Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

CHEMISTRY **9701/12**

Paper 1 Multiple Choice **October/November 2015**

1 hour

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

* 6 9 5 2 3 6 5 8 8 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.

1 Which type of bonding is **never** found in elements?

A covalent

B ionic

C metallic

D van der Waals' forces

2 Arsenic chloride, $AsCl_3$, reacts with sodium borohydride, $NaBH_4$.

$$\mathbf{p}AsCl_3 + \mathbf{q}NaBH_4 \rightarrow \mathbf{r}AsH_3 + \mathbf{s}NaCl + \mathbf{t}BCl_3$$

What are the numbers **p**, **q**, **r**, **s** and **t** when this equation is balanced correctly?

	p	**q**	**r**	**s**	**t**
A	2	3	2	3	1
B	3	3	3	3	2
C	4	3	4	3	3
D	4	4	4	4	3

3 Three substances have the physical properties shown in the table.

substance	melting point / °C	boiling point / °C	conductivity (solid)	conductivity (liquid)	conductivity (aqueous)
U	420	907	good	good	insoluble
V	993	1695	poor	good	good
W	–70	58	poor	poor	hydrolyses, resulting solution conducts well

What could be the identities of **U**, **V** and **W**?

	U	**V**	**W**
A	Na	KCl	$SiCl_4$
B	Na	NaF	C_2H_5Br
C	Zn	KCl	HCl
D	Zn	NaF	$SiCl_4$

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4 Flask X contains 5 dm^3 of helium at 12 kPa pressure and flask Y contains 10 dm^3 of neon at 6 kPa pressure.

If the flasks are connected at constant temperature, what is the final pressure?

A 8 kPa **B** 9 kPa **C** 10 kPa **D** 11 kPa

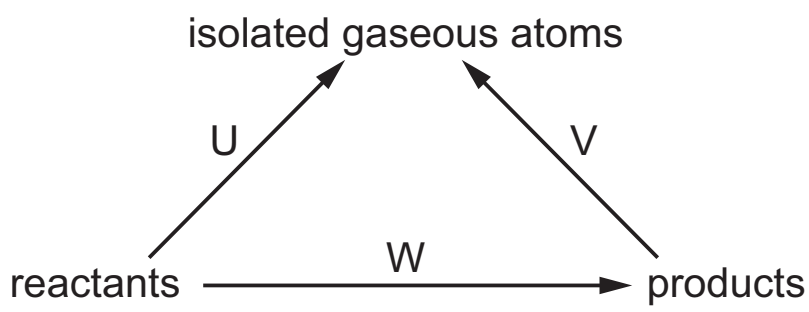
5 Calcium forms an ionic compound with carbon, called calcium carbide. The oxidation number of carbon in calcium carbide is –1.

Calcium carbide is readily hydrolysed by water giving two products only.

What could be the formulae of calcium carbide and the two products of hydrolysis?

	calcium carbide	products
A	Ca_2C	CaO and C_2H_4
B	Ca_2C	$Ca(OH)_2$ and C_2H_2
C	CaC_2	CaO and C_2H_4
D	CaC_2	$Ca(OH)_2$ and C_2H_2

6 Hess' law may be used to determine enthalpy changes using average bond energies, as shown in the diagram.



U is the sum of the average bond energies of the reactants, and V is the sum of the average bond energies of the products.

For the reaction shown below, which expression will give a value for W, the enthalpy change of combustion of methane?

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

A U – V **B** U + V **C** 2(U – V) **D** V – U

7 The process of electrolysis can be used to purify copper, and to extract aluminium from an aluminium oxide / cryolite mixture.

What are the reactions at the anode in each of these processes?

	purification of copper	extraction of aluminium
A	$Cu^{2+} + 2e^- \rightarrow Cu$	$2O^{2-} \rightarrow O_2 + 4e^-$
B	$Cu^{2+} + 2e^- \rightarrow Cu$	$4OH^- \rightarrow O_2 + 2H_2O + 4e^-$
C	$Cu \rightarrow Cu^{2+} + 2e^-$	$2O^{2-} \rightarrow O_2 + 4e^-$
D	$Cu \rightarrow Cu^{2+} + 2e^-$	$4OH^- \rightarrow O_2 + 2H_2O + 4e^-$

8 Hydrogen can be obtained by reacting methane with steam.

$$CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3H_2(g) \qquad \Delta H^{\ominus} = +210\,kJ\,mol^{-1}$$

Which conditions of pressure and temperature will give the greatest equilibrium yield of hydrogen?

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

9 Nitrogen monoxide reacts with oxygen in a reversible reaction according to the equation shown below.

$$2NO(g) + O_2(g) \rightleftharpoons 2NO_2(g)$$

The partial pressures of each of the components in an equilibrium mixture are shown in the table.

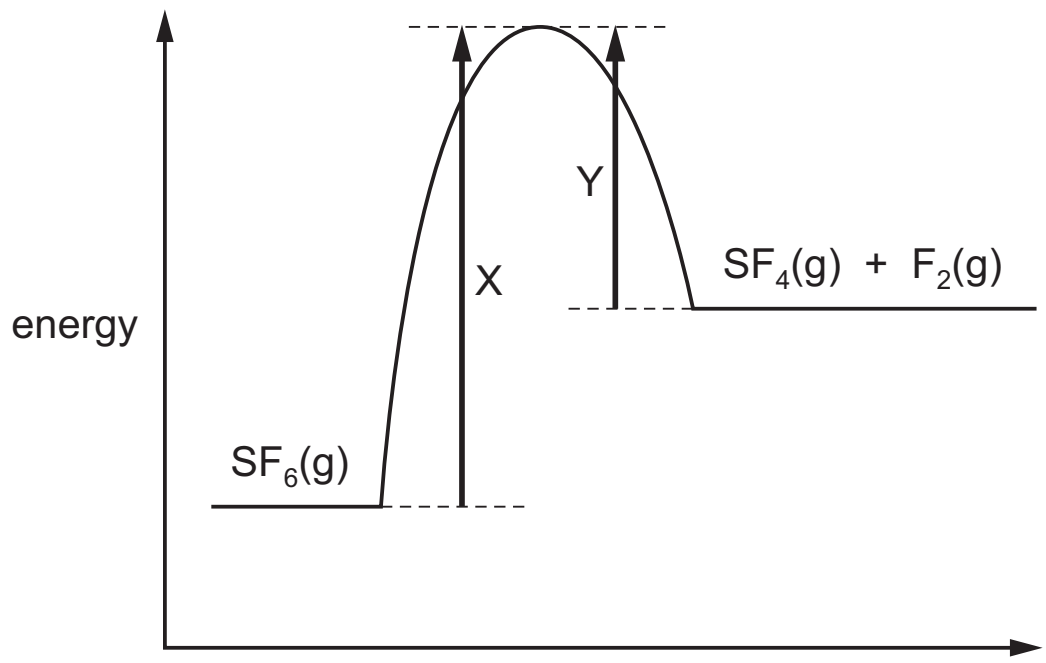
partial pressure NO / kPa	partial pressure O_2 / kPa	partial pressure NO_2 / kPa
10	30	20

What is the numerical value of the equilibrium constant, K_p, for this equilibrium?

A 6.67×10^{-2} **B** 1.33×10^{-1} **C** 7.50 **D** 15.0

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10 The decomposition reaction $SF_6(g) \rightarrow SF_4(g) + F_2(g)$ can be described by the reaction pathway diagram shown.



What are the values of $\Delta H^{\ominus}$ and E_a for this reaction?

	$\Delta H^{\ominus}$	E_a
A	X	X + Y
B	X	Y
C	X – Y	X
D	Y – X	X

11 Which row correctly describes what happens when the temperature of a chemical reaction is **decreased**?

	activation energy (E_a)	number of successful collisions
A	decreases	decreases
B	decreases	increases
C	remains the same	decreases
D	remains the same	increases

12 Which property decreases on descending Group II?

A radius of the cation, M^{2+}

B reactivity of the element with water

C shielding of outermost electrons

D the ease of thermal decomposition of the carbonates, MCO_3

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[Turn over

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

The reaction between aluminium powder and anhydrous barium nitrate is used as the propellant in some fireworks. The metal oxides and nitrogen are the only products.

Which volume of nitrogen, measured under room conditions, is produced when 0.783 g of anhydrous barium nitrate reacts with an excess of aluminium?

A 46.8 cm^3 **B** 72.0 cm^3 **C** 93.6 cm^3 **D** 144 cm^3

14 Which chloride of a Period 3 element dissolves in water to form a solution with a pH of 7?

A aluminium chloride

B phosphorus(V) chloride

C silicon(IV) chloride

D sodium chloride

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

Which row correctly compares the electrical conductivity and first ionisation energy of magnesium and aluminium?

	higher electrical conductivity	higher first ionisation energy
A	aluminium	aluminium
B	aluminium	magnesium
C	magnesium	aluminium
D	magnesium	magnesium

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

Brine is concentrated aqueous sodium chloride.

In the commercial electrolysis of brine, the products are chlorine, hydrogen and sodium hydroxide.

What is the maximum yield of each of these products when 58.5 kg of sodium chloride are electrolysed as brine?

	yield of chlorine / kg	yield of hydrogen / kg	yield of sodium hydroxide / kg
A	35.5	1	40
B	35.5	2	40
C	71	1	40
D	71	2	80

17 A student observed the reactions when sodium chloride and sodium iodide were each reacted separately with concentrated sulfuric acid and with concentrated phosphoric acid. Some observations are recorded in the table.

	sodium chloride	sodium iodide
conc. H_2SO_4	colourless acidic gas formed	purple vapour formed
conc. H_3PO_4	colourless acidic gas formed	colourless acidic gas formed

Which deduction can be made from these observations?

A Concentrated phosphoric acid is a stronger oxidising agent than concentrated sulfuric acid.

B Concentrated phosphoric acid is a stronger oxidising agent than iodine.

C Concentrated sulfuric acid is a stronger oxidising agent than chlorine.

D Concentrated sulfuric acid is a stronger oxidising agent than iodine.

18 A white powder is a mixture of sodium chloride and sodium iodide. It is dissolved in water in a test-tube. Excess aqueous silver nitrate is added to the test-tube. A precipitate, X, is observed.

Excess concentrated ammonia is then added to the test-tube containing X. After the test-tube has been shaken, a precipitate, Y, is observed.

Which statement about X or Y is correct?

A X is a pure white colour.

B X is pure silver iodide.

C Y is pure silver chloride.

D Y is yellow.

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

4.70 g of an ammonium salt is heated with excess aqueous sodium hydroxide. The volume of ammonia gas given off, measured at room temperature and pressure, is 1.41 dm^3.

Which ammonium salt was used?

A ammonium bromide (M_r = 97.9)

B ammonium carbonate (M_r = 96)

C ammonium nitrate (M_r = 80)

D ammonium sulfate (M_r = 132.1)

20 Which ester is formed when the alcohol CH_3CH_2OH is reacted with $CH_3CH_2CH_2CO_2H$?

A butyl ethanoate

B ethyl butanoate

C ethyl propanoate

D propyl ethanoate

21 Which compound shows optical isomerism?

A 2-chloropropane

B 1,2-dichloropropane

C 1,3-dichloropropane

D 2,2-dichloropropane

22 Methanoic acid, HCO_2H, has acidic properties similar to those of other carboxylic acids. In addition it can be oxidised by the same oxidising agents that are capable of oxidising aldehydes.

Which pair consists of two compounds that will give the same observations with Fehling's reagent?

A HCO_2H and CH_3CO_2H

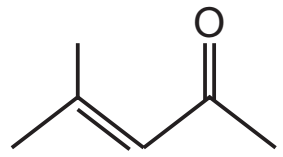
B HCO_2H and $CH_3CO_2CH_3$

C HCO_2H and $CH_3CH_2COCH_3$

D HCO_2H and CH_3CH_2CHO

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23 Compound Q can be made from propanone.



Q

Which types of reaction will Q undergo?

A nucleophilic addition and electrophilic addition

B nucleophilic addition and nucleophilic substitution

C nucleophilic addition only

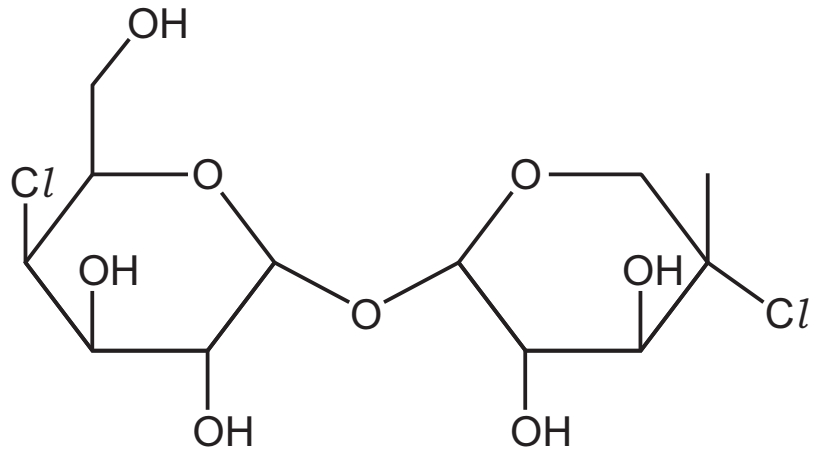
D nucleophilic substitution and electrophilic addition

24 The depletion of the ozone layer in the upper atmosphere reduces the Earth's natural protection from harmful ultraviolet radiation.

Which compound would cause the most depletion of the ozone layer?

A CCl_3F **B** CF_4 **C** CO_2 **D** SO_2

25 Compound X has been investigated for use as an artificial sweetener.



X

The two C–C*l* bonds can be hydrolysed by hot NaOH(aq). The C-O-C bonds **cannot** be hydrolysed by hot NaOH(aq).

What are the numbers of specified types of –OH groups before and after hydrolysing the two C–C*l* bonds?

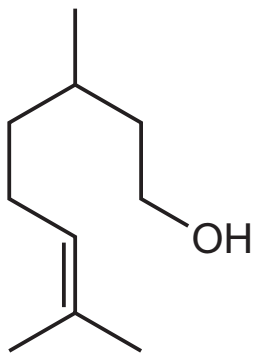
	before hydrolysis	after hydrolysis		
	secondary	primary	secondary	tertiary
A	0	1	2	4
B	0	2	1	4
C	4	1	5	1
D	4	2	4	1

26 The compounds below are all produced by plants.

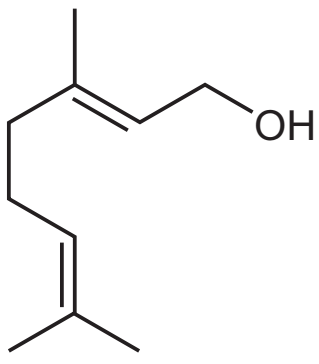
Each compound is warmed with acidified potassium dichromate(VI).

Which compound will give a different observation to the other three?

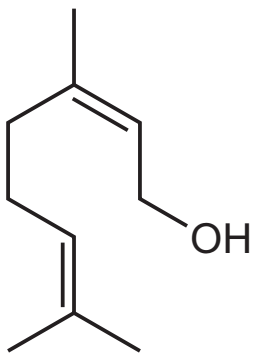
A



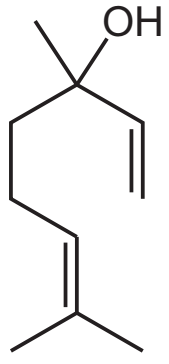
B



C



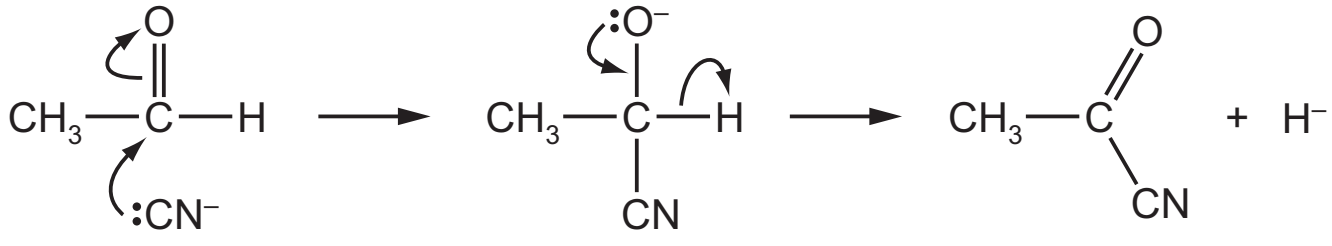
D



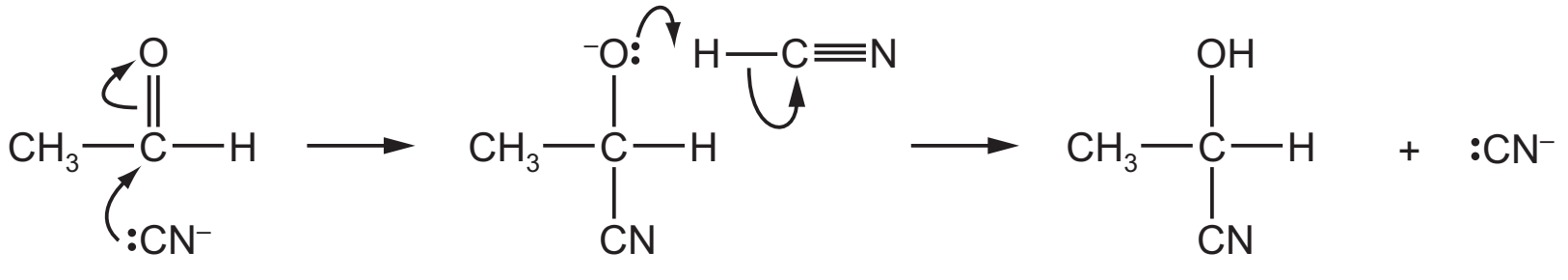
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27 What is the mechanism for the reaction of ethanal, CH_3CHO, with hydrogen cyanide, HCN, in the presence of a base?

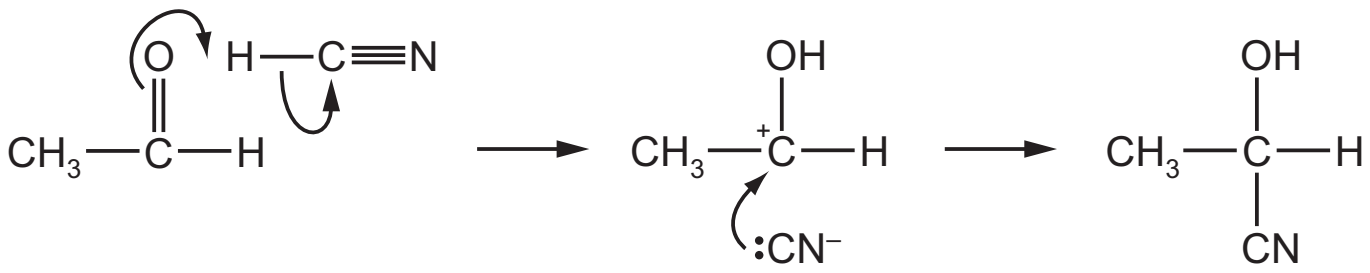
A



B



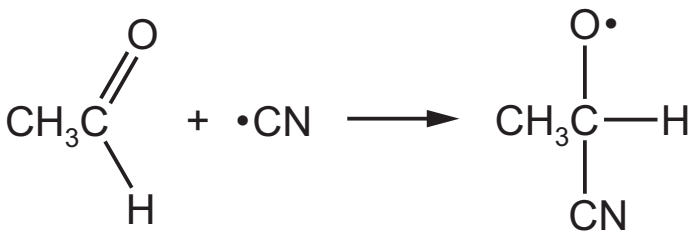
C

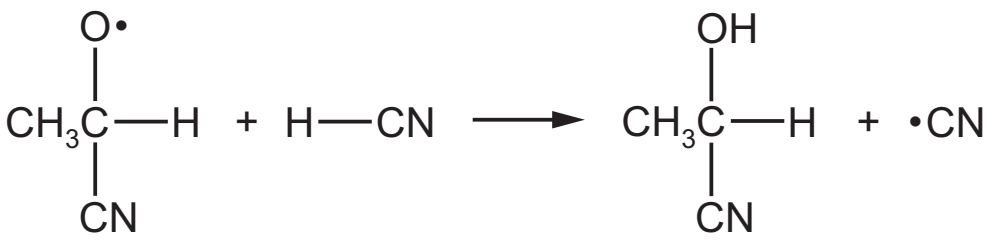


D

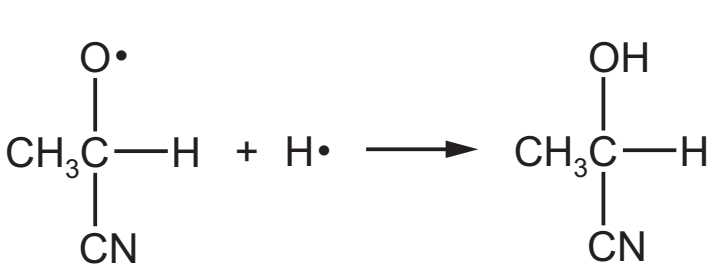
initiation $HCN \longrightarrow H\bullet + \bullet CN$

propagation





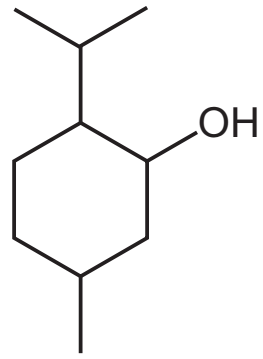
termination



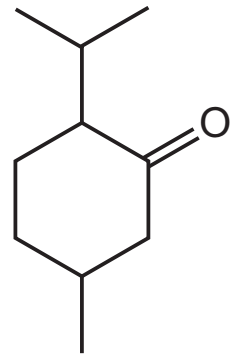
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[Turn over

28 Menthol and menthone are both found in peppermint oil.



menthol



menthone

Which statement about these compounds is correct?

A Both compounds can undergo mild oxidation.

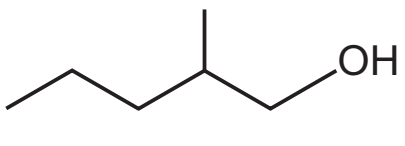
B Both compounds will give an orange precipitate with 2,4-dinitrophenylhydrazine reagent.

C Menthol can be formed from menthone by reaction with $NaBH_4$.

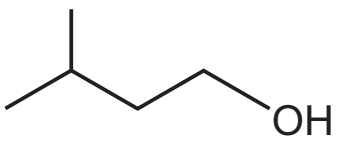
D Menthone gives a positive test when warmed with Tollens' reagent.

29 What is the skeletal formula of 2-methylpentan-1-ol?

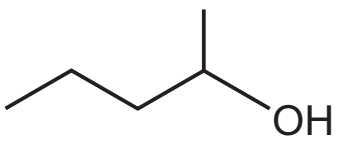
A



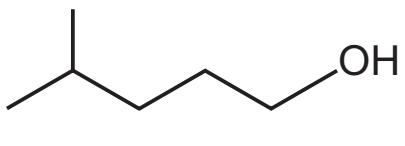
B



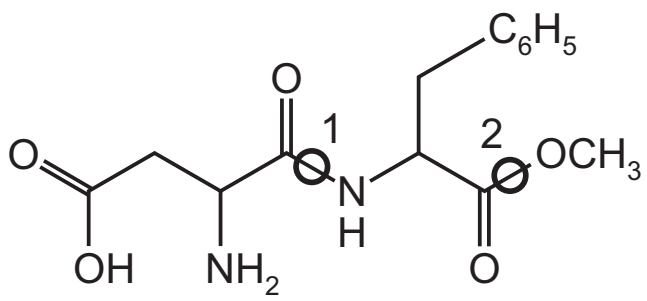
C



D



30 The structure of aspartame, which is used as an artificial sweetener, is shown.



aspartame

If aspartame is warmed in aqueous alkali, which of bonds 1 and 2 will be broken?

A both bond 1 and bond 2

B bond 1 only

C bond 2 only

D neither bond 1 nor bond 2

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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.

31 The relative molecular mass, M_r, of a particular sample of chlorine is 72.0.

Which properties of the atoms in this sample will be the same for all of the atoms?

1 radius

2 nucleon number

3 isotopic mass

32 Which of the following influence the size of the ionisation energy of an atom?

1 the amount of shielding by the inner electrons

2 the charge on the nucleus

3 the distance between the outer electrons and the nucleus

33 Which equations can apply to an ideal gas?

[p = pressure, V = volume, M = molar mass, ρ = density, c = concentration, R = gas constant, T = temperature]

1 $p = \frac{\rho RT}{M}$ **2** $pV = \frac{cRT}{M}$ **3** $pV = MRT$

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 Ammonia and chlorine react in the gas phase.

$$8NH_3 + 3Cl_2 \rightarrow N_2 + 6NH_4Cl$$

Which statements are correct?

1 Each nitrogen atom is oxidised.

2 Each chlorine atom is reduced.

3 Ammonia behaves as a base.

35 Which statements about calcium and strontium compounds are correct?

1 When calcium oxide and strontium oxide are added to water they both produce alkalis.

2 Calcium hydroxide is more soluble than strontium hydroxide.

3 Calcium sulfate is less soluble than strontium sulfate.

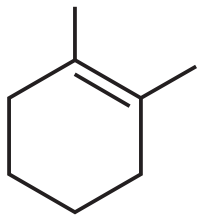
36 Which descriptions of the ammonium ion are correct?

1 It contains ten electrons.

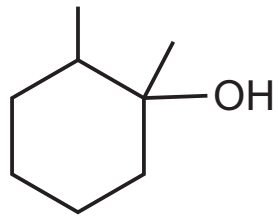
2 It has a bond angle of 109.5°.

3 It has only three bonding pairs of electrons.

37 Compound Q is obtained by adding H_2O across the double bond in compound P.



P



Q

Which statements about these two compounds are correct?

1 P shows *cis-trans* isomerism.

2 Q contains two chiral centres.

3 Q is a tertiary alcohol.

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38 **X** is an organic compound. **X** gives a precipitate with aqueous silver nitrate. Some or all of this precipitate remains undissolved when excess dilute aqueous ammonia is added.

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

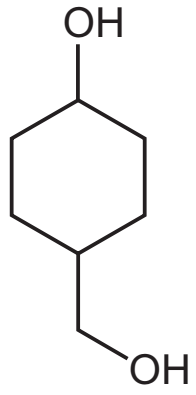
1 2-chlorobutane

2 2-bromobutane

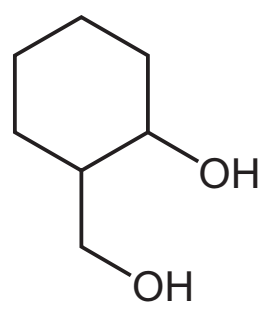
3 iodomethane

39 Which compounds, on heating with excess concentrated sulfuric acid, produce **only one** product with molecular formula C_7H_{10}?

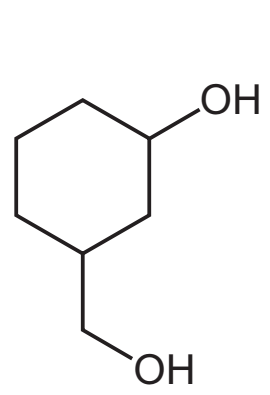
1



2



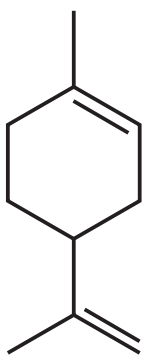
3



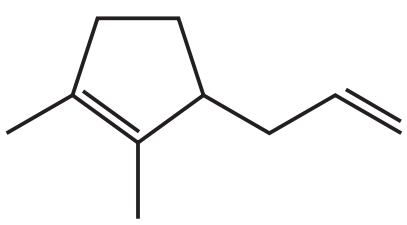
40 Compound **Z** is heated with concentrated acidified potassium manganate(VII). This produces an equimolar mixture of CO_2 and $CH_3COCH_2CH_2CH(COCH_3)CH_2CO_2H$.

What could be the structural formula of **Z**?

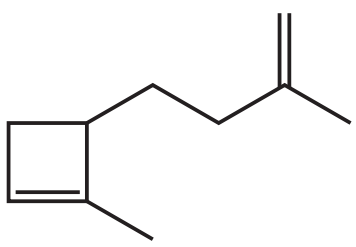
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