UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education
Advanced Subsidiary Level and Advanced Level

CHEMISTRY **9701/01**

Paper 1 Multiple Choice

May/June 2006

1 hour

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

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, 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.

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.

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.

1 N_2O_4 is a poisonous gas. It can be disposed of safely by reaction with sodium hydroxide.

$$N_2O_4(g) + 2NaOH(aq) \rightarrow NaNO_3(aq) + NaNO_2(aq) + H_2O(l)$$

What is the minimum volume of $0.5\,mol\,dm^{-3}$ NaOH(aq) needed to dispose of 0.02 mol of N_2O_4?

A $8\,cm^3$ **B** $12.5\,cm^3$ **C** $40\,cm^3$ **D** $80\,cm^3$

2 A sample of chlorine containing isotopes of mass numbers 35 and 37 was analysed in a mass-spectrometer.

How many peaks corresponding to Cl_2^+ were recorded?

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

3 Gallium nitride, GaN, could revolutionise the design of electric light bulbs because only a small length used as a filament gives excellent light at low cost.

Gallium nitride is an ionic compound containing the Ga^{3+} ion.

What is the electron arrangement of the nitrogen ion in gallium nitride?

A $1s^2\ 2s^2$

B $1s^2\ 2s^2\ 2p^3$

C $1s^2\ 2s^2\ 2p^4$

D $1s^2\ 2s^2\ 2p^6$

4 A radioactive isotope of thallium, $^{201}_{81}Tl$, is used to assess damage in heart muscles after a heart attack.

Which statement about $^{201}_{81}Tl$ is correct?

A This isotope has a nucleon number of 120.

B The number of electrons in one atom of this isotope is 81.

C The number of neutrons in one atom of this isotope is 201.

D $^{201}_{82}X$ is an isotope of $^{201}_{81}Tl$.

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5 In which process are hydrogen bonds broken?

A $H_2(l) \rightarrow H_2(g)$

B $NH_3(l) \rightarrow NH_3(g)$

C $2HI(g) \rightarrow H_2(g) + I_2(g)$

D $CH_4(g) \rightarrow C(g) + 4H(g)$

6 Which of the following least resembles an ideal gas?

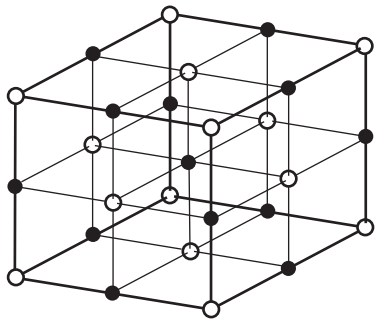
A ammonia

B helium

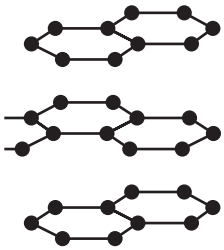
C hydrogen

D trichloromethane

7 The diagram shows part of the lattice structures of solids **X** and **Y**. [In **X**, ○ and ● represent particles of different elements.]



X



Y

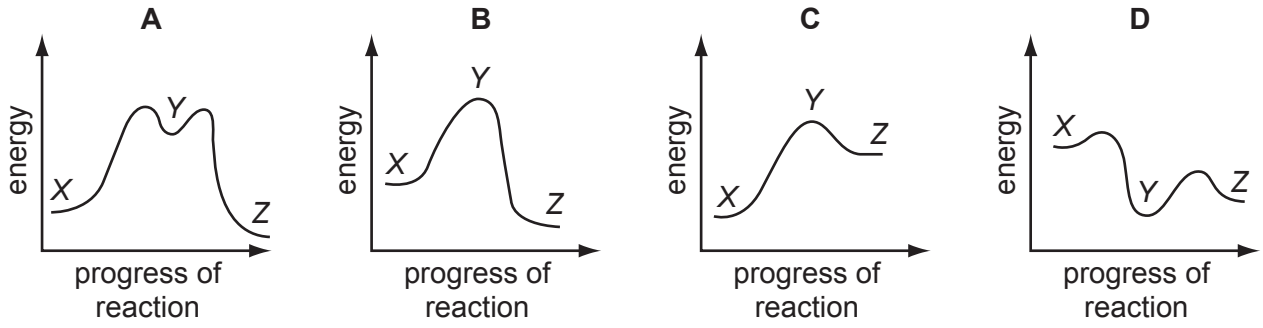
What are the types of bonding present in **X** and **Y**?

	X	**Y**
A	covalent	metallic
B	ionic	covalent
C	ionic	metallic
D	metallic	ionic

8 In the conversion of compound *X* into compound *Z*, it was found that the reaction proceeded by way of compound *Y*, which could be isolated. The following steps were involved.

$X \rightarrow Y$; ΔH, positive
$Y \rightarrow Z$; ΔH, negative

Which reaction profile fits these data?



9 The nickel-cadmium rechargeable battery is based upon the following overall reaction.

$$Cd + 2NiOOH + 4H_2O \rightarrow Cd(OH)_2 + 2Ni(OH)_2.H_2O$$

What is the oxidation number of nickel at the beginning and at the end of the reaction?

	beginning	end
A	+1.5	+2
B	+2	+3
C	+3	+2
D	+3	+4

10 At a total pressure of 1.0 atm, dinitrogen tetraoxide is 50 % dissociated at a temperature of 60 °C, according to the following equation.

$$N_2O_4 \rightleftharpoons 2NO_2$$

What is the value of the equilibrium constant, K_p, for this reaction at 60 °C?

A $^1/_3$ atm **B** $^2/_3$ atm **C** $^4/_3$ atm **D** 2 atm

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11 Swimming pool water can be kept free of harmful bacteria by adding aqueous sodium chlorate(I), NaOC*l*. This reacts with water to produce HOC*l* molecules which kill bacteria.

$$OCl^-(aq) + H_2O \rightleftharpoons OH^-(aq) + HOCl(aq)$$

In bright sunshine, the OCl^- ion is broken down by ultra-violet light.

$$OCl^-(aq) + \text{uv light} \rightarrow Cl^-(aq) + \tfrac{1}{2}O_2(g)$$

Which method would maintain the highest concentration of HOC*l*(aq)?

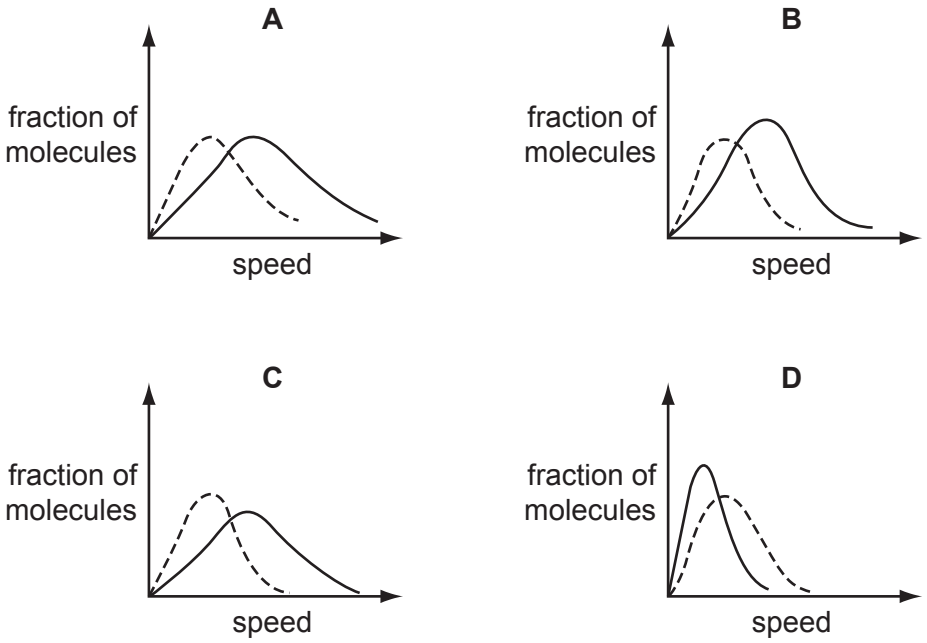
A acidify the pool water

B add a solution of chloride ions

C add a solution of hydroxide ions

D bubble air through the water

12 Which solid-line curve most accurately represents the distribution of molecular speeds in a gas at 500 K if the dotted-line curve represents the corresponding distribution for the same gas at 300 K?



13 In which pair is the radius of the second atom greater than that of the first atom?

A Na, Mg **B** Sr, Ca **C** P, N **D** C*l*, Br

14 The oxide and chloride of an element **X** are separately mixed with water. The two resulting solutions have the same effect on litmus.

What is element **X**?

A sodium

B magnesium

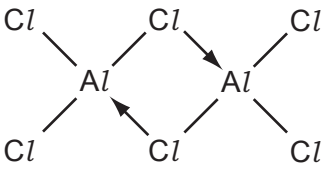
C aluminium

D phosphorus

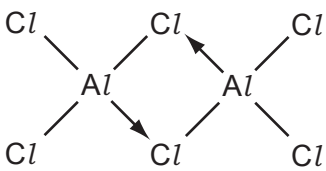
15 Aluminium chloride sublimes at 178 °C.

Which structure best represents the species in the vapour at this temperature?

A



B



C

$Al^{\bullet} + 3Cl^{\bullet}$

D

$Al^{3+}(Cl^{-})_3$

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

What mass of solid residue can 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

17 What happens when chlorine is bubbled through aqueous potassium iodide?

A Chlorine is oxidised to chloride ions.

B Hydrochloric acid is formed.

C Iodide ions are oxidised to iodine.

D Potassium iodide is reduced to iodine.

18 The emissions from a power station contain about 14 tonnes of SO_2 per hour from the oxidation of FeS_2 contained in the coal.

What is the most practical way of preventing the SO_2 from being released into the atmosphere?

A Cool the gases and the SO_2 will liquefy and can be removed.

B Dissolve the ionic FeS_2 in hexane.

C Pass the emissions through a bed of calcium oxide.

D Pass the gases through concentrated sulphuric acid to dissolve the SO_2.

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19 The gaseous oxides of nitrogen have positive enthalpy changes of formation.

Which factor is likely to make the most significant contribution to these enthalpy changes?

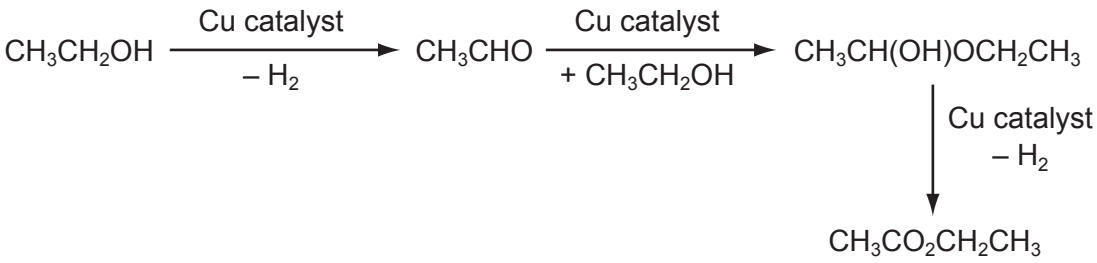
A the high bond energy of the nitrogen molecule, N_2

B the high electron affinity of nitrogen atoms

C the high electron affinity of oxygen atoms

D the similarity of the electronegativities of oxygen and nitrogen

20 A new industrial preparation of ethyl ethanoate has been developed using cheap sources of ethanol.



Which process is involved at some stage in this reaction sequence?

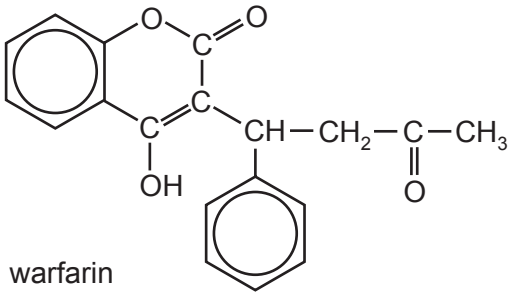
A disproportionation

B electrophilic addition

C nucleophilic addition

D reduction

21 Warfarin is used as a rat poison.



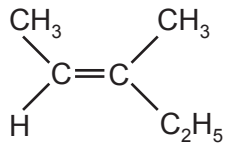
warfarin

How many chiral centres are present in the warfarin molecule?

A 0 **B** 1 **C** 2 **D** 3

22 The structures below show isomers of C_6H_{12}.

1



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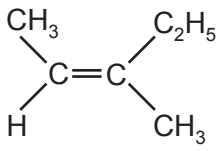

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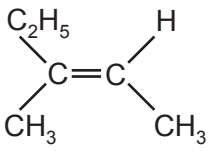

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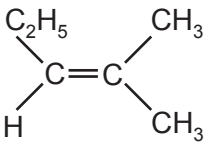

In which pair are the members *cis-trans* isomers of each other?

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

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

In which reaction is the relative molecular mass of the organic product the largest?

A bromoethane + aqueous sodium hydroxide

B bromoethane + alcoholic sodium hydroxide

C ethane + bromine

D ethanol + phosphorus pentachloride

24 Light initiates the following reaction.

alkane + chlorine $\rightarrow$ chloroalkane + hydrogen chloride

What happens to chlorine in this photochemical reaction?

A heterolytic fission to give an electrophile

B homolytic fission to give an electrophile

C heterolytic fission to give a free radical

D homolytic fission to give a free radical

25 High-energy irradiation in the stratosphere produces radicals from chlorofluoroalkanes, commonly known as CFCs.

Which radical could result from this irradiation of $CHFCl\dot{C}F_2C\dot{l}$?

A $CHFCl\dot{C}FCl$

B $\dot{C}HCl\dot{C}F_2Cl$

C $\dot{C}HFCF_2C\dot{l}$

D $\dot{C}FCl\dot{C}F_2C\dot{l}$

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26 Which reagent could detect the presence of alcohol in a petrol consisting mainly of a mixture of alkanes and alkenes?

A Na

B Br_2 (in CCl_4)

C $KMnO_4$(aq)

D 2,4-dinitrophenylhydrazine

27 Which alcohol may be oxidised to a product which reacts with 2,4-dinitrophenylhydrazine reagent but not with Fehling's reagent?

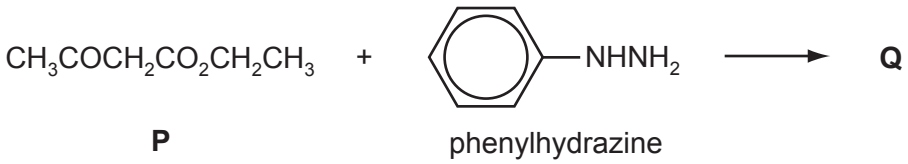
A butan-1-ol

B butan-2-ol

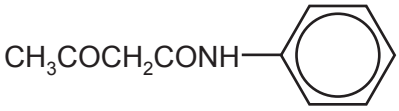
C 2-methylpropan-1-ol

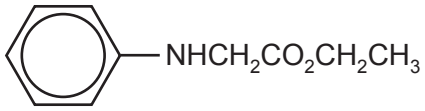
D 2-methylpropan-2-ol

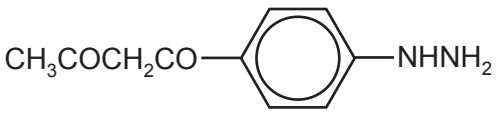
28 The first stage in the synthesis of antipyrine, a drug used in reducing fever, is the reaction between compound **P** and phenylhydrazine.

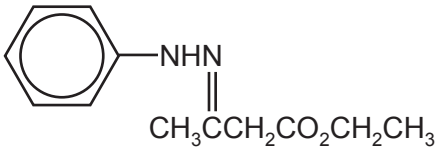


What is the product **Q** of this first stage?

A 

B 

C 

D 

29 Aldehydes and ketones are carbonyl compounds.

Which of them react both with $NaBH_4$ and with Tollens' reagent?

A both aldehydes and ketones

B aldehydes only

C ketones only

D neither aldehydes nor ketones

30 Which compound is a product of the hydrolysis of $CH_3CO_2C_3H_7$ by boiling aqueous sodium hydroxide?

A CH_3OH **B** C_3H_7OH **C** $C_3H_7CO_2H$ **D** $C_3H_7CO_2^-Na^+$

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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 Group IV elements carbon, silicon and germanium all exist in a diamond structure. The bond lengths in these structures are given below.

element *X*	C	Si	Ge
bond length *X*–*X* / nm	0.154	0.234	0.244

Why does the bond length increase down the group?

1 Orbital overlap decreases down the group.

2 Atomic radius increases down the group.

3 Nuclear charge increases down the group.

32 Sodium ions can be formed from sodium atoms.

$$Na(s) \rightarrow Na^{+}(g)$$

Which quantities are required to calculate the enthalpy change of formation of gaseous sodium ions?

1 enthalpy change of atomisation of sodium

2 first ionisation energy of sodium

3 enthalpy change of formation of sodium

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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.

33 Hydrazine, N_2H_4, is widely used as a rocket fuel because it reacts with oxygen as shown, producing 'environmentally friendly' gases.

$$N_2H_4(l) + O_2(g) \rightarrow N_2(g) + 2H_2O(g) \qquad \Delta H = -534\,kJ\,mol^{-1}$$

Despite its use as a rocket fuel, hydrazine does not spontaneously burn in oxygen.

Why does hydrazine not burn spontaneously?

1 The activation energy is too high.

2 The N≡N bond is very strong.

3 Hydrazine is a liquid.

34 Compound **X**

- does not conduct electricity when in a liquid state,
- when added to water produces a solution that readily conducts electricity.

What could **X** be?

1 $MgCl_2$

2 $SiCl_4$

3 PCl_3

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35 Hydroxyapatite, a basic calcium phosphate, $Ca(OH)_2.3Ca_3(PO_4)_2$, is the mineral found in bone.

In older people, calcium ions can be lost from the hydroxyapatite, weakening the bone structure. In such cases, strontium salts are administered to strengthen the bone. The strontium ions replace the lost calcium ions in the hydroxyapatite.

Which statements are correct?

1 Strontium ions are nearly the same size as calcium ions and so may easily replace them in the hydroxyapatite.

2 Strontium hydroxide is less soluble than calcium hydroxide and so will precipitate better in the bone structure.

3 There is ionic, covalent and metallic bonding in hydroxyapatite which gives it strength.

36 Ammonia and chlorine react in the gas phase.

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

Which statements are correct?

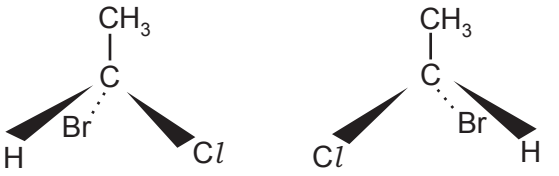
1 Ammonia behaves as a reducing agent.

2 Ammonia behaves as a base.

3 The oxidation number of the hydrogen changes.

37 In which pairs are the members stereoisomers of each other?

1



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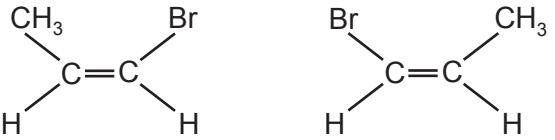

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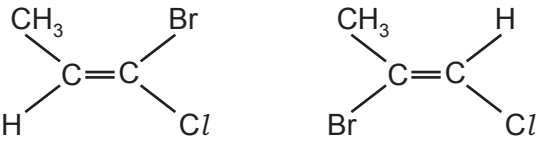


The responses **A** to **D** should be selected on the basis of

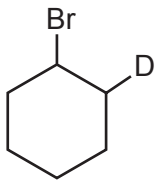
A	B	C	D
1, 2 and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

38 Deuterium, D, is the $^{2}_{1}H$ isotope of hydrogen. DBr has the same chemical properties as HBr.

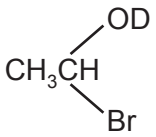
Which compounds could be made by the reaction of DBr with another compound in a single reaction?

1



2 $CHBr_2CHDBr$

3



39 How can the rate of reaction between ethanal and aqueous hydrogen cyanide be increased?

1 by irradiation with ultraviolet light

2 by a rise in temperature

3 by the addition of a small quantity of aqueous sodium cyanide

40 Which statements about lactic acid, $CH_3CH(OH)CO_2H$, are correct?

1 Lactic acid forms optical isomers.

2 Two hydrogen atoms per lactic acid molecule can be involved in hydrogen bonding.

3 Lactic acid would form an aldehyde when oxidised by acidified potassium dichromate(VI).

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