Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

CHEMISTRY **9701/11**

Paper 1 Multiple Choice **May/June 2015**

1 hour

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

4421037076

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 **15** printed pages and **1** blank page.

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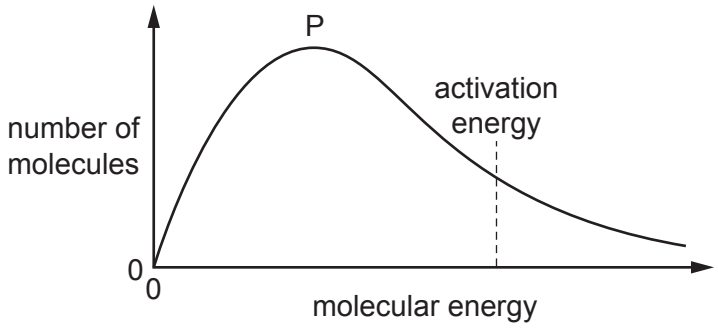
Section A

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 an effective catalyst is added to the mixture?

A The height of the peak decreases and the activation energy moves to the right.

B The height of the peak decreases and the activation energy moves to the left.

C The height of the peak remains the same and the activation energy moves to the right.

D The height of the peak remains the same and the activation energy moves to the left.

2 Which quantity gives the best indication of the relative strengths of the hydrogen bonds between the molecules in liquid hydrogen halides?

A bond dissociation energies

B enthalpy changes of formation

C enthalpy changes of solution

D enthalpy changes of vaporisation

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

1.00 g of carbon is combusted in a limited supply of pure oxygen. 0.50 g of the carbon combusts to form CO_2 and 0.50 g of the carbon combusts to form CO.

The resultant mixture of CO_2 and CO is passed through excess NaOH(aq) and the remaining gas is then dried and collected.

What is the volume of the remaining gas? (All gas volumes are measured at 25 °C and 1 atmosphere pressure.)

A 1 dm^3 **B** 1.5 dm^3 **C** 2 dm^3 **D** 3 dm^3

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4 In oxygen difluoride, OF_2, fluorine has an oxidation number of –1. OF_2 will react with sulfur dioxide according to the following equation.

$$OF_2 + SO_2 \rightarrow SO_3 + F_2$$

What is oxidised and what is reduced in this reaction?

	fluorine	oxygen in OF_2	sulfur
A	oxidised	oxidised	reduced
B	oxidised	reduced	oxidised
C	reduced	oxidised	reduced
D	reduced	reduced	oxidised

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

The gas laws can be summarised in the ideal gas equation below.

$$pV = nRT$$

0.96 g of oxygen gas is contained in a glass vessel of volume $7.0 \times 10^{-3}\,m^3$ at a temperature of 30 °C.

Assume the gas behaves as an ideal gas.

What is the pressure in the vessel?

A 1.1 kPa **B** 2.1 kPa **C** 10.8 kPa **D** 21.6 kPa

6 One mole of phosphorus(V) chloride, PCl_5, is heated to 600 K in a sealed flask of volume 1 dm^3. Equilibrium is established and measurements are taken.

$$PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$$

The experiment is repeated with one mole of phosphorus(V) chloride heated to 600 K in a sealed flask of volume 2 dm^3.

How will the measurements vary?

A The equilibrium concentrations of $PCl_3(g)$ and $Cl_2(g)$ are higher in the second experiment.

B The equilibrium concentration of $PCl_5(g)$ is lower in the second experiment.

C The equilibrium concentrations of all three gases are the same in both experiments.

D The value of the equilibrium constant is higher in the second experiment.

7 The standard enthalpy changes of combustion of glucose and ethanol are given as –2820 and –1368 kJ mol^{-1} respectively.

Glucose, $C_6H_{12}O_6$, can be converted into ethanol.

$$C_6H_{12}O_6(s) \rightarrow 2C_2H_5OH(l) + 2CO_2(g)$$

What is the standard enthalpy change for this reaction?

A –1452 kJ mol^{-1}

B –84 kJ mol^{-1}

C +84 kJ mol^{-1}

D +1452 kJ mol^{-1}

8 In which reaction is the underlined substance acting as a base?

A $HNO_3 + \underline{H_2SO_4} \rightarrow H_2NO_3^+ + HSO_4^-$

B $HSiO_3^- + \underline{HCN} \rightarrow CN^- + H_2O + SiO_2$

C $HNO_2 + \underline{HCO_3^-} \rightarrow H_2O + CO_2 + NO_2^-$

D $C_6H_5O^- + \underline{CH_2ClCO_2H} \rightarrow C_6H_5OH + CH_2ClCO_2^-$

9 One molecule of haemoglobin, Hb, can bind with four molecules of oxygen according to the following equation.

$$Hb(aq) + 4O_2(aq) \rightleftharpoons Hb(O_2)_4(aq)$$

When the equilibrium concentration of O_2 is 7.6×10^{-6} mol dm^{-3}, the equilibrium concentrations of Hb and $Hb(O_2)_4$ are equal.

What is the value of K_c for this equilibrium?

A 3.0×10^{20} **B** 1.3×10^{5} **C** 7.6×10^{-6} **D** 3.3×10^{-21}

10 The double bond between the two carbon atoms in an ethene molecule consists of one σ bond and one π bond.

Which orbitals overlap to form each of these bonds?

	σ bond	π bond
A	sp^2–sp^2	p–p
B	sp^2–sp^2	sp^2–sp^2
C	sp^3–sp^3	p–p
D	sp^3–sp^3	sp^2–sp^2

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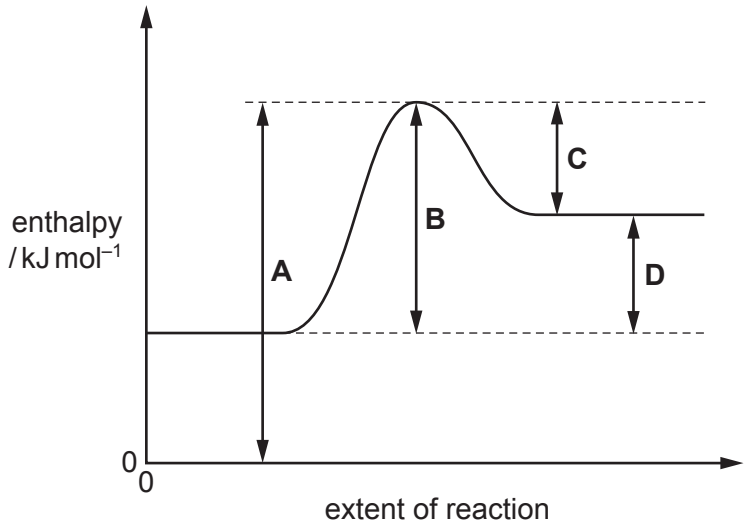
11 The diagram shows a reaction pathway for an endothermic reaction.

Which arrow represents the activation energy for the forward reaction?



12 In the industrial electrolysis of brine to manufacture chlorine, the diaphragm used is a porous screen which allows the flow of electrolytes but keeps other chemicals separate.

Which substance needs to be kept separate from the chlorine by the diaphragm?

A hydrogen

B sodium chloride

C sodium hydroxide

D water

13 The three minerals below are obtained from mines around the world. Each one behaves as a mixture of two carbonate compounds. They can be used as fire retardants because they decompose in the heat, producing CO_2. This gas smothers the fire.

barytocite	$BaCa(CO_3)_2$
dolomite	$CaMg(CO_3)_2$
huntite	$Mg_3Ca(CO_3)_4$

What is the order of effectiveness as fire retardant, from best to worst?

	best → worst		
A	dolomite	barytocite	huntite
B	dolomite	huntite	barytocite
C	huntite	barytocite	dolomite
D	huntite	dolomite	barytocite

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[Turn over

14 Which observations are made when a sample of silicon chloride, $SiCl_4$, is added to a beaker of water?

A No visible changes are observed.

B Steamy fumes and a white precipitate are both observed.

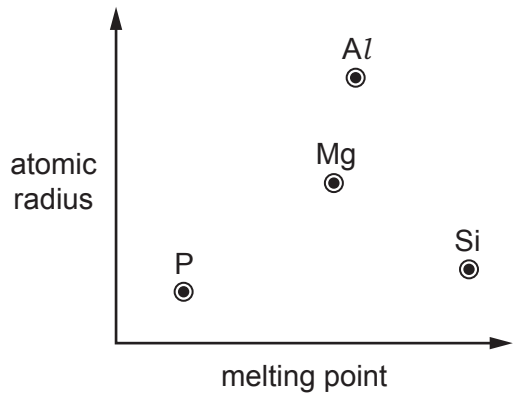
C The appearance of a white precipitate is the only observation.

D The appearance of steamy fumes is the only observation.

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

Which diagram correctly shows the atomic radii of the elements Mg, Al, Si and P plotted against their melting points?

A



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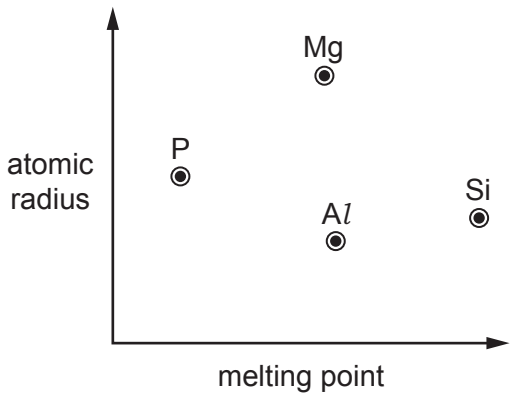

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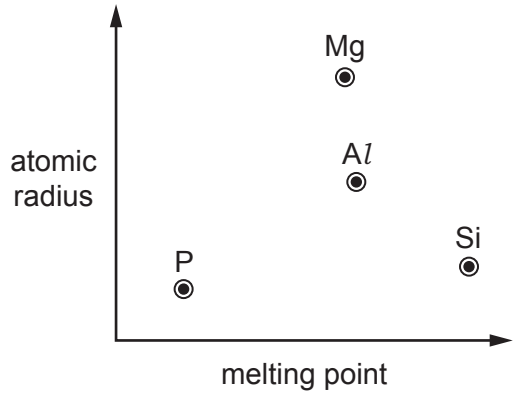
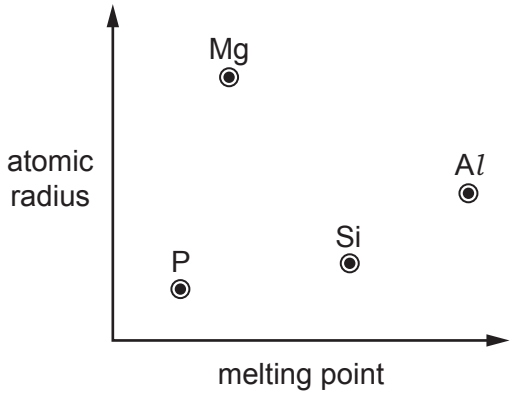


D



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16 Chlorine is widely used in water treatment plants.

Which reaction takes place when chlorine dissolves in water?

A $Cl_2 + H_2O \rightarrow HCl + HClO$

B $2Cl_2 + 2H_2O \rightarrow 3HCl + HClO_2$

C $3Cl_2 + 3H_2O \rightarrow 5HCl + HClO_3$

D $4Cl_2 + 4H_2O \rightarrow 7HCl + HClO_4$

17 Astatine, At, is below iodine in Group VII of the Periodic Table.

Which statement is most likely to be correct?

A AgAt(s) reacts with excess dilute aqueous ammonia to form a solution of a soluble complex.

B Astatine and KCl(aq) react to form KAt(aq) and chlorine.

C KAt(aq) and dilute sulfuric acid react to form white fumes of HAt(g).

D NaAt(s) and concentrated sulfuric acid react to form astatine.

18 Mohr's salt is a pale green crystalline solid which is soluble in water. It contains two cations, one of which is Fe^{2+}, and one anion which is SO_4^{2-}.

The identity of the second cation was determined by heating Mohr's salt with aqueous sodium hydroxide. A colourless gas was evolved which readily dissolved in water giving an alkaline solution.

A green precipitate was also formed.

What are the identities of the gas and the precipitate?

	gas	precipitate
A	NH_3	$Fe(OH)_2$
B	NH_3	Na_2SO_4
C	SO_2	$Fe(OH)_2$
D	SO_2	Na_2SO_4

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

Which mass of solid residue will be obtained from the thermal decomposition of 4.10 g of anhydrous calcium nitrate?

A 0.70 g **B** 1.00 g **C** 1.40 g **D** 2.25 g

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20 Which reagent will give a different observation with compounds P and Q?

$HOCH_2CH(OH)CHO$	$HOCH_2COCH_2OH$
P	Q

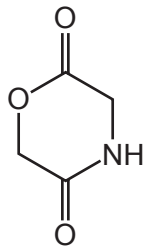
A $Br_2(aq)$

B hot acidified $KMnO_4$

C silver nitrate in ammonia solution

D warm acidified $K_2Cr_2O_7$

21 The cyclic compound M is heated with dilute hydrochloric acid.



compound M

What are the products of the reaction?

A $HOCH_2CO_2H$ and $H_2NCH_2CO_2H$

B HO_2CCH_2OH and $HO_2CCH_2NH_3^+$

C H_2NCOCH_2OH and $HOCH_2CHO$

D $HOCH_2CONH_3^+$ and $HOCH_2CHO$

22 Cottonseed oil contains large amounts of polyunsaturated carboxylic acids. When this oil is used to make margarine, the C=C double bonds in the unsaturated carboxylic acids are hydrogenated.

What reagents and conditions would be suitable to bring about this hydrogenation reaction?

A H_2 gas, nickel catalyst, 400 °C

B $LiAlH_4$ in dry ether

C $NaBH_4$, aqueous solution

D steam, concentrated H_2SO_4, 300 °C and 60 atm pressure

23 Which intermediate ion forms in the greatest amount during the addition of HBr to propene?

A $CH_3CH^+CH_3$

B $CH_3CH_2CH_2^+$

C $CH_3CH^-CH_2Br$

D $CH_3CHBrCH_2^-$

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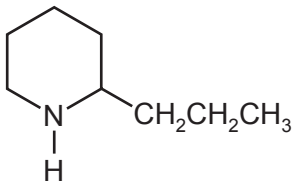
24 Coniine is the major constituent of the poison 'oil of hemlock'.



coniine

Coniine can be synthesised by reacting ammonia with a dibromo compound, **X**.

$$NH_3 + C_8H_{16}Br_2 \rightarrow \text{coniine} + 2HBr$$

X

What is the name of compound **X**?

A 1,1-dibromo-2-propylcyclopentane

B 1,2-dibromo-2-propylcyclopentane

C 1,4-dibromooctane

D 1,5-dibromooctane

25 2-bromopropane reacts with a hot concentrated solution of sodium hydroxide in ethanol.

Which substance is the major product of this reaction?

A propan-1-ol

B propan-2-ol

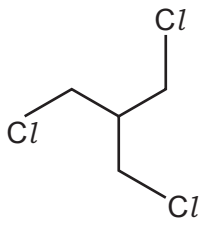
C 2-hydroxypropene

D propene

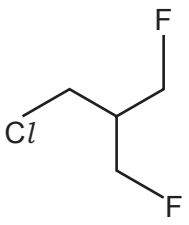
26 The presence of a halogen in an organic compound may be detected by warming the organic compound with aqueous silver nitrate.

Which compound would be the quickest to produce a precipitate?

A



B



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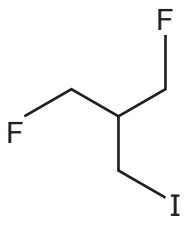
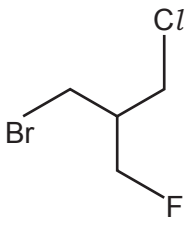
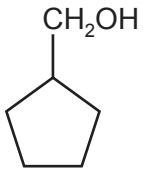


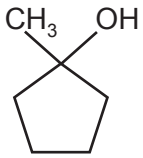
D



27 Which reagent will give a different observation with compounds W and X?



W



X

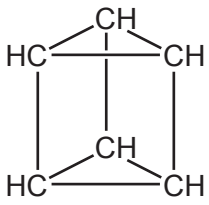
A hot $SOCl_2$

B hot acidified $K_2Cr_2O_7$

C NaOH(aq)

D warm Fehling's reagent

28 In 1869 Ladenburg suggested a structure for benzene, C_6H_6, in which one hydrogen atom is attached to each carbon atom.



Ladenburg structure

A compound $C_6H_4Cl_2$ could be formed with **the same** carbon skeleton as the Ladenburg structure.

How many **structural** isomers would this compound have?

A 3 **B** 4 **C** 5 **D** 6

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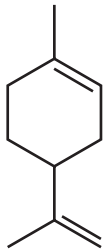
29 The citrus flavour of lemons is due to the compound limonene, present in both the peel and the juice.



limonene

What is the mole ratio of carbon dioxide to water produced when limonene is completely burnt in oxygen?

	number of moles carbon dioxide	number of moles water
A	4	3
B	5	4
C	5	8
D	9	7

30 What is the organic product when ethanamide, CH_3CONH_2, is boiled with excess aqueous sodium hydroxide?

A CH_3CN

B $CH_3CO_2^-NH_4^+$

C $CH_3CONH^-Na^+$

D $CH_3CO_2^-Na^+$

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[Turn over

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

The isotope ^{99}Tc is radioactive and has been found in lobsters and seaweed adjacent to nuclear fuel reprocessing plants.

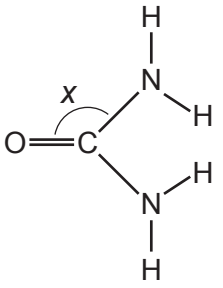
Which statements are correct about an atom of ^{99}Tc?

1 It has 13 more neutrons than protons.

2 It has 43 protons.

3 It has 99 nucleons.

32 Urea is a product of animal metabolism. It can also be used as a fertiliser.



urea

The diagram shows angle *x* in this molecule.

Which statements about the structure of urea are correct?

1 Angle *x* is approximately 120°.

2 The molecule has two π bonds.

3 The molecule has only three lone pairs of electrons.

33 Aluminium is extracted from aluminium oxide by electrolysis.

Which statements are correct?

1 Aluminium oxide has an extremely high melting point.

2 Bauxite is added to the aluminium oxide to lower its melting point.

3 Oxygen produced at the graphite cathode reacts with the graphite to produce CO_2.

34 Why does raising the pressure of a fixed mass of gaseous reactants at a constant temperature cause an increase in the rate of reaction?

1 More collisions occur per second when the pressure is increased.

2 More molecules have energy greater than the activation energy at the higher pressure.

3 Raising the pressure lowers the activation energy.

35 Which statements about the industrial manufacture of sulfuric acid are correct?

1 Sulfur is burned to form sulfur dioxide.

2 The stage that forms sulfur trioxide involves a V_2O_5 catalyst.

3 The stage that forms sulfur trioxide is non-reversible.

36 **X** is a Group II metal. It forms a sulfate which is more soluble than barium sulfate. It forms a hydroxide which is more soluble than calcium hydroxide.

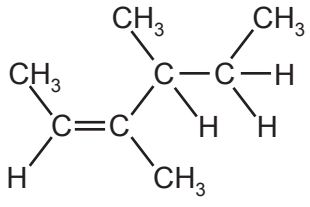
What could be the identity of **X**?

1 strontium

2 magnesium

3 beryllium

37 The diagram shows the structure of an alkene molecule.



Which statements about this molecule are correct?

1 All the carbon atoms are in the same plane.

2 It has geometrical isomers.

3 It is optically active.

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 An organic compound, **X**, will react with calcium metal to produce a salt with the empirical formula $CaC_4H_4O_4$.

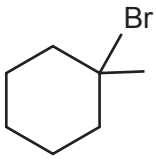
What could be the identity of **X**?

1 ethanoic acid

2 butanedioic acid

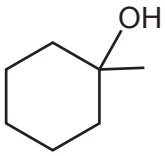
3 2-methylpropanedioic acid

39 Which compounds will react with HBr to give the compound R?



R

1



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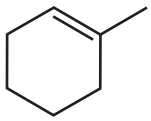

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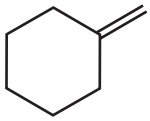
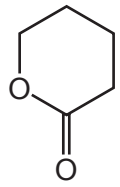


40 5-hydroxypentanoic acid is readily converted into the cyclic compound L.



L

Which statements about this reaction are correct?

1 Acidified sodium dichromate(VI) is used as a reagent.

2 A water molecule is produced in the reaction.

3 The reaction is catalysed by concentrated H_2SO_4.

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