Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

CHEMISTRY **9701/12**

Paper 1 Multiple Choice **May/June 2014**

1 hour

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

* 5 2 3 5 3 8 1 6 5 9 *

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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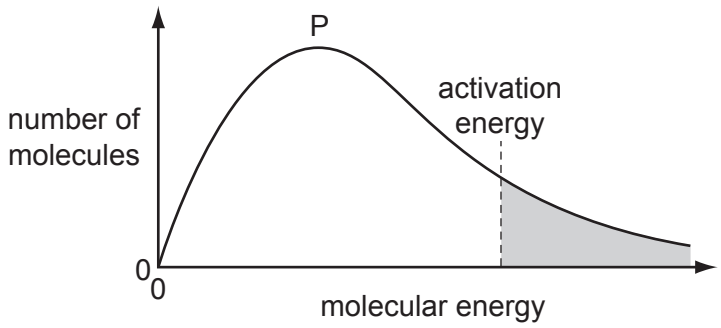
Section A

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

1 The diagram shows a Boltzmann distribution of molecular energies for a gaseous mixture. The distribution has a peak, labelled P on the diagram.



What happens when the temperature of the mixture increases?

A The height of the peak, P, decreases and the activation energy moves to the left.

B The height of the peak, P, decreases and the activation energy moves to the right.

C The height of the peak, P, decreases and the activation energy does not change.

D The height of the peak, P, increases and the activation energy moves to the left.

2 Substances X, Y and Z are all solids. Some of their physical properties are given in the table.

substance	X	Y	Z
melting point / °C	772	114	1610
boiling point / °C	1407	183	2205
electrical conductivity of the liquid state	conducts	does not conduct	does not conduct

What type of lattice could each substance have?

	X	Y	Z
A	giant molecular	simple molecular	ionic
B	ionic	giant molecular	simple molecular
C	ionic	simple molecular	giant molecular
D	simple molecular	ionic	giant molecular

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3 The enthalpy change of formation of carbon dioxide is –394 kJ mol^{-1}.
The enthalpy change of formation of water is –286 kJ mol^{-1}.
The enthalpy change of formation of methane is –74 kJ mol^{-1}.

What is the enthalpy change of combustion of methane?

A –892 kJ mol^{-1}

B –606 kJ mol^{-1}

C +606 kJ mol^{-1}

D +892 kJ mol^{-1}

4 Hydrogen and carbon dioxide gases are mixed in equal molar amounts at 800 K. A reversible reaction takes place.

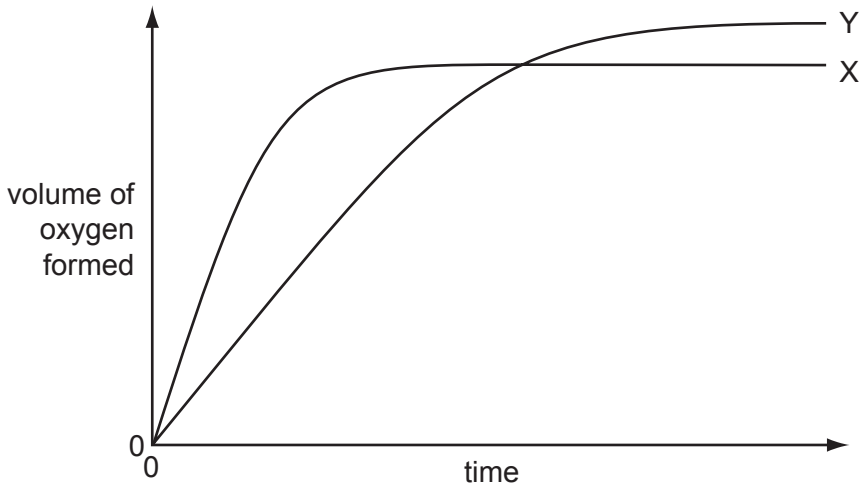
$$H_2(g) + CO_2(g) \rightleftharpoons H_2O(g) + CO(g)$$

At equilibrium, the partial pressures of H_2 and CO_2 are both 10.0 kPa. K_p is 0.288 at 800 K.

What is the partial pressure of CO in the equilibrium mixture?

A 5.37 kPa **B** 18.6 kPa **C** 28.8 kPa **D** 347 kPa

5 In the diagram, curve X was obtained by observing the decomposition of 100 cm^3 of 1.0 mol dm^{-3} hydrogen peroxide, catalysed by manganese(IV) oxide.



Which alteration to the original experimental conditions would produce curve Y?

A adding more manganese(IV) oxide

B adding some 0.1 mol dm^{-3} hydrogen peroxide

C adding water

D raising the temperature

6 In which reaction is the species in **bold** acting as an oxidising agent?

A $\mathbf{2Ca} + O_2 \rightarrow 2CaO$

B $Cr_2O_7^{2-} + 8H^+ + \mathbf{3SO_3^{2-}} \rightarrow 2Cr^{3+} + 4H_2O + 3SO_4^{2-}$

C $Mg + \mathbf{Fe^{2+}} \rightarrow Mg^{2+} + Fe$

D $\mathbf{SO_2} + 2H_2O + 2Cu^{2+} + 2Cl^- \rightarrow H_2SO_4 + 2H^+ + 2CuCl$

7 The formation of hydrogen and ethyne, C_2H_2, from methane reaches dynamic equilibrium.

$$2CH_4(g) \rightleftharpoons 3H_2(g) + C_2H_2(g)$$

What are the units of K_c?

A $mol\,dm^{-3}$ **B** $mol^2\,dm^{-6}$ **C** $mol^3\,dm^{-9}$ **D** $mol^4\,dm^{-12}$

8 Which equation represents the standard enthalpy change of formation of ethanol, C_2H_5OH?

A $2C(g) + 3H_2(g) + \frac{1}{2}O_2(g) \rightarrow C_2H_5OH(l)$

B $2C(s) + 3H_2(g) + \frac{1}{2}O_2(g) \rightarrow C_2H_5OH(l)$

C $2C(s) + 3H_2(g) + \frac{1}{2}O_2(g) \rightarrow C_2H_5OH(g)$

D $2C(g) + 6H(g) + O(g) \rightarrow C_2H_5OH(l)$

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

In an experiment, $12.0\,dm^3$ of oxygen, measured under room conditions, is used to burn completely 0.10 mol of propan-1-ol.

What is the final volume of gas, measured under room conditions?

A $7.20\,dm^3$ **B** $8.40\,dm^3$ **C** $16.8\,dm^3$ **D** $18.00\,dm^3$

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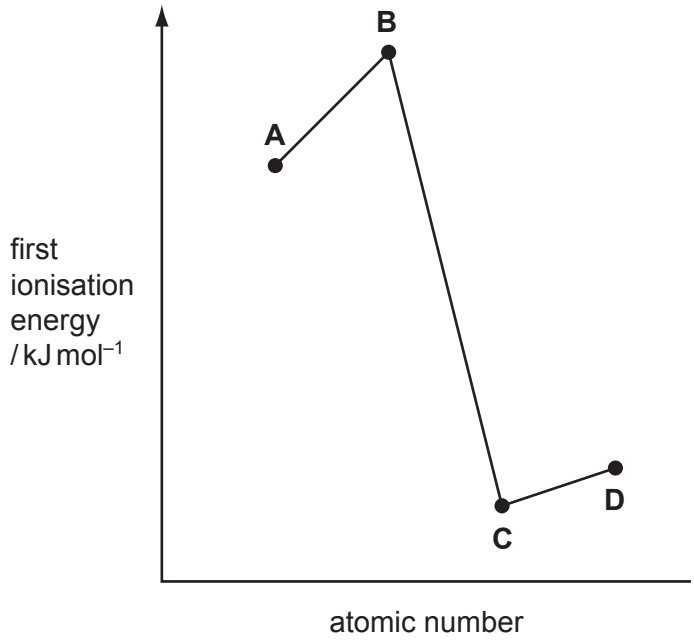
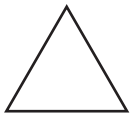
10 Shown on the graph are the relative values of the first ionisation energies of four elements that have consecutive atomic numbers.

One of the elements reacts with hydrogen to form a covalent compound with formula HX.

Which element could be X?



11 The diagram shows the skeletal formula of cyclopropane.



The enthalpy change of formation of cyclopropane is +53.3 kJ mol^{-1} and the enthalpy change of atomisation of graphite is +717 kJ mol^{-1}.

The bond enthalpy of H – H is 436 kJ mol^{-1} and of C – H is 410 kJ mol^{-1}.

What value for the average bond enthalpy of the C – C bond in cyclopropane can be calculated from this data?

A 187 kJ mol^{-1} **B** 315 kJ mol^{-1} **C** 351 kJ mol^{-1} **D** 946 kJ mol^{-1}

12 When barium is burnt in oxygen, what colour is the flame?

A green

B orange

C red

D white

13 X and Y are oxides of different Period 3 elements.

If one mole of Y is added to water, the solution formed is neutralised by exactly one mole of X.

What could be the identities of X and Y?

	X	Y
A	Al_2O_3	P_4O_{10}
B	Al_2O_3	SO_3
C	Na_2O	P_4O_{10}
D	Na_2O	SO_3

14 Ammonium sulfate in the soil is slowly oxidised by air, producing sulfuric acid, nitric acid and water as the only products.

How many moles of oxygen gas are needed for the complete oxidation of one mole of ammonium sulfate?

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

15 Which statement about the oxides and hydroxides of the Group II elements Mg, Ca, Sr and Ba is correct?

A Each of the oxides reacts readily with water to form a solution of pH 12 or above.

B Magnesium oxide is used as a furnace lining because it has a giant molecular structure and hence a high melting point.

C The hydroxides are produced directly by the thermal decomposition of the corresponding nitrates.

D The solubility of the hydroxides increases from $Mg(OH)_2$ to $Ba(OH)_2$.

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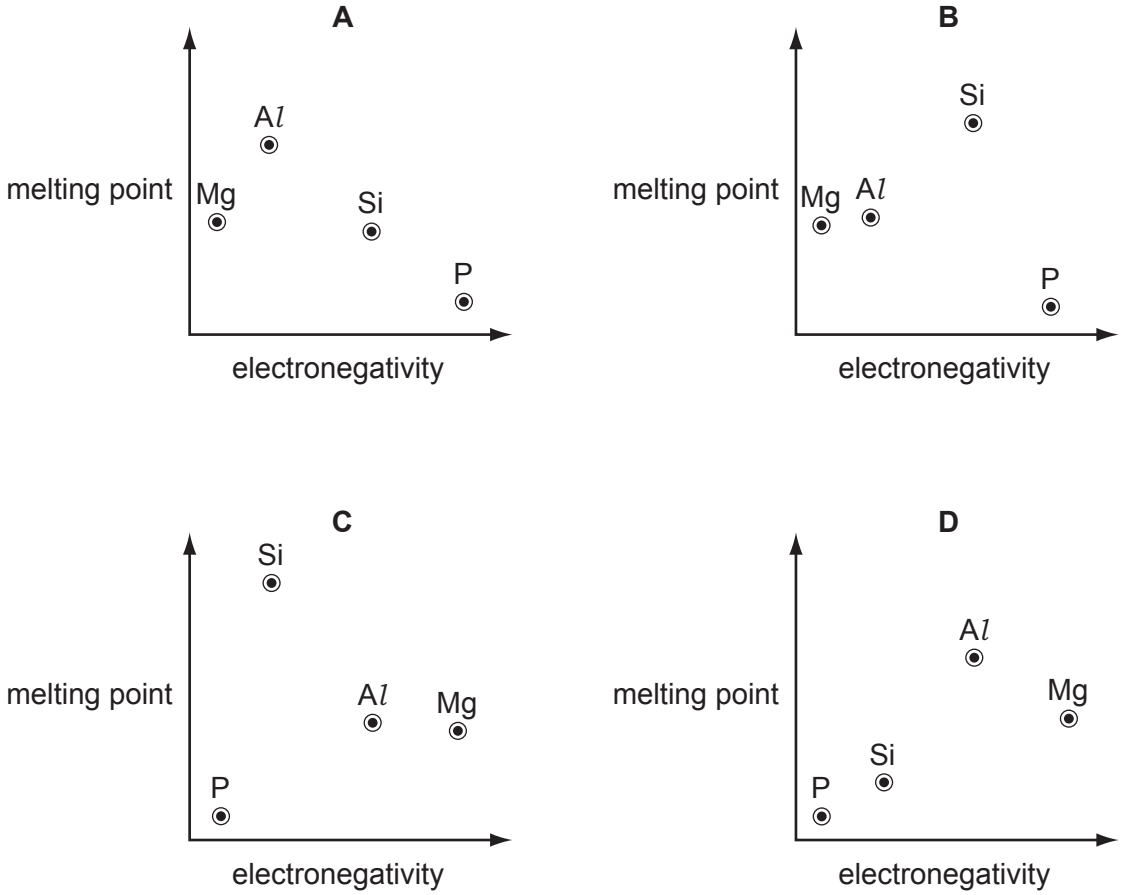
16 Which graph correctly shows the relative melting points of the elements Mg, A*l*, Si and P plotted against their relative electronegativities?



17 When solid sodium iodide reacts with concentrated sulfuric acid, the products include $NaHSO_4$, H_2S, SO_2 and S.

In the formation of which product has the oxidation state of sulfur changed by a value of 8?

A H_2S **B** $NaHSO_4$ **C** S **D** SO_2

18 A test-tube of HBr(g) and a test-tube of HI(g) are heated to the same temperature.

Which combination of observations is possible?

	tube of HBr(g)	tube of HI(g)
A	a brown vapour appears	no change is apparent
B	a purple vapour appears	no change is apparent
C	no change is apparent	a brown vapour appears
D	no change is apparent	a purple vapour appears

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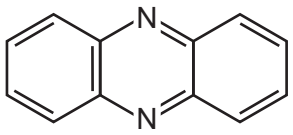
19 *Use of the Data Booklet is relevant to this question.*

In an experiment, 0.125 mol of chlorine gas, Cl_2, is reacted with an excess of cold aqueous sodium hydroxide. One of the products is a compound of sodium, oxygen, and chlorine.

Which mass of this product is formed?

A 9.31 g **B** 13.3 g **C** 18.6 g **D** 26.6 g

20 The diagram shows the skeletal formula of phenazine.



phenazine

What is the empirical formula of phenazine?

A C_6H_4N **B** C_6H_6N **C** $C_{12}H_8N_2$ **D** $C_{12}H_{12}N_2$

21 Halogenoalkanes undergo a range of nucleophilic substitution reactions.

Which reaction proceeds **only** by an S_N1 mechanism?

A $CH_3CH_2Br + NH_3$

B $CH_3CH_2CH_2I + OH^-$

C $CH_3CHBrCH_3 + NH_3$

D $(CH_3)_3CI + OH^-$

22 Which alcohol has a chiral centre **and** can be oxidised to a ketone?

A pentan-2-ol

B pentan-3-ol

C 3-methylhexan-1-ol

D 3-methylhexan-3-ol

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23 An ester of structural formula $CH_3CO_2CH_3$ is heated with an aqueous solution of sodium hydroxide.

What are the two organic products of this reaction?

A ethanoic acid and methanol

B methanoic acid and ethanol

C sodium ethanoate and methanol

D sodium methanoate and ethanol

24 Ethene reacts with aqueous bromine to give two products, CH_2BrCH_2Br and CH_2BrCH_2OH.

Which statement about these products is correct?

A Both products are obtained in this reaction by electrophilic substitution.

B Both products are obtained in this reaction by nucleophilic addition.

C Both products can be hydrolysed to form the same organic compound.

D Both products can form hydrogen bonds with water.

25 Which statement does **not** correctly describe a problem related to the disposal of PVC?

A PVC is slowly degraded in the environment by bacteria and fungi.

B PVC is slowly degraded in the environment by sunlight.

C When PVC is burnt, a significant amount of ethene gas is present in the products.

D When PVC is burnt, a significant amount of HC*l* gas is present in the products.

26 Compound X, C_4H_8O, produces an orange precipitate when it is reacted with 2,4-dinitrophenylhydrazine reagent. Compound X produces a carboxylic acid when heated under reflux with an acidified solution of potassium dichromate(VI).

What could be compound X?

A butanal

B butanone

C 2-methylbutanal

D 4-hydroxybut-1-ene

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27 Dichlorodifluoromethane, CCl_2F_2, has been used in aerosol propellants and as a refrigerant.

Which statement helps to explain why dichlorodifluoromethane is chemically inert?

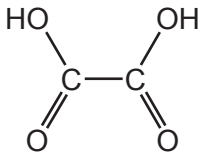
A All fluorine compounds are non-flammable.

B Fluorine is highly electronegative.

C The carbon-fluorine bond energy is large.

D The carbon-fluorine bond has a low polarity.

28 The diagram shows the structure of ethanedioic acid.



Ethanedioic acid reacts with ethanol in the presence of a few drops of concentrated sulfuric acid to form a diester. The molecular formula of the diester is $C_6H_{10}O_4$.

What is the structural formula of the diester?

A $CH_3CH_2CO_2CO_2CH_2CH_3$

B $CH_3CH_2OCOCO_2CH_2CH_3$

C $CH_3CH_2O_2CO_2CCH_2CH_3$

D $CH_3CO_2CH_2CH_2OCOCH_3$

29 When heated with KOH dissolved in ethanol, halogenoalkanes can undergo an elimination reaction to form alkenes.

What are the possible elimination products when 2-bromobutane is heated with KOH dissolved in ethanol?

A $CH_3CH{=}CHCH_3$ only

B $CH_3CH_2CH{=}CH_2$ only

C $CH_3CH{=}CHCH_3$ and $CH_3CH_2CH{=}CH_2$

D $CH_3CH{=}CHCH_3$ and $CH_2{=}CHCH{=}CH_2$

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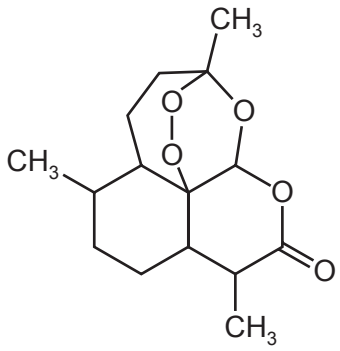
30 Artemisinin is a powerful anti-malarial drug.



artemisinin

How many chiral centres are there in each molecule of artemisinin?

A 4 **B** 6 **C** 7 **D** 8

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 P and Q are two compounds with similar M_r values. Molecules of P attract each other by hydrogen bonds. Molecules of Q attract each other by van der Waals' forces only.

A sample of liquid P is compared to a sample of liquid Q.

How will their properties differ?

1 P is more soluble in water than Q.

2 P has a higher melting point than Q.

3 P is more viscous than Q.

32 The reaction

$$E + F \rightleftharpoons G + H$$

is catalysed by platinum.

Which statements about the properties of the catalyst are correct?

1 The catalyst has no effect on the enthalpy change of the reaction.

2 The catalyst increases the rate of the reverse reaction.

3 The catalyst increases the average kinetic energy of the reacting particles.

33 Which elements have atoms which can form π bonds with atoms of other elements?

1 oxygen

2 nitrogen

3 fluorine

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34 Sulfuric acid is a Brønsted-Lowry acid.

In which reactions is sulfuric acid behaving as an acid?

1 $H_2SO_4 + HNO_3 \rightarrow H_2NO_3^+ + HSO_4^-$

2 $H_2SO_4 + CO_3^{2-} \rightarrow CO_2 + H_2O + SO_4^{2-}$

3 $H_2SO_4 + MgO \rightarrow MgSO_4 + H_2O$

35 Silver chloride dissolves in aqueous ammonia.

What happens in this process?

1 Ammonia forms a complex with the Ag^+ ion.

2 Ammonia acts as a Brønsted-Lowry base.

3 A redox reaction occurs.

36 A car has a catalytic converter fitted to its exhaust. On analysis its exhaust gases are shown to contain small quantities of nitrogen oxides.

Which modifications would result in lower exhaust concentrations of nitrogen oxides?

1 an increase in the surface area of the catalyst in the converter

2 an increase in the rate of flow of the exhaust gases through the converter

3 a much higher temperature of combustion in the engine

37 Which alcohols **cannot** be dehydrated to form alkenes?

1 CH_3OH

2 $(CH_3)_3COH$

3 CH_3CH_2OH

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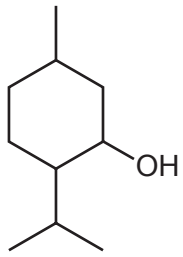
The responses **A** to **D** should be selected on the basis of

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.

38 Menthol is a naturally-occurring alcohol found in peppermint oil.



menthol

Which reagents will react with menthol?

1 aqueous bromine

2 sodium metal

3 aqueous acidified manganate(VII)

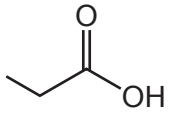
39 Which pairs of reagents will take part in a redox reaction under suitable conditions?

1 $CH_3(CH_2)_4CHO$ + Tollens' reagent

2 $CH_3(CH_2)_4CH_3$ + Br_2

3 $CH_3CO(CH_2)_4CH_3$ + Fehling's reagent

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 could be used to synthesise propanoic acid?

1 $CH_3CH_2CH_2OH$

2 CH_3CH_2CHO

3 CH_3CH_2CN

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