Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

CHEMISTRY **9701/12**

Paper 1 Multiple Choice **February/March 2017**

1 hour

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

7298237059

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 Which ion has the same electronic configuration as Cl^-?

A F^- **B** P^+ **C** Sc^{3+} **D** Si^{4+}

2 Compounds J and K each contain 40% carbon by mass.

What could J and K be?

	J	K
A	a hexose, $C_6H_{12}O_6$	starch, $(C_6H_{10}O_5)_n$
B	a pentose, $C_5H_{10}O_5$	a hexose, $C_6H_{12}O_6$
C	a pentose, $C_5H_{10}O_5$	sucrose, $C_{12}H_{22}O_{11}$
D	starch, $(C_6H_{10}O_5)_n$	sucrose, $C_{12}H_{22}O_{11}$

3 Two moles of compound P were placed in a sealed container. The container was heated and P was partially decomposed to produce Q and R only. A dynamic equilibrium between P, Q and R was established.

At equilibrium *x* moles of R were present and the total number of moles present was $\left(2+\frac{x}{2}\right)$.

What is the equation for this reversible reaction?

A $P \rightleftharpoons 2Q + R$

B $2P \rightleftharpoons 2Q + R$

C $2P \rightleftharpoons Q + R$

D $2P \rightleftharpoons Q + 2R$

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4 The boiling points of methane, ethane, propane and butane are given.

compound	CH_4	CH_3CH_3	$CH_3CH_2CH_3$	$CH_3CH_2CH_2CH_3$
boiling point / K	112	185	231	273

Which statement explains the increase in boiling point from methane to butane?

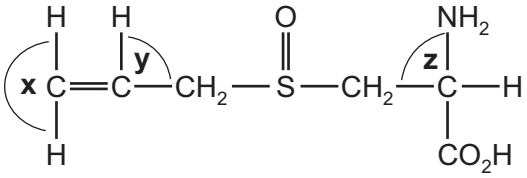
A Closer packing of molecules results in stronger van der Waals' forces.

B More covalent bonds are present and therefore more energy is required to break the bonds.

C More electrons in the molecules results in stronger van der Waals' forces.

D More hydrogen atoms in the molecules results in stronger hydrogen bonding.

5 The characteristic smell of garlic is due to alliin.



alliin

What are the approximate bond angles **x**, **y** and **z** in a molecule of alliin?

	x	**y**	**z**
A	90°	90°	109°
B	120°	109°	90°
C	120°	120°	109°
D	180°	109°	109°

6 Which gas sample contains the **fewest** molecules?

A 1.00 dm^3 of carbon dioxide at 27 °C and 2.0 kPa

B 1.00 dm^3 of hydrogen at 100 °C and 2.0 kPa

C 1.00 dm^3 of nitrogen at 300 °C and 4.0 kPa

D 1.00 dm^3 of oxygen at 250 °C and 3.0 kPa

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7 A student mixed 25.0 cm^3 of 4.00 mol dm^{-3} hydrochloric acid with an equal volume of 4.00 mol dm^{-3} sodium hydroxide. The initial temperature of both solutions was 15.0 °C. The maximum temperature recorded was 30.0 °C.

Using these results, what is the enthalpy change of neutralisation of hydrochloric acid?

A –62.7 kJ mol^{-1}

B –31.4 kJ mol^{-1}

C –15.7 kJ mol^{-1}

D –3.14 kJ mol^{-1}

8 HOCl(aq) is the molecule that kills bacteria when chlorine is added to water.

The following reaction produces this molecule.

$$Cl_2(g) + H_2O(l) \rightleftharpoons HOCl(aq) + H^+(aq) + Cl^-(aq)$$

Which statement about this reaction is correct?

A Chlorine is both oxidised and reduced.

B Chlorine is oxidised but not reduced.

C Hydrogen is both oxidised and reduced.

D Hydrogen is oxidised but not reduced.

9 All the reactants and products of an exothermic reaction are gaseous.

Which statement about this reaction is correct?

A The total bond energy of the products is less than the total bond energy of the reactants, and ΔH for the reaction is negative.

B The total bond energy of the products is less than the total bond energy of the reactants, and ΔH for the reaction is positive.

C The total bond energy of the products is more than the total bond energy of the reactants, and ΔH for the reaction is negative.

D The total bond energy of the products is more than the total bond energy of the reactants, and ΔH for the reaction is positive.

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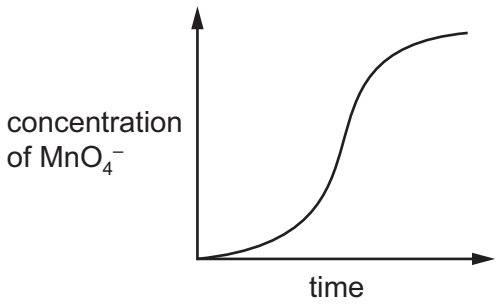
10 Oxidation of ethanedioate ions by acidified manganate(VII) ions is very slow at room temperature.

$$2MnO_4^- + 5C_2O_4^{2-} + 16H^+ \rightarrow 2Mn^{2+} + 10CO_2 + 8H_2O$$

Mn^{2+} ions catalyse this reaction.

Which graph shows how the concentration of acidified manganate(VII) ions varies after ethanedioate ions are added?

A



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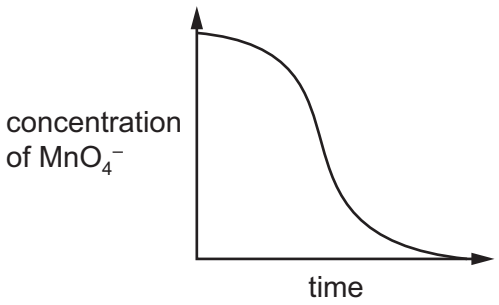

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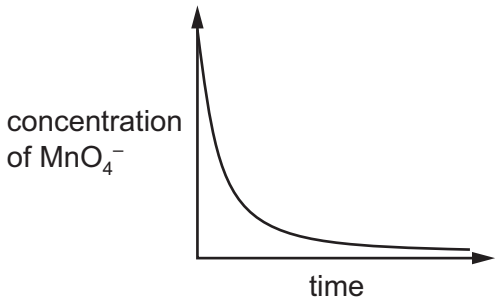
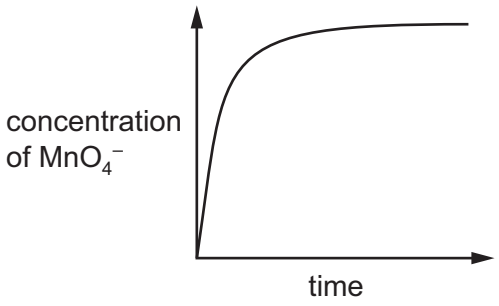


D



11 Ammonia is manufactured from nitrogen and hydrogen using the Haber process.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

What is the expression for K_c for this equilibrium?

A $\dfrac{2[NH_3(g)]}{[N_2(g)] + 3[H_2(g)]}$

B $\dfrac{2[NH_3(g)]}{[N_2(g)] \times 3[H_2(g)]}$

C $\dfrac{[NH_3(g)]^2}{[N_2(g)] + [H_2(g)]^3}$

D $\dfrac{[NH_3(g)]^2}{[N_2(g)] \times [H_2(g)]^3}$

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12 The electrical conductivities of two compounds, Y and Z, are shown in the table.

	Y	Z
conductivity of the compound in the liquid state	good	does not conduct
conductivity of the mixture obtained by adding the compound to water	good	good

What could compounds Y and Z be?

	Y	Z
A	Al_2O_3	$SiCl_4$
B	NaF	Al_2O_3
C	NaF	$SiCl_4$
D	$SiCl_4$	Al_2O_3

13 Which reagent, when mixed with ammonium sulfate and then heated, liberates ammonia?

A aqueous bromine

B dilute hydrochloric acid

C limewater

D potassium dichromate(VI) in acidic solution

14 Why does barium react more rapidly with cold water than magnesium does?

A Barium atoms are larger and form ions more easily than magnesium atoms.

B Barium floats on the surface of the water but magnesium sinks in the water.

C Barium hydroxide is less soluble than magnesium hydroxide.

D The sum of the 1st and 2nd ionisation energies of barium is more than that for magnesium.

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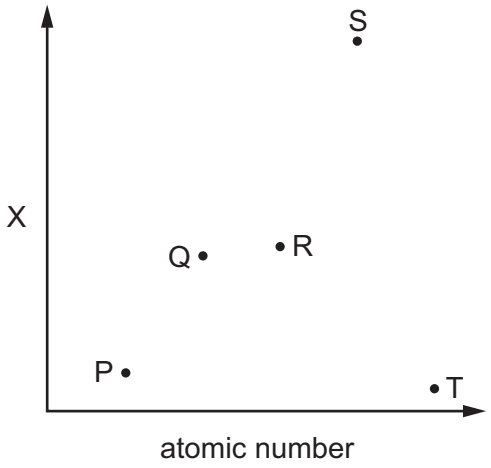
15 The magnitude of property X of five elements from the third period of the Periodic Table, P, Q, R, S and T is shown. P, Q, R, S and T have consecutive atomic numbers. The letters do not represent the symbols of the elements.



Which row correctly identifies property X and element R?

	property X	element R
A	electrical conductivity	Al
B	electronegativity	Si
C	melting point	Al
D	melting point	Si

16 Some uses of chlorine and bromine are given.

Which is a use of bromine?

A making bleaches for textiles and the paper industry

B making CFCs

C making flame retardants and fire extinguishers

D making the polymer PVC

17 In an experiment, 0.600 mol of chlorine gas, Cl_2, is reacted with an excess of hot aqueous sodium hydroxide. One of the products is $NaClO_3$.

Which mass of $NaClO_3$ is formed?

A 21.3 g **B** 44.7 g **C** 63.9 g **D** 128 g

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18 **Z** is an anhydrous compound of a Group 2 element. When it is heated, **Z** undergoes thermal decomposition to produce two different gases. **Z** has relatively low thermal stability compared to other Group 2 compounds containing the same anion as **Z**.

What is compound **Z**?

A barium carbonate

B barium nitrate

C magnesium carbonate

D magnesium nitrate

19 Methylamine, CH_3NH_2, has very similar chemical properties to ammonia, NH_3.

Methylamine reacts with hydrogen chloride to form a white crystalline salt, methylammonium chloride.

$$CH_3NH_2 + HCl \rightarrow CH_3NH_3^+Cl^-$$

A sample of methylammonium chloride is heated with aqueous sodium hydroxide.

What are the products?

A ammonia, sodium chloride and water

B ammonia, sodium hydrogencarbonate and sodium chloride

C methylamine, hydrogen chloride and water

D methylamine, sodium chloride and water

20 Structural isomerism and stereoisomerism should be considered when answering this question.

How many isomers with the formula C_4H_8 have structures that contain a π bond?

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

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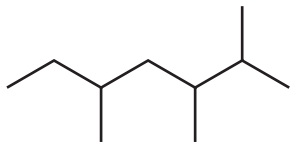
21 Kerosene is used as an aircraft fuel. Q is one of the molecules in kerosene and has the skeletal formula shown.

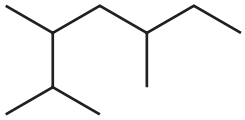


Q

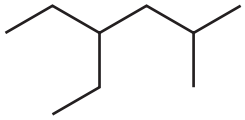
Other structural isomers of this molecule are also found in kerosene.

Which structure is a structural isomer of Q?

A



B



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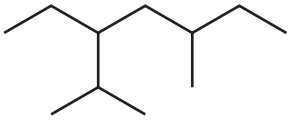

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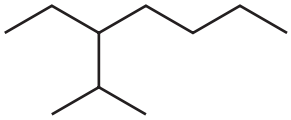

22 Which radical is most likely to form by the homolytic fission of one covalent bond in bromochloromethane, CH_2BrCl?

A $\bullet CH_2Cl$ **B** $\bullet CH_2Br$ **C** $\bullet CHBrCl$ **D** $\bullet CH_2BrCl$

23 Propene undergoes a variety of reactions.

Which row is correct?

	reagent added to propene	products include
A	$Br_2(aq)$	1-bromopropane
B	cold, dilute, acidified $KMnO_4(aq)$	propanoic acid
C	HBr(g)	2-bromopropane
D	hot, concentrated, acidified $KMnO_4(aq)$	propanoic acid

24 Polymerisation of ethene gives poly(ethene).

How does the bonding between carbon atoms in poly(ethene) compare with that in ethene?

A longer and stronger in poly(ethene)

B longer and weaker in poly(ethene)

C shorter and stronger in poly(ethene)

D shorter and weaker in poly(ethene)

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25 Diols in which both hydroxy groups are bonded to the same carbon can spontaneously eliminate a molecule of water to produce a carbonyl compound.

Which compound, after complete hydrolysis, gives a positive reaction with Tollens' reagent?

A 1,1-dibromobutane

B 1,2-dibromobutane

C 1,3-dibromobutane

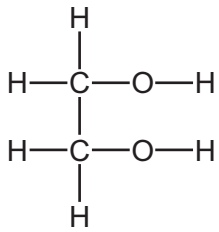
D 2,2-dibromobutane

26 Propan-2-ol undergoes many reactions.

Which row is correct?

	reagent added to propan-2-ol	product
A	acidified $KMnO_4$	CH_3CH_2CHO
B	Cl_2	$CH_3CHClCH_3$
C	conc. H_2SO_4	CH_3CHCH_2
D	methanoic acid	$HCO_2CH_2CH_2CH_3$

27 Ethane-1,2-diol has the following structure.



Without breaking the C–C bond, there are five possible oxidation products.

What is the **total** number of aldehyde groups and carboxylic acid groups in these five products?

	–CHO	–COOH
A	3	3
B	3	4
C	4	3
D	4	4

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28 $CH_3CH_2COCH_2CH_3$ reacts with hydrogen cyanide to form an organic product called a cyanohydrin.

Which statement is correct?

A The cyanohydrin product has one chiral centre.

B The cyanohydrin product is formed by electrophilic addition.

C The cyanohydrin product is formed via an intermediate which contains a C–OH group.

D The formation of the cyanohydrin product requires the use of cyanide ions as a catalyst.

29 Compound X, $CH_3CH(OH)CH(CHO)CH_3$, is heated under reflux with an excess of acidified $K_2Cr_2O_7$ to form compound Y.

Both X and Y are separately warmed with Fehling's solution and the observations noted.

What are the observations?

A Both X and Y give a red precipitate.

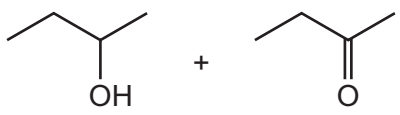
B Only X gives a red precipitate.

C Only Y gives a red precipitate.

D Neither X nor Y gives a red precipitate.

30 Which two compounds can react together to produce an ester?

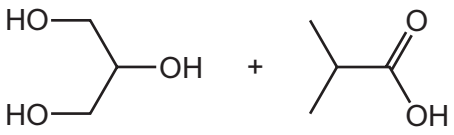
A



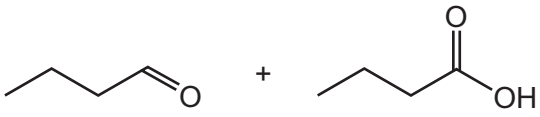
B



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 Nitrogen and phosphorus are both in Group 15 of the Periodic Table. Phosphorus forms a chloride with the formula PCl_5 but nitrogen does not form NCl_5.

Which statements help to explain this?

1 Nitrogen's outer shell cannot contain more than eight electrons.

2 Nitrogen cannot have an oxidation state of +5.

3 Nitrogen is less electronegative than phosphorus.

32 When a sample of a gas is compressed at constant temperature from 1500 kPa to 6000 kPa, its volume changes from 76.0 cm^3 to 20.5 cm^3.

Which statements are possible explanations for this result?

1 The gas does not behave ideally.

2 The gas partially liquefies.

3 Some of the gas is lost from the container.

33 Which of these statements are always correct?

1 The sum of the oxidation numbers of all the atoms in a compound is zero.

2 The oxidation number of sodium in a salt is positive.

3 The oxidation number of chlorine in a compound is negative.

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34 Sulfur dioxide and oxygen react in the gas phase.

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

Which statements are correct?

1 Increasing the pressure increases the equilibrium yield of SO_3.

2 Increasing the temperature lowers the value of the equilibrium constant K_p.

3 The presence of a vanadium(V) oxide catalyst increases the equilibrium yield of SO_3.

35 Three test-tubes, X, Y, and Z, each contain a small amount of water.

- A small amount of NaCl is added to test-tube X.
- A small amount of SiCl_4 is added to test-tube Y.
- A small amount of AlCl_3 is added to test-tube Z.

After a short time, two drops of Universal Indicator solution are added to each test-tube.

Which observations are made?

1 The indicator added to test-tube X stays green.

2 The indicator added to test-tube Y turns red.

3 The indicator added to test-tube Z turns red.

36 Sodium chloride and sodium iodide react with concentrated sulfuric acid.

Which statements are correct?

1 Sodium chloride is not oxidised by concentrated sulfuric acid.

2 No colour change is seen when concentrated sulfuric acid is added to sodium chloride.

3 Sodium iodide is oxidised by concentrated sulfuric acid.

37 Which compounds can be obtained from but-2-ene in a **single** reaction?

1 $CH_3CH(OH)CH(OH)CH_3$

2 $CH_3CH(OH)CH_2CH_3$

3 CH_3CO_2H

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 Which statements help to explain the mechanism of the reaction between 1-chloropropane and ammonia?

1 1-chloropropane has a $\delta-$ chlorine atom that forms hydrogen bonds with a $\delta+$ hydrogen atom in ammonia.

2 1-chloropropane is a polar compound with a $\delta+$ carbon atom.

3 There is a lone pair of electrons on the nitrogen atom in ammonia.

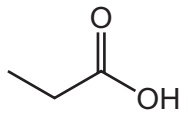
39 Which compounds react with alkaline aqueous iodine to give a pale yellow precipitate of tri-iodomethane?

1 butanone

2 ethanal

3 propan-2-ol

40 Propanoic acid occurs naturally as a result of the bacterial fermentation of milk and is partly responsible for the flavour of Swiss cheese.



propanoic acid

Which starting materials can be used to produce propanoic acid?

1 $CH_3CH_2CH_2OH$

2 CH_3CH_2CHO

3 CH_3CH_2CN

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