Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

CHEMISTRY **9701/11**

Paper 1 Multiple Choice **May/June 2018**

1 hour

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

* 2 2 1 8 8 4 7 4 3 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.

This document consists of **14** printed pages and **2** blank pages.

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Section A

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

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

1 This question refers to isolated gaseous atoms.

In which atom are all electrons paired?

A Ba **B** Br **C** S **D** Si

2 Which compound has a boiling point that is influenced by hydrogen bonding?

A CH_3CHO **B** CH_3OCH_3 **C** HCO_2CH_3 **D** HCO_2H

3 Which fuel would produce the largest mass of CO_2 when 10 kg of the fuel undergo complete combustion?

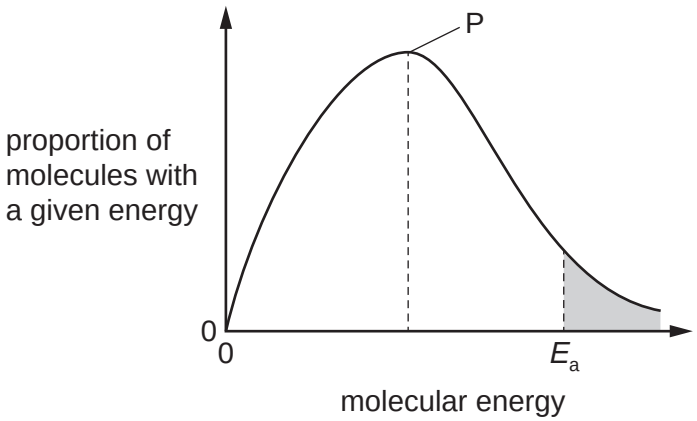
A biodiesel, $C_{17}H_{34}O_2$

B ethanol, C_2H_6O

C octane, C_8H_{18}

D propane, C_3H_8

4 The diagram shows the Boltzmann distribution of energies in a gas. The gas can take part in a reaction with an activation energy, E_a. The gas is maintained at a constant temperature.



Which statement is correct?

A If a catalyst is added, peak P will be lower and E_a will move to the left.

B If a catalyst is added, peak P will be lower and E_a will move to the right.

C If a catalyst is added, peak P will be the same and E_a will move to the left.

D If a catalyst is added, peak P will be the same and E_a will move to the right.

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5 Which molecule has no overall dipole?

A CH_3Cl **B** CH_2Cl_2 **C** $CHCl_3$ **D** CCl_4

6 Which solid contains more than one type of bonding?

A iodine

B silicon dioxide

C sodium chloride

D zinc

7 Enthalpy changes of combustion can be used to determine enthalpy changes of formation. The following equation represents the enthalpy change of formation of butane.

$$4C(s) + 5H_2(g) \rightarrow C_4H_{10}(g)$$

By using the following standard enthalpy of combustion data, what is the value of the standard enthalpy change of formation, $\Delta H_f^{\ominus}$, of butane?

substance	$\Delta H_c^{\ominus}$ / kJ mol^{-1}
C(s)	–394
$H_2(g)$	–286
$C_4H_{10}(g)$	–2877

A –5883 kJ mol^{-1}

B –129 kJ mol^{-1}

C +129 kJ mol^{-1}

D +2197 kJ mol^{-1}

8 Ethanedioate ions, $C_2O_4^{2-}$, react with a suitable reagent to form CO_2. A half-equation for this reaction is shown.

$$C_2O_4^{2-} \rightarrow 2CO_2 + 2e^-$$

Which row is correct?

	oxidation state of carbon in $C_2O_4^{2-}$	type of reaction
A	+3	oxidation
B	+3	reduction
C	+5	oxidation
D	+5	reduction

9 Oxidation numbers should be used to answer this question.

A redox reaction takes place between hydroxylammonium ions, $[NH_3OH]^+$, and acidified iron(III) ions, Fe^{3+}. The products are iron(II) ions, Fe^{2+}, H^+ ions, water and a compound of nitrogen.

The mole ratio of reacting hydroxylammonium ions to reacting iron(III) ions is 1 : 2.

Which nitrogen-containing compound could be formed in the reaction?

A NH_3 **B** N_2O **C** NO **D** NO_2

10 Element X has a higher first ionisation energy than element Y.

Two students state what they believe is one factor that helps to explain this.

student 1 "X has a higher first ionisation energy than Y because an atom of X has more protons in its nucleus than an atom of Y."

student 2 "X has a higher first ionisation energy than Y because X has a smaller atomic radius than Y."

Only **one** of the two students is correct.

What could X and Y be?

	X	Y
A	carbon	boron
B	magnesium	aluminium
C	oxygen	nitrogen
D	oxygen	sulfur

11 Hydrogen ions catalyse the hydrolysis of esters.

Which statement is correct?

A The hydrogen ions act as a heterogeneous catalyst.

B The hydrogen ions are in the same phase as the reactants.

C The hydrogen ions are used up in the reaction.

D The hydrogen ions have no effect on the activation energy of the reaction.

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12 Silicon is heated in an excess of chlorine, producing compound J.

Excess water is added to the sample of J produced.

Which row is correct?

	structure of J	Is HC*l* produced when water is added to J?
A	giant molecular	no
B	giant molecular	yes
C	simple molecular	no
D	simple molecular	yes

13 Which element has the **second** smallest atomic radius in its group and the **third** lowest first ionisation energy in its period?

A boron

B calcium

C magnesium

D sodium

14 Chlorine reacts with **cold** aqueous sodium hydroxide to produce sodium chloride, water and compound X.

Chlorine reacts with **hot** aqueous sodium hydroxide to produce sodium chloride, water and compound Y.

What are the oxidation states of chlorine in compound X and compound Y?

	X	Y
A	–1	–5
B	–1	+5
C	+1	–5
D	+1	+5

15 In which reaction does ammonia behave as a Brønsted-Lowry base?

A $NH_3 + CH_3CH_2Br \rightarrow CH_3CH_2NH_2 + HBr$

B $NH_3 + H_2O + CO_2 \rightarrow (NH_4)HCO_3$

C $2NH_3 + 2Na \rightarrow 2NaNH_2 + H_2$

D $4NH_3 + 3O_2 \rightarrow 2N_2 + 6H_2O$

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16 Aqueous silver nitrate is added to a solution of potassium iodide.

Aqueous ammonia is then added.

What would be observed?

A a cream precipitate that dissolves on addition of aqueous ammonia

B a cream precipitate that does not dissolve on addition of aqueous ammonia

C a yellow precipitate that dissolves on addition of aqueous ammonia

D a yellow precipitate that does not dissolve on addition of aqueous ammonia

17 Oxides of nitrogen are present in the environment due to natural and man-made sources.

Which row is correct?

	natural source of nitrogen oxides	man-made source of nitrogen oxides
A	electrical discharges in the atmosphere	internal combustion engines
B	electrical discharges in the atmosphere	as a by-product of the Haber process
C	decomposition of dead plants in rivers	internal combustion engines
D	decomposition of dead plants in rivers	as a by-product of the Haber process

18 When 3.00 g of an anhydrous nitrate of a Group 2 metal is decomposed, 1.53 g of gas is produced.

What is the nitrate compound?

A beryllium nitrate

B calcium nitrate

C magnesium nitrate

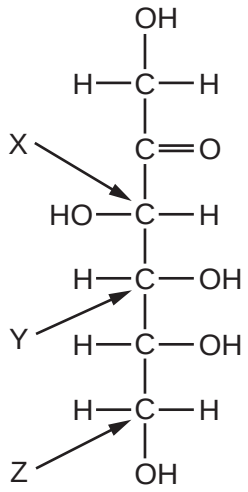
D strontium nitrate

19 Which row correctly describes one property of barium and one property of barium oxide?

	observation when barium metal is added to water	pH of solution obtained when a spatula measure of BaO is added to 100 cm^3 of water
A	a few gas bubbles form on the metal surface	8
B	a few gas bubbles form on the metal surface	13
C	rapid effervescence is seen	8
D	rapid effervescence is seen	13

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20 Fructose is a sugar with more than one chiral centre. The fructose molecule is shown with X, Y and Z indicating three carbon atoms.



fructose

Which carbon atoms are chiral centres?

A X, Y and Z **B** X and Y only **C** X only **D** Y only

21 Which pair of alcohols are isomers of each other?

A butan-1-ol and 2,2-dimethylpropan-1-ol

B butan-2-ol and 2-methylpropan-2-ol

C pentan-1-ol and 2-methylpropan-2-ol

D propan-2-ol and 2-methylpropan-2-ol

22 Sodium methoxide, $Na^+CH_3O^-$, reacts with 2-chloro-2-methylpropane in a nucleophilic substitution reaction. The nucleophile is the CH_3O^- ion.

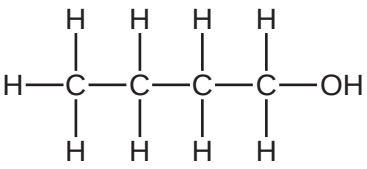
Which row is correct?

	intermediate or transition state	product
A	$(CH_3)_3C^+$	$(CH_3)_3COCH_3$
B	$(CH_3)_3C^+$	$(CH_3)_3CCH_2OH$
C	$[HOCH_2\text{- - -}C(CH_3)_3\text{- - -}Cl]^-$	$HOCH_2C(CH_3)_3$
D	$[H_3CO\text{- - -}C(CH_3)_3\text{- - -}Cl]^-$	$H_3COC(CH_3)_3$

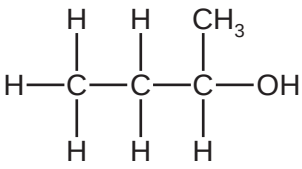
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23 Which alcohol can be dehydrated to give two products which are structural isomers of each other?

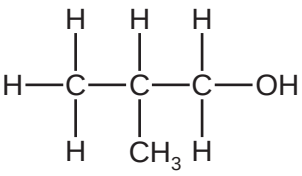
A



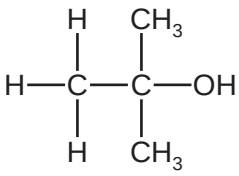
B



C



D



24 Which reagent could detect the presence of alcohol in a mixture consisting mainly of alkanes and alkenes?

A Na

B Br_2 (in CCl_4)

C $KMnO_4$(aq)

D 2,4-dinitrophenylhydrazine

25 Compound Q

- contains a chiral centre,
- gives a positive result with Fehling's reagent,
- gives a positive result with alkaline aqueous iodine.

What could compound Q be?

A 1-hydroxybutanone

B 2-hydroxybutanal

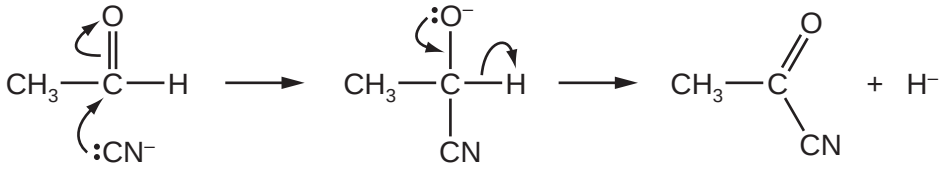
C 3-hydroxybutanal

D 3-hydroxybutanone

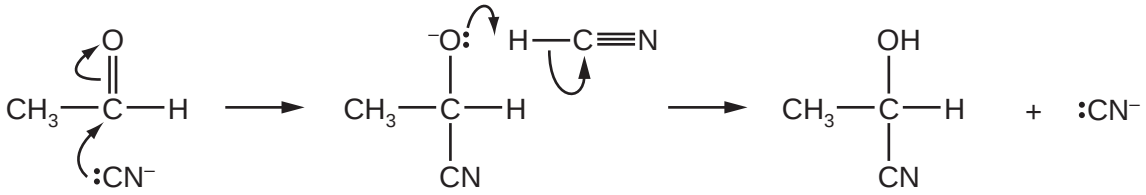
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26 What is the mechanism for the reaction of ethanal, CH_3CHO, with hydrogen cyanide, HCN, in the presence of NaCN?

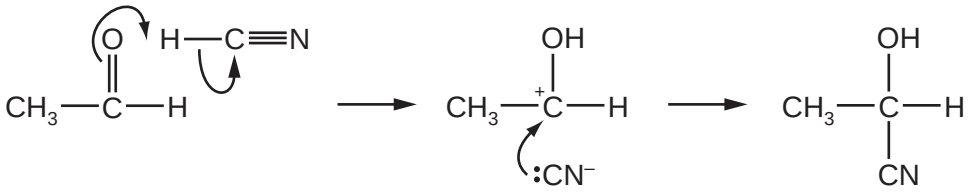
A



B



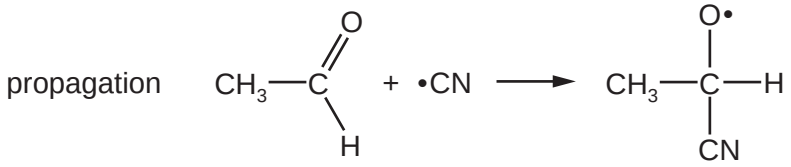
C

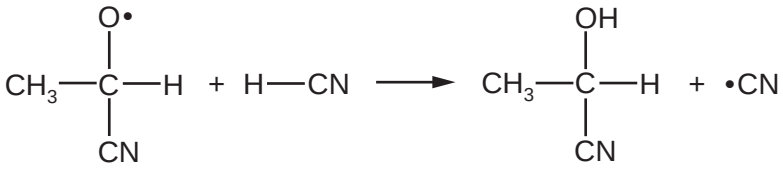


D

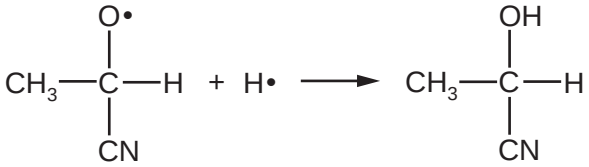
initiation $HCN \longrightarrow H\bullet + \bullet CN$

propagation





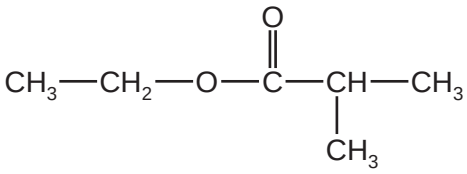
termination



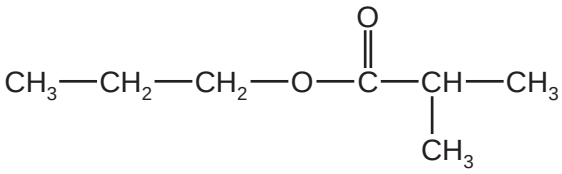
27 Ethyl propanoate is refluxed with aqueous sodium hydroxide. The alcohol produced is then reacted with methyl propanoic acid to make a second ester.

What is the structural formula of this second ester?

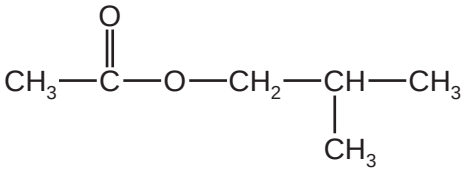
A



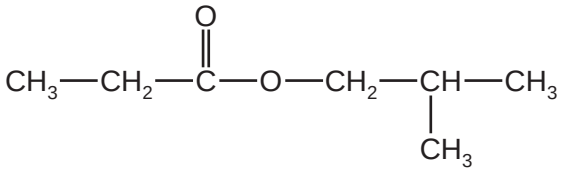
B



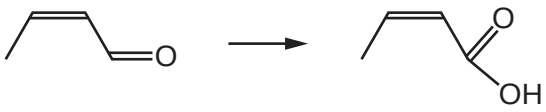
C



D



28 Which reagent could be used to carry out the following reaction?



A a solution containing acidified dichromate(VI) ions

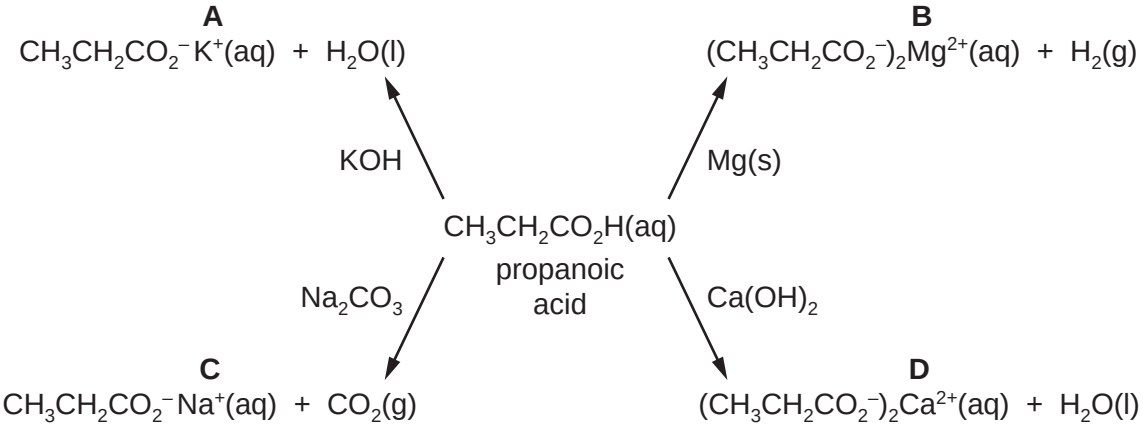
B a solution containing dilute, acidified manganate(VII) ions

C a solution containing hot, concentrated, acidified manganate(VII) ions

D concentrated sulfuric acid

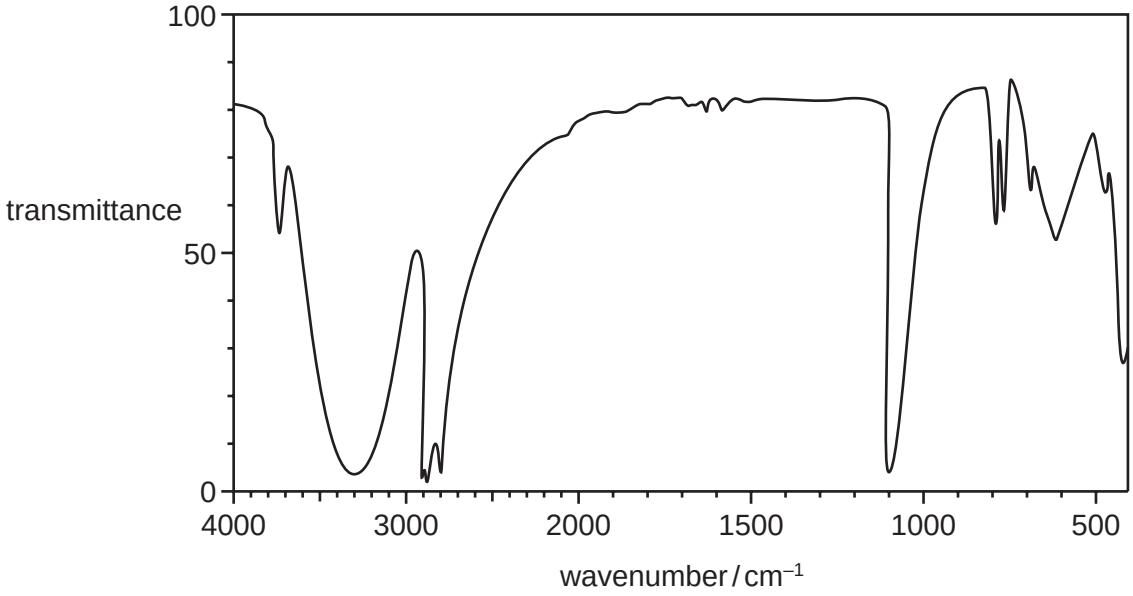
29 Four reactions of propanoic acid to form salts and other products are shown.

Which reaction does **not** show the formulae of **all** the correct products?



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30 Compound X contains three carbon atoms. Part of a simplified infra-red spectrum of compound X is shown.



Which compound could be X?

A CH_3CH_2CHO

B $CH_3CH_2CO_2H$

C $CH_3CH_2CH_2OH$

D $CH_3CO_2CH_3$

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 One mole of sulfuric acid is used to make an aqueous solution. The solution contains H_2SO_4 molecules, H^+ ions, SO_4^{2-} ions and HSO_4^- ions.

Which statements are correct?

1 The solution contains 6.02×10^{23} sulfur atoms.

2 The solution contains an exactly equal number of H^+ ions and HSO_4^- ions.

3 One mole of SO_4^{2-} ions contains two moles of electrons.

32 Which statements are correct?

1 The hydrogen bonds in ice are more regularly arranged than in water.

2 The solidification of water to form ice is exothermic.

3 Pure water is less dense than ice.

33 Calcium reacts with water to form calcium hydroxide and hydrogen.

$$Ca(s) + 2H_2O(l) \rightarrow Ca(OH)_2(s) + H_2(g)$$

The standard enthalpy change for this reaction is $-414\,kJ\,mol^{-1}$.

What further information is needed in order to calculate the standard enthalpy change of formation of calcium hydroxide, $\Delta H_f^\ominus Ca(OH)_2(s)$?

1 $\Delta H_f^\ominus$ for $H_2O(l)$

2 $\Delta H_f^\ominus$ for $H_2(g)$

3 first and second ionisation energies of Ca

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34 Which statements are correct when a reversible reaction is at equilibrium?

1 All species are at equal concentration.

2 The concentrations of all species remain constant.

3 The rate of the forward reaction equals the rate of the reverse reaction.

35 Each of the three mixtures shown can result in a chemical reaction.

Which mixtures result in a redox reaction?

1 bromine + hydrogen

2 sodium chloride + concentrated sulfuric acid

3 potassium iodide + silver nitrate

36 Which statements correctly describe an oxide of nitrogen acting as an atmospheric pollutant?

1 Nitrogen monoxide, NO, reacts with oxygen to form nitrogen dioxide which contributes to acid rain.

2 Nitrogen dioxide reacts with sulfur dioxide to form sulfur trioxide which reacts with water to form sulfuric acid.

3 Nitrogen oxides react with unburnt hydrocarbons in sunlight to form other pollutants.

37 Polymer Z contains the length of polymer chain shown below.

This short length of chain is found many times within the chains of polymer Z, although it is **not** the repeat unit.

$$-CH_2-CHCl-CH_2-$$

What could be the name of polymer Z?

1 poly(2-chloropropene)

2 poly(chloroethene)

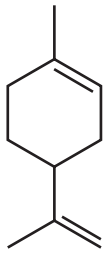
3 PVC

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 Limonene is found in lemons.



limonene

Limonene is heated with concentrated acidified potassium manganate(VII).

Which compounds are produced?

1 $CH_3COCH_2CH_2CH(CH_2CO_2H)_2$

2 CO_2

3 $CH_3COCH_2CH_2CH(COCH_3)CH_2CO_2H$

39 Chlorofluoroalkanes have been used as the refrigerant in refrigerators but care has to be taken in disposing of old refrigerators.

Which statements about chlorofluoroalkanes are correct?

1 C–C*l* bonds more readily undergo homolytic fission than C–F bonds.

2 Care is taken in the disposal of old refrigerators because of possible ozone depletion.

3 C_2H_4ClF is more volatile than C_2H_6.

40 The M_r of compound X is 72. The composition by mass of X is 66.7% carbon, 11.1% hydrogen and 22.2% oxygen. X gives an orange precipitate with 2,4-dinitrophenylhydrazine reagent. X does not react with Fehling's reagent.

What can be deduced from this information?

1 X is a carbonyl compound.

2 X is a ketone.

3 X is butanone.

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