Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

CHEMISTRY **9701/11**

Paper 1 Multiple Choice **May/June 2016**

1 hour

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

9811287382

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 equation shows the reaction that occurs during the standard enthalpy change of atomisation of bromine?

A $Br_2(l) \rightarrow 2Br(g)$

B $Br_2(g) \rightarrow 2Br(g)$

C $\frac{1}{2} Br_2(l) \rightarrow Br(g)$

D $\frac{1}{2} Br_2(g) \rightarrow Br(g)$

2 What is the correct number of bonds of each type in the Al_2Cl_6 molecule?

	covalent	co-ordinate (dative covalent)
A	6	1
B	6	2
C	7	0
D	7	1

3 Tetraethyl lead, $Pb(C_2H_5)_4$, has been used as a petrol additive.

What is the percentage by mass of carbon in tetraethyl lead?

A 10.2 **B** 14.9 **C** 29.7 **D** 32.0

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4 When nuclear reactions take place, the elements produced are different from the elements that reacted. Nuclear equations, such as the one below, are used to represent the changes that occur.

$$^{235}_{92}U + {}^{1}_{0}n \rightarrow {}^{144}_{56}Ba + {}^{89}_{36}Kr + 3\,{}^{1}_{0}n$$

The nucleon (mass) number total is constant at 236 and the proton number total is constant at 92.

In another nuclear reaction, uranium-238 is reacted with deuterium atoms, ${}^{2}_{1}H$. An isotope of a new element, **J**, is formed as well as two neutrons.

$$^{238}_{92}U + {}^{2}_{1}H \rightarrow \mathbf{J} + 2\,{}^{1}_{0}n$$

What is isotope **J**?

A ^{238}Np **B** ^{238}Pu **C** ^{240}Np **D** ^{240}Pu

5 Dicarbon monoxide, C_2O, is found in dust clouds in space. The structure of this molecule is C=C=O. The molecule contains no unpaired electrons.

How many lone pairs of electrons are present in a molecule of C_2O?

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

6 A white powder is known to be a mixture of magnesium oxide and aluminium oxide.

100 cm^3 of 2 mol dm^{-3} NaOH(aq) is just sufficient to cause the aluminium oxide in *x* grams of the mixture to dissolve.

The reaction occurring is $Al_2O_3 + 2OH^- + 3H_2O \rightarrow 2Al(OH)_4^-$.

800 cm^3 of 2 mol dm^{-3} HCl(aq) is just sufficient to cause **all** of the oxide in *x* grams of the mixture to dissolve.

The reactions occurring are $Al_2O_3 + 6H^+ \rightarrow 2Al^{3+} + 3H_2O$
and $MgO + 2H^+ \rightarrow Mg^{2+} + H_2O$.

How many moles of each oxide are present in *x* grams of the mixture?

	aluminium oxide	magnesium oxide
A	0.05	0.25
B	0.05	0.50
C	0.10	0.25
D	0.10	0.50

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7 At room temperature and pressure, H_2O is a liquid and H_2S is a gas.

What is the reason for this difference?

A O has higher first and second ionisation energies than S.

B The covalent bond between O and H is stronger than the covalent bond between S and H.

C There is significant hydrogen bonding between H_2O molecules but not between H_2S molecules.

D The instantaneous dipole-induced dipole forces between H_2O molecules are stronger than the instantaneous dipole-induced dipole forces between H_2S molecules.

8 Gaseous phosphorus pentachloride can be decomposed into gaseous phosphorus trichloride and chlorine by heating. The table gives the bond energies.

bond	bond energy / kJ mol^{-1}
P–Cl (in both chlorides)	330
Cl–Cl	242

What is the enthalpy change for the decomposition of PCl_5 to PCl_3 and Cl_2?

A –418 kJ mol^{-1}

B –88 kJ mol^{-1}

C +88 kJ mol^{-1}

D +418 kJ mol^{-1}

9 An aqueous solution was prepared containing a mixture of 1.0 mol of $AgNO_3$ and 1.0 mol of $FeSO_4$ in 1.00 dm^3 of water. When equilibrium was established, there was 0.44 mol of $Ag^+(aq)$ in the mixture.

$$Ag^+(aq) + Fe^{2+}(aq) \rightleftharpoons Ag(s) + Fe^{3+}(aq)$$

What is the numerical value of K_c?

A 0.62 **B** 1.40 **C** 1.62 **D** 2.89

10 The equation for the reaction between carbon monoxide and hydrogen is shown.

$$CO(g) + 3H_2(g) \rightleftharpoons CH_4(g) + H_2O(g)$$

What are the units of K_p for this reaction?

A kPa **B** kPa^{-1} **C** kPa^2 **D** kPa^{-2}

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11 Enzymes are biological catalysts. Many enzymes show specificity. An example of an enzyme which shows specificity is glucokinase. Glucokinase is involved in the metabolism of glucose.

What does specificity mean in this context?

A Glucokinase is most effective as a catalyst over a narrow pH range.

B Glucokinase is most effective as a catalyst over a narrow range of temperatures.

C Glucokinase only operates on a narrow range of substrate molecules.

D Glucokinase provides an alternative route for the reactions it catalyses.

12 Why is the ionic radius of a chloride ion larger than the ionic radius of a sodium ion?

A A chloride ion has one more occupied electron shell than a sodium ion.

B Chlorine has a higher proton number than sodium.

C Ionic radius increases regularly across the third period.

D Sodium is a metal, chlorine is a non-metal.

13 Elements D and E are both in Period 3. Element D has the smallest atomic radius in Period 3. There are only two elements in Period 3 which have a lower melting point than element E. Elements D and E react together to form compound L.

Which compound could be L?

A $MgCl_2$ **B** MgS **C** Na_2S **D** PCl_3

14 X and Y are both Group 2 metals.

X and Y both form hydroxide compounds, but $X(OH)_2$ is more soluble in water than $Y(OH)_2$.

If a piece of metal Y is put into cold water a very slow reaction occurs, and only a very few, small hydrogen bubbles can be seen.

What could be the identities of X and Y?

	X	Y
A	barium	magnesium
B	barium	strontium
C	calcium	strontium
D	magnesium	calcium

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15 The solids sodium chloride and sodium iodide both react with concentrated sulfuric acid at room temperature.

With NaCl, the products are $NaHSO_4$ and HCl.
With NaI, the products are $NaHSO_4$, HI, I_2, SO_2, H_2O, S and H_2S.

What is the best explanation for this difference in products?

A Chloride ions will displace iodine from solution.

B Hydrogen chloride is more volatile than hydrogen iodide.

C Iodide ions are better reducing agents than chloride ions.

D Sulfuric acid is able to act as a dehydrating agent with NaI.

16 In some areas lime, $Ca(OH)_2$, is added to soil to improve crop growth.

Which statement correctly describes a reason why lime improves crop growth?

A Lime acts as a catalyst which speeds up the release of nitrates into the soil.

B Lime is an effective pesticide and protects the plants from damage.

C Lime is used to reduce the acidity of the soil.

D Lime lowers the pH of the soil.

17 A piece of rock has a mass of 2.00 g. It contains calcium carbonate, but no other basic substances. It neutralises exactly 36.0 cm^3 of 0.500 mol dm^{-3} hydrochloric acid.

What is the percentage of calcium carbonate in the 2.00 g piece of rock?

A 22.5% **B** 45.0% **C** 72.0% **D** 90.1%

18 Which statement about the ammonia molecule and/or the ammonium ion is correct?

A Ammonia molecules are basic because they can donate H^+ ions.

B Ammonium ions are basic because they can accept H^+ ions.

C If ammonium ions are heated with NaOH(aq), ammonia molecules are formed.

D The bond angle in NH_4^+ is 2.5° less than the bond angle in NH_3.

19 Which reaction **does not** contribute to the problem of acid rain?

A the combustion of fossil fuels

B the oxidation of sulfur dioxide to sulfur trioxide catalysed by nitrogen dioxide

C the reaction between nitrogen monoxide and carbon monoxide in a catalytic converter

D the reaction of sulfur trioxide with water

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20 The diagrams show two different compounds.



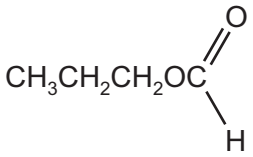
1 2

What is

- the total number of structural isomers, including compound 2, that could be formed by adding a second methyl group to the ring of compound 1,
- the number of π electrons in each compound?

	number of isomers	number of π electrons
A	3	2
B	3	4
C	5	2
D	5	4

21 The structural formula of compound **X** is shown below.



compound **X**

What is the name of compound **X** and how does its boiling point compare with that of butanoic acid?

	name of **X**	boiling point of **X**
A	methyl propanoate	higher than butanoic acid
B	methyl propanoate	lower than butanoic acid
C	propyl methanoate	higher than butanoic acid
D	propyl methanoate	lower than butanoic acid

22 Which pair of reagents will take part in a redox reaction?

A CH_3CHCH_2 + Br_2

B $CH_3CH_2CH_2OH$ + concentrated H_3PO_4

C CH_3COCH_3 + HCN

D $HCO_2C_2H_5$ + dilute H_2SO_4

23 The **first** propagation step in the reaction between methane and chlorine is shown.

$$CH_4 + Cl\bullet \rightarrow CH_3\bullet + HCl$$

How many different **first** propagation steps are possible in the reaction between pentane and chlorine?

A 2 **B** 3 **C** 4 **D** 5

24 Alcohol Y gives product Z after mild oxidation. Z gives a positive result with Tollens' reagent and with 2,4-dinitrophenylhydrazine reagent.

What could be the identity of alcohol Y?

A butan-1-ol

B butan-2-ol

C butan-2,3-diol

D 2-methylbutan-2-ol

25 A student prepares pentan-1-ol by the alkaline hydrolysis of 1-iodopentane. She gently warms the reaction mixture for 20 minutes.

$$CH_3CH_2CH_2CH_2CH_2I + OH^- \rightarrow CH_3CH_2CH_2CH_2CH_2OH + I^-$$

When the student uses 1-chloropentane to prepare the same alcohol she has to change the condition of the reaction.

Which change in condition should she use and what is the correct reason for its use?

	change in condition	reason
A	heat under reflux	C–Cl bond is more polar than the C–I bond
B	heat under reflux	C–Cl bond is stronger than the C–I bond
C	room temperature	C–Cl bond is more polar than the C–I bond
D	room temperature	C–Cl bond is shorter than the C–I bond

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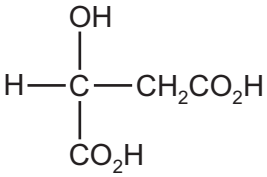
26 Malic acid is found in apples.



malic acid

Which reagent will react with all three –OH groups present in the malic acid molecule?

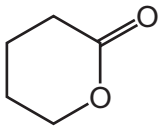
A ethanol in the presence of concentrated sulfuric acid

B potassium hydroxide

C sodium

D sodium carbonate

27 Cyclic esters are also known as lactones. *Delta* lactone is used as a solvent and in the manufacture of polyesters.



delta lactone

From which compound could *delta* lactone be made by a single reaction?

A $HOCH_2CH_2CH_2CH_2CHO$

B $HOCH_2CH_2CH_2CH_2CO_2H$

C $HOCH_2CH_2CH_2CH_2CH_2OH$

D $HOCH_2CH_2CH_2CH_2CH_2CO_2H$

28 Which reagent **cannot** be used to distinguish between ethanal and propanone?

A acidified sodium dichromate(VI) solution

B alkaline aqueous iodine

C cold acidified potassium manganate(VII) solution

D Fehling's reagent

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29 The ester $CH_3CH_2CH_2CO_2CH_2CH(CH_3)_2$ was hydrolysed under acidic conditions.

What are the organic products of this hydrolysis?

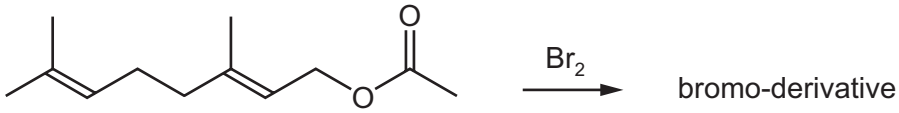
A butanoic acid and 2-methylpropan-1-ol

B butanoic acid and 2-methylpropan-2-ol

C butan-1-ol and 2-methylpropanoic acid

D propanoic acid and 2-methylpropan-1-ol

30 Geranyl ethanoate is present in ginger and cocoa, and is used in shampoos and soaps as a perfume. It reacts with an excess of bromine in an organic solvent to give X, a bromo-derivative.



geranyl ethanoate X

Including geranyl ethanoate, how many cis-trans isomers are there of geranyl ethanoate, and how many chiral centres are there in X?

	cis-trans isomers	chiral centres in X
A	2	3
B	2	4
C	4	3
D	4	4

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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 X is a particle with 18 electrons and 20 neutrons.

What could be the symbol of X?

1 $^{38}_{18}Ar$

2 $^{40}_{20}Ca^{2+}$

3 $^{39}_{19}K^{+}$

32 What are basic assumptions of the kinetic theory as applied to an ideal gas?

1 Gas particles are in continuous random motion.

2 Gas particles experience no intermolecular forces.

3 The volume of each gas particle is zero.

33 Bromine reacts with water.

$$Br_2 + H_2O \rightleftharpoons HOBr + HBr$$

Which oxidation states of bromine are present in the equilibrium mixture?

1 +3

2 0

3 –1

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 A little water is added to each of the following compounds and the mixture warmed.

For which compounds will an acidic gas be evolved?

1 aluminium chloride

2 silicon tetrachloride

3 phosphorous pentachloride

35 The element astatine, At, is below iodine in Group 17 of the Periodic Table.

Which statements concerning At are likely to be correct?

1 It is a dark-coloured solid at room temperature.

2 It is a more powerful oxidising agent than iodine.

3 Its hydride is thermally stable.

36 Which types of reaction can occur with 1-bromobutane?

1 elimination

2 hydrolysis

3 free radical substitution

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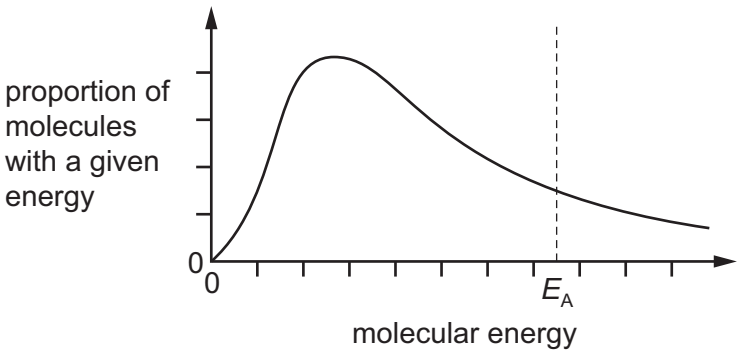
37 The equation shows a gas phase reaction.

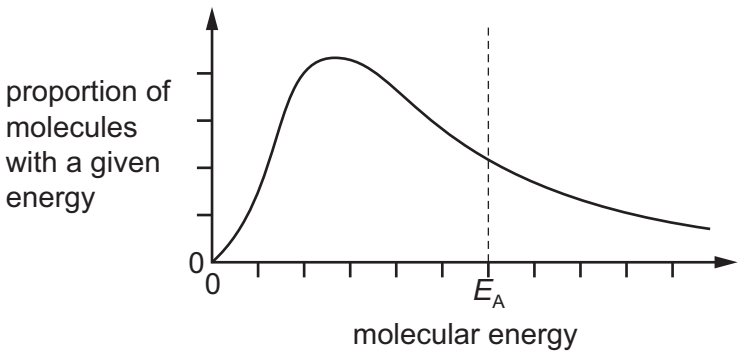
$$X(g) \rightarrow 2Y(g)$$

The diagram shows the Boltzmann distribution of a fixed mass of X(g) at temperature *T* in the absence of a catalyst. The line E_A indicates the activation energy.

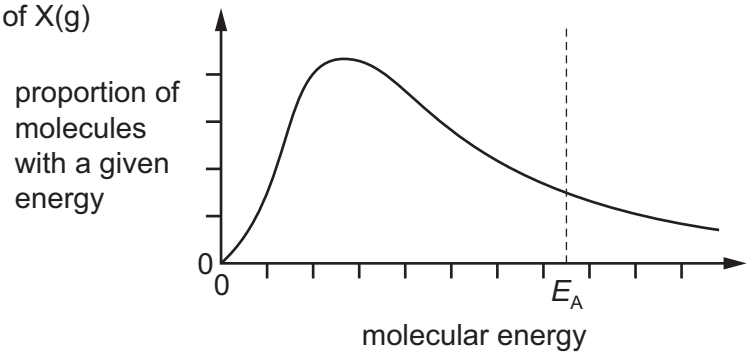


Which diagrams correctly show the effect of the following changes made separately and independently?

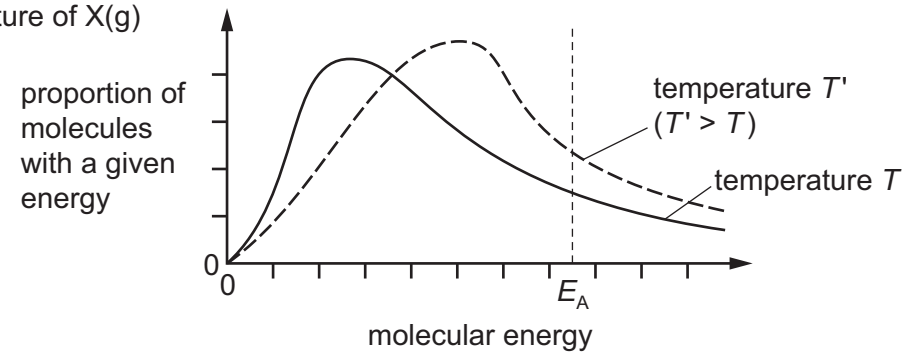
1 adding a catalyst



2 increasing the pressure of X(g)



3 increasing the temperature of X(g)



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.

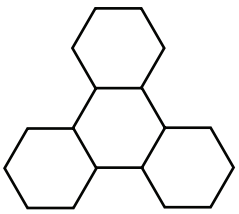
38 The diagram shows the structure of cyclohexene.



cyclohexene

Which structures could be formed by addition reactions with cyclohexene as the only reactant?

1



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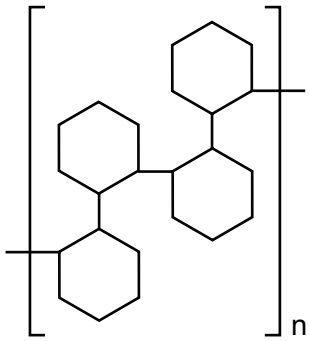

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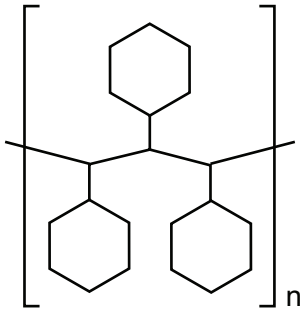

39 Several steps are involved in the synthesis of 2-hydroxypropanoic acid from ethanol.

$$C_2H_5OH \rightarrow \rightarrow \rightarrow CH_3CH(OH)CO_2H$$

Which statements concerning this synthesis are correct?

1 The chain length can be increased during a step involving reaction between HCN and an aldehyde.

2 The carboxyl group can be made by hydrolysis of a nitrile by boiling with NaOH(aq) and then acidifying.

3 The ethanol should be first oxidised by heating it under reflux with an excess of acidified potassium dichromate(VI).

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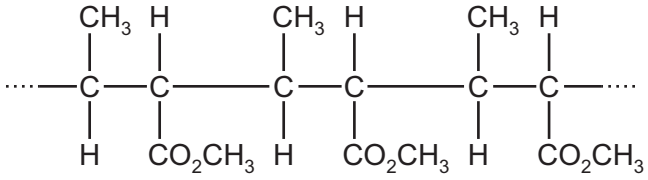
40 The diagram shows the structure of an addition polymer, X.



Which reagents react with polymer X?

1 aqueous sulfuric acid

2 aqueous sodium hydroxide

3 sodium

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