhexene

**C** *trans*-5-hydroxyhex-3-ene

**D** *trans*-5-hydroxyhexene

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

Which reaction occurs quickly at room temperature, 20 °C?

**A** $C_2H_4 + Br_2 \rightarrow C_2H_4Br_2$

**B** $C_2H_4 + H_2O \rightarrow CH_3CH_2OH$

**C** $CH_3CH_2OH \rightarrow C_2H_4 + H_2O$

**D** $CH_3CH_2OH + HBr \rightarrow CH_3CH_2Br + H_2O$

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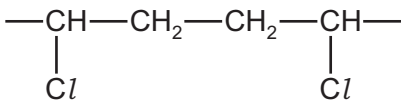
**23** A section of an addition polymer chain is shown.



Which monomer could be used to make this polymer?

**A** $CH_2CHCH_2Cl$

**B** $CH_2CHCl$

**C** $CH_3CHCHCl$

**D** $CHClCHCH_2CH_2Cl$

**24** Which organic reaction is an example of nucleophilic substitution?

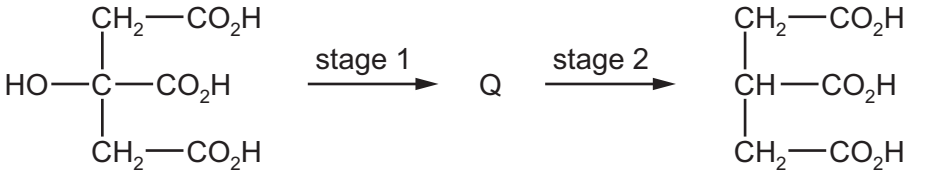
**A** $CH_3CH_2Br + NaOH \rightarrow CH_2CH_2 + H_2O + NaBr$

**B** $CH_3CH_2Br + NaOH \rightarrow CH_3CH_2OH + NaBr$

**C** $CH_2CH_2 + HCl \rightarrow C_2H_5Cl$

**D** $C_2H_6 + Cl_2 \rightarrow C_2H_5Cl + HCl$

**25** Citric acid can be converted into tricarballylic acid in two stages. An intermediate, Q, is formed.

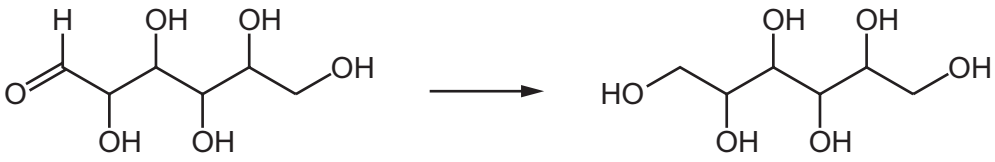



citric acid tricarballylic acid

Which reagents are needed for each stage?

| | stage 1 | stage 2 |
|---|---|---|
| **A** | concentrated $H_2SO_4$ | $H_2$(g) and Ni |
| **B** | concentrated $H_2SO_4$ | $LiAlH_4$ |
| **C** | $LiAlH_4$ | $H_2SO_4$(aq) |
| **D** | NaOH(aq) | $H_2$(g) and Ni |

**26** Glucose can be used to prepare sorbitol, a compound used as a sugar substitute.




glucose sorbitol

Which reagent may be used for this conversion?

**A** acidified potassium dichromate(VI)

**B** sodium borohydride

**C** sodium hydroxide

**D** Tollens' reagent

**27** 3-methylbutanone is treated with alkaline aqueous iodine. The mixture of products is then acidified.

Which compound is present in the final mixture of products?

**A** 3-methylbutanoic acid

**B** butanoic acid

**C** methylpropanoic acid

**D** propanoic acid

**28** At room temperature, propanoic acid was reacted to produce sodium propanoate. No gas was produced during the reaction.

What could the propanoic acid have reacted with?

**A** $NaHCO_3(aq)$ **B** $NaOH(aq)$ **C** $Na_2CO_3(aq)$ **D** $Na_2SO_4(aq)$

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**29** Ethene is reacted with steam in the presence of concentrated $H_3PO_4$. The product of this reaction is added to acidified potassium dichromate(VI) and heated under reflux for one hour. The final organic product is collected and labelled X.

But-2-ene is treated with hot, concentrated, acidified potassium manganate(VII). The final organic product is collected and labelled Y.

Which statement is correct?

**A** One molecule of X has more carbon atoms than one molecule of Y.

**B** One molecule of Y has more carbon atoms than one molecule of X.

**C** X and Y have different functional groups.

**D** X is the same compound as Y.

**30** A sample of the ester $CH_3CH_2CH_2CO_2CH_2CH_3$ is hydrolysed. The product mixture is then treated with hot, acidified $KMnO_4$.

What are the final carbon-containing products?

**A** $CH_3CH_2CO_2H$ only

**B** $CH_3CO_2H$ + $CH_3CH_2CO_2H$

**C** $CH_3CO_2H$ + $CH_3CH_2CH_2CO_2H$

**D** $CH_3CH_2OH$ + $CH_3CH_2CH_2CO_2H$

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**[Turn over**

## Section B

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

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

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

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

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

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

**31** The definitions of many chemical terms can be illustrated by chemical equations.

Which terms can be illustrated by an equation that includes the formation of a positive ion?

**1** first ionisation energy

**2** heterolytic fission of a covalent bond

**3** enthalpy change of atomisation

**32** A student makes sodium chloride by reacting together 0.025 mol of sodium carbonate with an excess of 0.2 mol $dm^{-3}$ hydrochloric acid.

$$Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$$

Which statements about the quantities of substance are correct?

**1** 600 $cm^3$ of carbon dioxide are produced at room temperature and pressure.

**2** 250 $cm^3$ of the hydrochloric acid are needed to exactly neutralise the sodium carbonate.

**3** 1.46 g of sodium chloride are produced.

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**33** One way of recovering tin from old printed circuit boards is to dissolve it in a mixture of concentrated hydrochloric acid and concentrated nitric acid. The tin dissolves because it reacts with the mixture of these concentrated acids.

$$Sn + 4HCl + 2HNO_3 \rightarrow SnCl_4 + NO_2 + NO + 3H_2O$$

Which statements about this reaction are correct?

**1** Nitrogen is present in three different oxidation states in the reactants and products.

**2** The oxidation state of tin increases from 0 to +4.

**3** The oxidation state of chlorine remains the same.

**34** The following reaction takes place in a suitable solvent.

$$Na^+NH_2^- + NH_4^+Cl^- \rightarrow Na^+Cl^- + 2NH_3$$

Which statements explain why this reaction should be classified as a Brønsted-Lowry acid-base reaction?

**1** The ammonium ion acts as a proton donor.

**2** $Na^+Cl^-$ is a salt.

**3** Ammonia is a nucleophile.

**35** Which statements about the elements barium and calcium and their compounds are correct?

**1** Barium nitrate decomposes at a higher temperature than calcium nitrate.

**2** Barium hydroxide is more soluble in water than is calcium hydroxide.

**3** Calcium is more reactive with water than is barium.

**36** Which statements explain why nitrogen gas is unreactive?

**1** Nitrogen atoms are highly electronegative.

**2** Nitrogen molecules are non-polar.

**3** The triple bond between nitrogen atoms is very strong.

**37** In which molecules do all the carbon atoms lie in the same plane?

**1** 2,3-dimethylbut-2-ene

**2** propane

**3** cyclohexane

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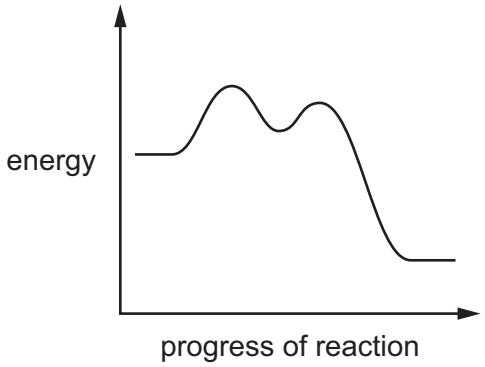
The responses **A** to **D** should be selected on the basis of

| 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.

**38** A reaction pathway diagram is shown.




Which reactions would have this reaction pathway diagram?

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

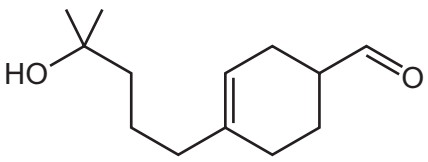
**2** $CH_3CH_2CH_2Br + NaOH \rightarrow CH_3CH_2CH_2OH + NaBr$

**3** $(CH_3)_3CCH_2CH_2C\mathit{l} + 2NH_3 \rightarrow (CH_3)_3CCH_2CH_2NH_2 + NH_4C\mathit{l}$

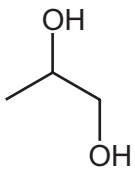
**39** The compounds below are used to make perfumes.

Which compounds will produce a yellow precipitate with alkaline aqueous iodine?

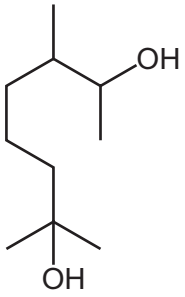
**1**




**2**




**3**



**40** The reaction of ethanal, $CH_3CHO$, with HCN to form 2-hydroxypropanenitrile is catalysed by NaCN.

What are features of the intermediate of this reaction?

**1** It is chiral.

**2** It has a single negative charge on one of its atoms.

**3** It is a nucleophile.

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