Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

CHEMISTRY **9701/12**

Paper 1 Multiple Choice **May/June 2015**

1 hour

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

* 5 8 8 2 2 6 7 3 8 2 *

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.

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

In which option do all three particles have the same electronic configuration **and** the same number of neutrons?

A $^{15}N^{3-}$ $^{16}O^{2-}$ $^{19}F^{-}$

B $^{18}O^{2-}$ $^{19}F^{-}$ ^{20}Ne

C $^{19}F^{-}$ ^{20}Ne $^{23}Na^{+}$

D ^{22}Ne ^{23}Na $^{24}Mg^{2+}$

2 The shell of a chicken's egg makes up 5% of the mass of an average egg. An average egg has a mass of 50 g.

Assume the egg shell is pure calcium carbonate.

How many complete chicken's egg shells would be needed to neutralise 50 cm^3 of 2.0 mol dm^{-3} ethanoic acid?

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

3 Phosphorus forms a compound with hydrogen called phosphine, PH_3. This compound can react with a hydrogen ion, H^+.

Which type of interaction occurs between PH_3 and H^+?

A dative covalent bond

B dipole-dipole forces

C hydrogen bond

D ionic bond

4 Which solid has a simple molecular lattice?

A calcium fluoride

B nickel

C silicon(IV) oxide

D sulfur

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

The gas laws can be summarised in the ideal gas equation below.

$$pV = nRT$$

The volume of a sample of methane is measured at a temperature of 60 °C and a pressure of 103 kPa. The volume measured is 5.37×10^{-3} m^3.

Assume the gas behaves as an ideal gas.

What is the mass of the sample of methane, given to two significant figures?

A 0.00018 g **B** 0.0032 g **C** 0.18 g **D** 3.2 g

6 Metaldehyde, $(CH_3CHO)_4$, is used as a solid fuel for camping stoves. The equation for the complete combustion of metaldehyde is shown.

$$(CH_3CHO)_4(s) + 10\,O_2(g) \rightarrow 8CO_2(g) + 8H_2O(l)$$

$\Delta H_c^{\ominus}$ = standard enthalpy change of combustion.

Which expression will give a correct value for the enthalpy change of formation of metaldehyde?

A $\Delta H_c^{\ominus}$metaldehyde – ($8\Delta H_c^{\ominus}$carbon + $8\Delta H_c^{\ominus}$hydrogen)

B $\Delta H_c^{\ominus}$metaldehyde – ($8\Delta H_c^{\ominus}$carbon + $16\Delta H_c^{\ominus}$hydrogen)

C ($8\Delta H_c^{\ominus}$carbon + $8\Delta H_c^{\ominus}$hydrogen) – $\Delta H_c^{\ominus}$metaldehyde

D ($8\Delta H_c^{\ominus}$carbon + $16\Delta H_c^{\ominus}$hydrogen) – $\Delta H_c^{\ominus}$metaldehyde

7 In industry, copper metal is purified by electrolysis.

Which changes occur to the masses of the electrodes and to the colour of the electrolyte during this process?

	mass of anode	mass of cathode	colour of electrolyte
A	decrease	increase	little or no change occurs
B	decrease	increase	pale blue to blue
C	increase	decrease	little or no change occurs
D	increase	decrease	blue to pale blue

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8 Nitrogen dioxide, NO_2, exists in equilibrium with dinitrogen tetroxide, N_2O_4.

$$2NO_2(g) \rightleftharpoons N_2O_4(g) \qquad \Delta H = -57\,kJ\,mol^{-1}$$

Which conditions give the greatest percentage of $N_2O_4(g)$ at equilibrium?

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

9 When a sample of HI is warmed to a particular temperature the equilibrium below is established.

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

At this temperature, it is found that the partial pressure of HI(g) is 28 times the partial pressure of $H_2(g)$.

What is the value of K_p at this temperature?

A 1.28×10^{-3} **B** 0.035 **C** 28 **D** 784

10 Photochromic glass, used for sunglasses, darkens when exposed to bright light and becomes more transparent again when the light is less bright. The darkness of the glass is related to the concentration of silver atoms.

The following reactions are involved.

reaction 1 $Ag^+ + Cl^- \rightleftharpoons Ag + Cl$

reaction 2 $Cu^+ + Cl \rightarrow Cu^{2+} + Cl^-$

reaction 3 $Cu^{2+} + Ag \rightarrow Cu^+ + Ag^+$

Which statement about these reactions is correct?

A Cu^+ and Cu^{2+} ions act as catalysts.

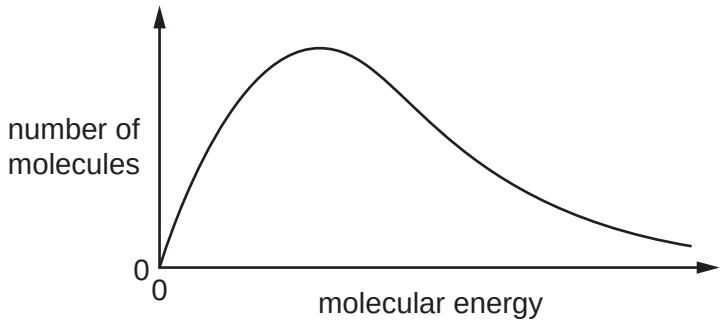
B Cu^+ ions act as an oxidising agent in reaction 2.

C Reaction 3 increases the darkness of the glass.

D Silver atoms are reduced in reaction 3.

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11 The Boltzmann distribution below shows the distribution of molecular energies in a sample of a gas at a given temperature.



Which statement correctly describes the change in such a distribution if the temperature is increased?

A Fewer molecules possess the most probable energy value and this value shifts to the left.

B Fewer molecules possess the most probable energy value and this value shifts to the right.

C More molecules possess the most probable energy value and this value shifts to the left.

D The area under the curve of the distribution increases.

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

When 3.00 g of an anhydrous nitrate of a Group II metal is decomposed, 1.53 g of gas is produced.

What is the nitrate compound?

A beryllium nitrate

B calcium nitrate

C magnesium nitrate

D strontium nitrate

13 What happens when a piece of magnesium ribbon is placed in cold water?

A A vigorous effervescence occurs.

B Bubbles of gas form slowly on the magnesium.

C The magnesium floats on the surface of the water and reacts quickly.

D The magnesium glows and a white solid is produced.

14 Compound **X** releases carbon dioxide gas and forms a white solid, **Y**, when it is heated. Neither **X** nor **Y** are soluble in water. Compound **Y** is used as a refractory kiln lining.

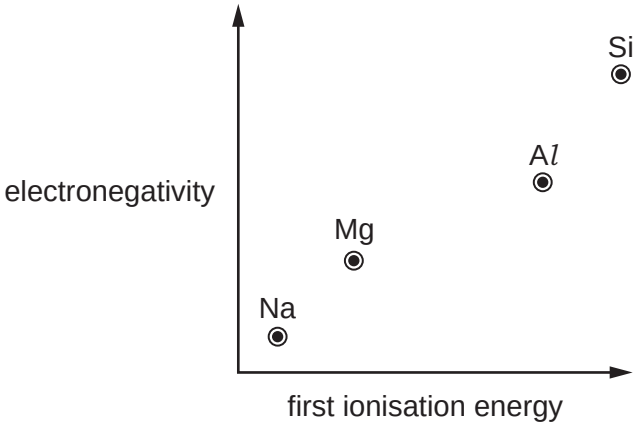
What is compound **X**?

A $CaCO_3$ **B** CaO **C** $MgCO_3$ **D** MgO

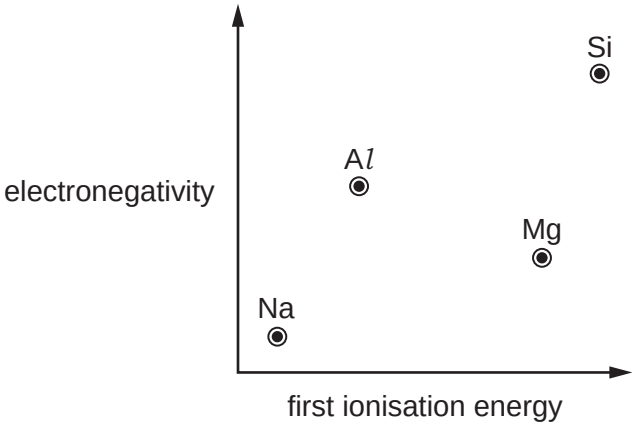
15 *Use of the Data Booklet is relevant to this question.*

Which diagram correctly shows the electronegativity of the elements Na, Mg, A*l* and Si plotted against their first ionisation energies?

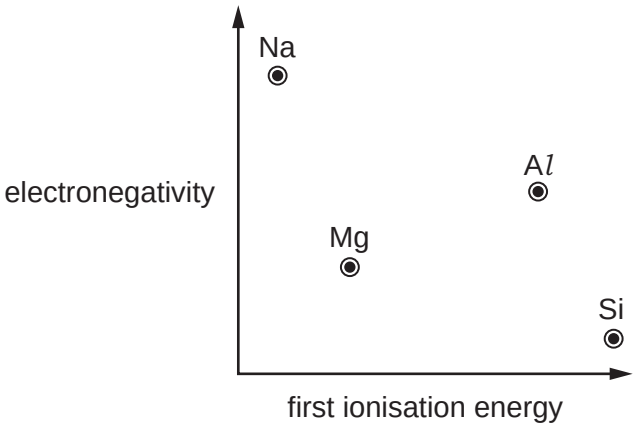
A



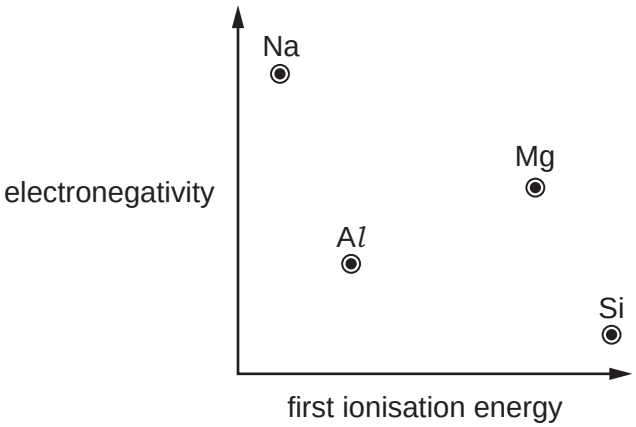
B



C

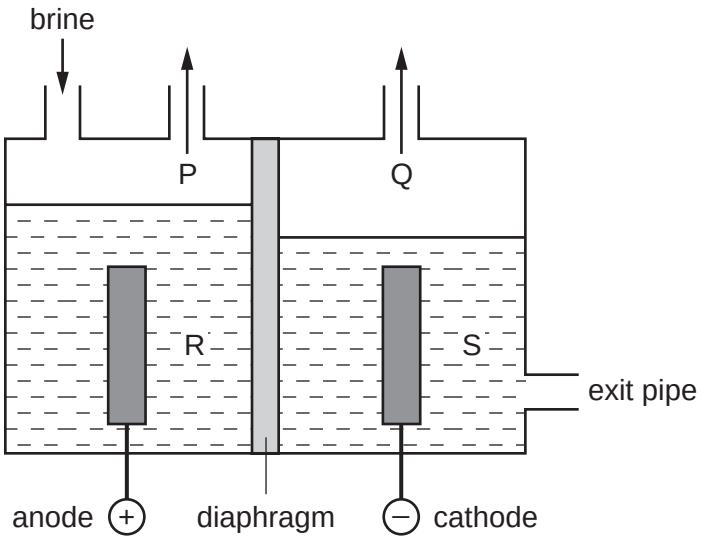


D



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16 The diagram shows a diaphragm cell used for the electrolysis of brine. Brine is concentrated aqueous sodium chloride.



A solution of sodium chlorate(I), commonly used as bleach, can be made by mixing which two substances?

A P and R **B** P and S **C** Q and R **D** Q and S

17 Which statement about the ammonium ion, NH_4^+, is correct?

A All bond angles are 107°.

B Ammonium ions are formed when ammonia behaves as an acid.

C Ammonium ions are unreactive when heated with NaOH(aq).

D The bonds are all the same length.

18 Carbon monoxide, CO, nitrogen dioxide, NO_2, and sulfur dioxide, SO_2, are all atmospheric pollutants.

Which reaction concerning these compounds occurs in the atmosphere?

A CO is spontaneously oxidised to CO_2

B NO_2 is reduced to NO by CO

C NO_2 is reduced to NO by SO_2

D SO_2 is oxidised to SO_3 by CO_2

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19 Chlorate(V) ions, ClO_3^-, are produced in the redox reaction between chlorine and hot aqueous sodium hydroxide. Oxidation numbers can be used to help balance the equation for this reaction.

What will be the values of coefficients **v**, **x** and **y** in the balanced equation?

$$\mathbf{v}Cl_2(g) + \mathbf{w}OH^-(aq) \rightarrow \mathbf{x}Cl^-(aq) + \mathbf{y}ClO_3^-(aq) + \mathbf{z}H_2O(l)$$

	v	**x**	**y**
A	2	3	1
B	3	4	2
C	3	5	1
D	7	12	2

20 Which alcohol will react with an acidified solution of potassium dichromate(VI) to produce a ketone containing six carbon atoms?

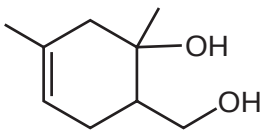
A 2,2-dimethylbutan-1-ol

B 2-methylpentan-3-ol

C 3,3-dimethylpentan-2-ol

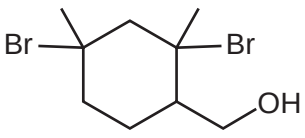
D 3-methylpentan-3-ol

21 What is the major product formed when compound Q is warmed with excess HBr?

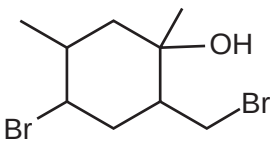


Q

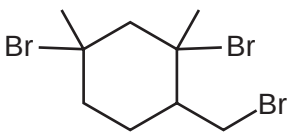
A



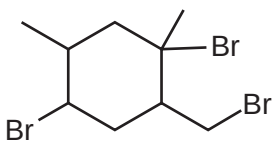
B



C



D



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22 Four students, W, X, Y and Z, made the following statements about alkanes and alkenes.

W 'Bromine reacts with alkanes by electrophilic substitution.'

X 'Bromine reacts with alkenes by a free-radical addition mechanism.'

Y 'Alkenes can be oxidised by acidified manganate(VII) ions.'

Z 'Alkenes are formed from alkanes by cracking.'

Which two students are correct?

A W and X **B** W and Z **C** X and Y **D** Y and Z

23 Butanedioic acid may be synthesised in two steps from 1,2-dibromoethane.

$$BrCH_2CH_2Br \xrightarrow{\text{step 1}} X \xrightarrow{\text{step 2}} HO_2CCH_2CH_2CO_2H$$

Which reagents could be used for this synthesis?

	step 1	step 2
A	HCN(g)	HC*l*(aq)
B	HCO_2Na(aq)	HC*l*(aq)
C	KCN(alcoholic)	H_2SO_4(aq)
D	NaOH(aq)	$K_2Cr_2O_7 / H_2SO_4$(aq)

24 Which reaction would **not** give propene?

A adding excess hot concentrated sulfuric acid to propan-1-ol

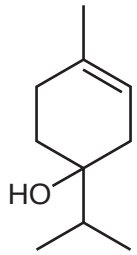
B adding warm aqueous sodium hydroxide to 2-bromopropane

C adding warm ethanolic sodium hydroxide to 1-bromopropane

D passing propan-2-ol vapour over heated aluminium oxide

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25 Terpinen-4-ol is one of the active ingredients in tea tree oil.



terpinen-4-ol

What is the molecular formula of terpinen-4-ol?

A $C_7H_{11}O$ **B** $C_{10}H_{16}O$ **C** $C_{10}H_{17}O$ **D** $C_{10}H_{18}O$

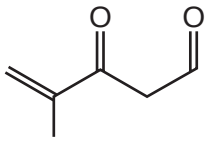
26 *Use of the Data Booklet is relevant to this question.*

2.40 g of propan-2-ol were mixed with excess acidified potassium dichromate(VI). The reaction mixture was then boiled under reflux for twenty minutes. The organic product was then collected by distillation. The yield of product was 75.0%.

What mass of product was collected?

A 1.74 g **B** 1.80 g **C** 2.22 g **D** 2.32 g

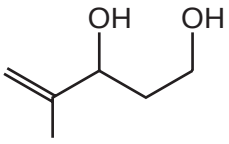
27 The diagram shows the structure of compound X.



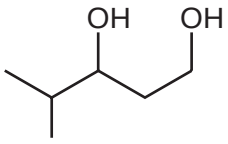
X

What is the product of the reaction between compound X and an excess of $NaBH_4$?

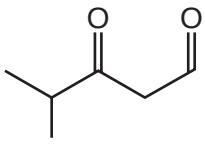
A



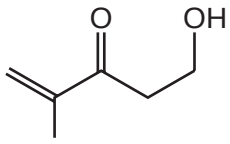
B



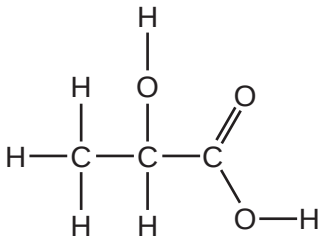
C



D



28 Lactic acid occurs naturally, for example in sour milk.



lactic acid

What is a property of lactic acid?

A It decolourises aqueous bromine rapidly.

B It is insoluble in water.

C It reduces Fehling's reagent.

D Two molecules react with each other in the presence of a strong acid.

29 Citric acid is found in lemon juice.

$HO_2CCH_2C(OH)(CO_2H)CH_2CO_2H$

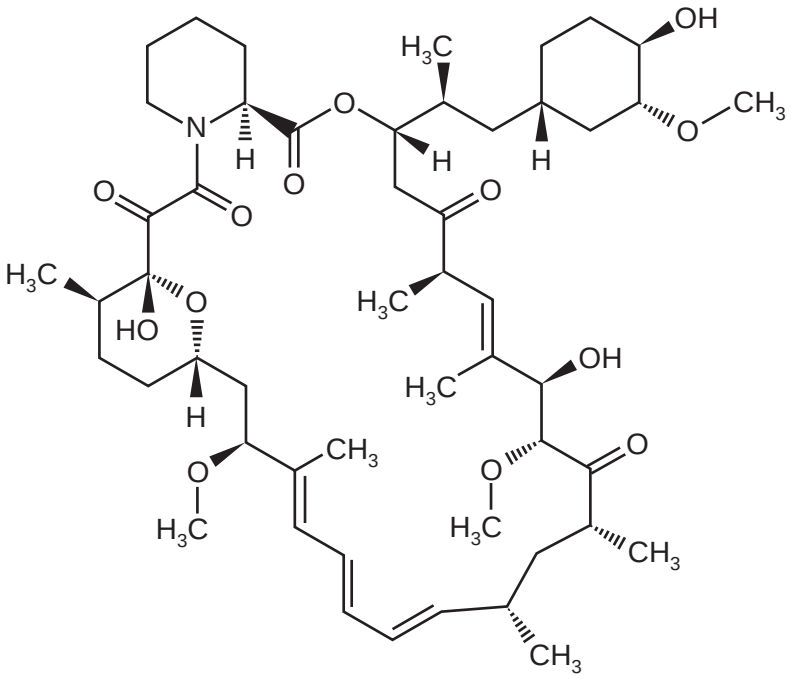
citric acid

What is the volume of 0.4 mol dm^{-3} sodium hydroxide solution required to neutralise a solution containing 0.005 mol of citric acid?

A 12.5 cm^3 **B** 25.0 cm^3 **C** 37.5 cm^3 **D** 50.0 cm^3

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30 The drug *Sirolimus* is used to treat patients after kidney transplants.

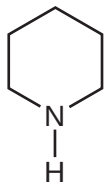


Sirolimus

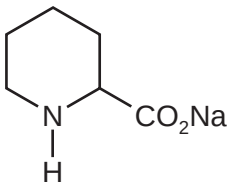
On reaction with hot aqueous sodium hydroxide, *Sirolimus* produces an equimolar mixture of two organic products.

What is the structural formula of the product with the lower relative molecular mass?

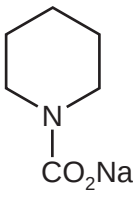
A



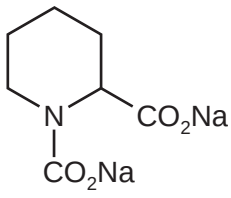
B



C



D



Section B

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

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

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

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

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

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

Which statements about the phosphide ion, $^{31}P^{3-}$, and the chloride ion, $^{35}Cl^{-}$, are correct?

1 They have the same number of electrons.

2 They have the same number of neutrons.

3 They have the same number of protons.

32 Why does aluminium chloride, Al_2Cl_6, sublime at the relatively low temperature of 180 °C?

1 The intermolecular forces between the Al_2Cl_6 molecules are weak.

2 The co-ordinate bonds between aluminium and chlorine are weak.

3 The covalent bonds between aluminium and chlorine are weak.

33 Which statements are correct for **all** exothermic reactions?

1 ΔH for the reaction is negative.

2 On a reaction pathway diagram the products are shown lower than the reactants.

3 The reaction will happen spontaneously.

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

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

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

34 Which of these reactions are redox reactions?

1 $6NO(g) + 4NH_3(g) \rightarrow 5N_2(g) + 6H_2O(g)$

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

3 $SO_3(g) + H_2O(g) \rightarrow H_2SO_4(g)$

35 When added to water, which oxides will cause a change in the pH of the water?

1 SiO_2

2 CaO

3 SO_2

36 Halogenated hydrocarbons have many uses.

What have halogenated hydrocarbons been used for?

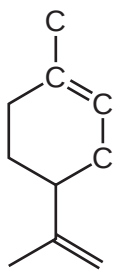
1 solvents

2 refrigerants

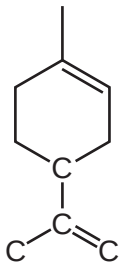
3 monomers in polymer manufacture

37 In which structures do the four carbon atoms labelled C lie in the same plane?

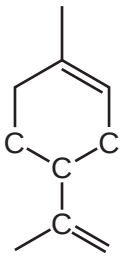
1



2



3



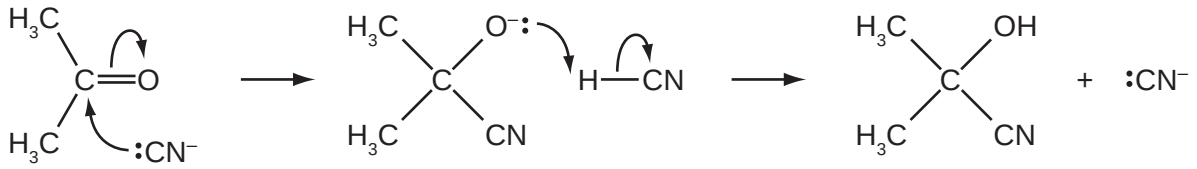
38 Which statements about 2-methylbutan-1-ol are correct?

1 It can give HCl(g) on reaction with PCl_5.

2 It can be oxidised to give an aldehyde.

3 It exists in two optically active forms.

39 Propanone and hydrogen cyanide react together by this mechanism.



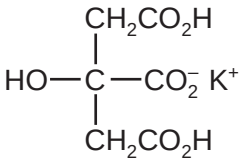
Which statements about this mechanism are correct?

1 CN^- is an electrophile.

2 It is an addition reaction.

3 Heterolytic bond breaking is involved.

40 Monopotassium citrate is used as an emulsifying agent in powdered milk and in powdered soups. It may be represented by the formula shown.



monopotassium citrate

Which statements about monopotassium citrate are correct?

1 It does **not** have a chiral carbon atom.

2 It can act as a dibasic acid.

3 It reacts with $NaHCO_3$ to give CO_2.

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