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

CHEMISTRY **9701/01**

Paper 1 Multiple Choice **October/November 2007**

1 hour

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

* 6 1 6 8 3 5 5 4 6 4 *

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.

© UCLES 2007

Section A

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

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

When a sports medal with a total surface area of 150 cm^2 was evenly coated with silver, using electrolysis, its mass increased by 0.216 g.

How many atoms of silver were deposited per cm^2 on the surface of the medal?

A 8.0×10^{18}

B 1.8×10^{19}

C 1.2×10^{21}

D 4.1×10^{22}

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

In forming ionic compounds, elements generally form an ion with the electronic structure of a noble gas.

Which ion does **not** have a noble gas electronic structure?

A I^- **B** Rb^+ **C** Sn^{2+} **D** Sr^{2+}

3 The first stage in the manufacture of nitric acid is the oxidation of ammonia by oxygen.

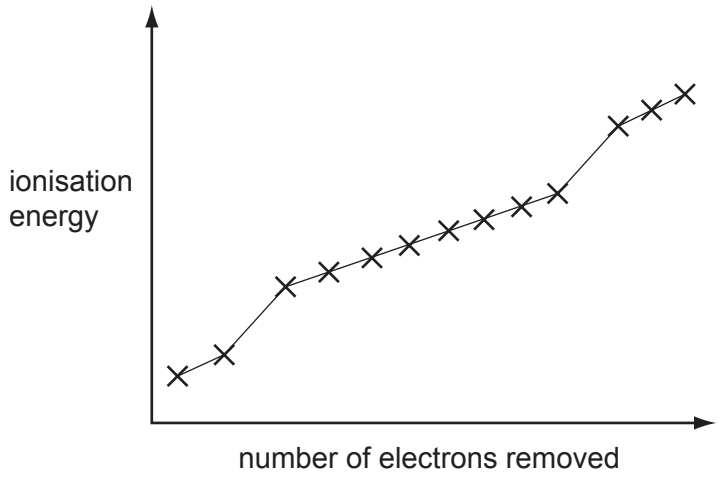
$$\mathbf{w}NH_3(g) + \mathbf{x}O_2(g) \rightarrow \mathbf{y}NO(g) + \mathbf{z}H_2O(g)$$

Which values for **w**, **x**, **y** and **z** are needed to balance the equation?

	w	**x**	**y**	**z**
A	4	5	4	6
B	4	6	4	5
C	5	6	5	4
D	6	5	6	4

© UCLES 2007

4 The graph shows the first thirteen ionisation energies for element **X**.



What can be deduced about element **X** from the graph?

A It is in the second period (Li to Ne) of the Periodic Table.

B It is a d-block element.

C It is in Group II of the Periodic Table.

D It is in Group III of the Periodic Table.

5 Hydrogen bonding can occur between molecules of methanal, HCHO, and molecules of liquid **Y**.

What could liquid **Y** be?

A CH_3OH

B CH_3CHO

C CH_3COCH_3

D $CH_3CO_2CH_3$

6 *Lycra*® is a polyurethane fibre used in the fashion industry. It is a polymer made from two monomers, one of which has the following formula.

$$O{=}C{=}N{-}(CH_2)_n{-}N{=}C{=}O$$

What is the O–C–N bond angle in this molecule?

A 90° **B** 109° **C** 120° **D** 180°

7 What are the lattice structures of solid diamond, iodine and silicon(IV) oxide?

	giant molecular	simple molecular
A	diamond, silicon(IV) oxide	iodine
B	diamond, iodine	silicon(IV) oxide
C	iodine	diamond, silicon(IV) oxide
D	silicon(IV) oxide	diamond, iodine

8 Which equation represents 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 $\frac{1}{2} Br_2(g) \rightarrow Br(g)$

9 In an experiment, 50.0 cm^3 of a 0.10 mol dm^{-3} solution of a metallic salt reacted exactly with 25.0 cm^3 of 0.10 mol dm^{-3} aqueous sodium sulphite.

The half-equation for oxidation of sulphite ion is shown below.

$$SO_3^{2-}(aq) + H_2O(l) \rightarrow SO_4^{2-}(aq) + 2H^+(aq) + 2e^-$$

If the original oxidation number of the metal in the salt was +3, what would be the new oxidation number of the metal?

A +1 **B** +2 **C** +4 **D** +5

10 Nitrogen dioxide decomposes on heating according to the following equation.

$$2NO_2(g) \rightleftharpoons 2NO(g) + O_2(g)$$

When 4 mol of nitrogen dioxide were put into a 1 dm^3 container and heated to a constant temperature, the equilibrium mixture contained 0.8 mol of oxygen.

What is the value of the equilibrium constant, K_c, at the temperature of the experiment?

A $\frac{0.8^2 \times 0.8}{4^2}$ **B** $\frac{1.6 \times 0.8}{2.4^2}$ **C** $\frac{1.6^2 \times 0.8}{4^2}$ **D** $\frac{1.6^2 \times 0.8}{2.4^2}$

© UCLES 2007

11 It is often said that the rate of a typical reaction is roughly doubled by raising the temperature by 10 °C.

What explains this observation?

A Raising the temperature by 10 °C doubles the average kinetic energy of each molecule.

B Raising the temperature by 10 °C doubles the average velocity of the molecules.

C Raising the temperature by 10 °C doubles the number of molecular collisions in a given time.

D Raising the temperature by 10 °C doubles the number of molecules having more than a certain minimum energy.

12 When dangerous chemicals are transported by road, vehicles must carry signs that indicate what measures should be taken in the event of a spillage of the chemical carried.

Which material must be used if there were a spillage of metallic sodium?

A ethanol

B jets of water

C sand

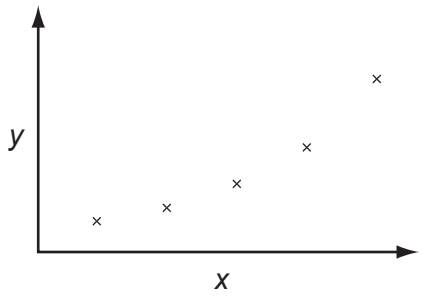
D water spray

13 Which species has the largest radius?

A P^{3-} **B** Cl^- **C** Ar **D** K^+

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

The sketch graph shows the variation of one physical or chemical property with another for the Group II elements.



What are the correct labels for the axes?

	x-axis	*y*-axis
A	atomic number	mass number
B	atomic number	melting point
C	first ionisation energy	atomic number
D	first ionisation energy	atomic radius

15 The chemical properties of an element at the top of a group in the Periodic Table are often different from those of the rest of the elements in the group.

Of the following properties of beryllium and its compounds, which property **is** typical of the elements below it in Group II?

A Be does not react with hot water.

B $BeCl_2$ is covalent.

C $Be(NO_3)_2$ produces BeO on thermal decomposition.

D BeO dissolves in alkalis.

16 Compound **X** on refluxing with aqueous sodium hydroxide gave mixture **Y** which on distillation with acidified potassium dichromate(VI) produced propanone. Mixing **Y** with dilute nitric acid and aqueous silver nitrate gave a cream precipitate.

What could compound **X** be?

A $CH_3CHBrCH_3$

B CH_3CHICH_3

C $CH_3CH_2CH_2Br$

D $CH_3CH_2CH_2I$

17 There are three stages in the Contact process for the production of sulphuric acid.

1 $S + O_2 \rightarrow SO_2$

2 $SO_2 + \frac{1}{2}O_2 \rightarrow SO_3$

3 $SO_3 + H_2O \rightarrow H_2SO_4$

Which statement about this process is correct?

A In the first stage a large excess of air under high pressure is used to improve the yield.

B Two of the three stages are equilibria.

C All three stages are exothermic.

D In the final stage SO_3 is absorbed by water droplets.

18 Gaseous nitrogen is less reactive than gaseous fluorine.

What is the reason for this difference in reactivity?

A The boiling point of nitrogen is lower than that of fluorine.

B The relative molecular mass of nitrogen is lower than that of fluorine.

C The atomic radius of nitrogen is greater than that of fluorine.

D The bond strength in the molecule is greater in nitrogen than in fluorine.

© UCLES 2007

19 Which molecules, each with a linear carbon chain, can have an optically active isomer?

I	II	III	IV
C_3H_6BrI	C_3H_4BrI	$C_3H_6I_2$	$C_3H_4Br_2$

A I and II only

B I, II and III only

C II and III only

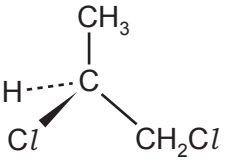
D I, II and IV only

20 In which pair do the isomers have identical boiling points?

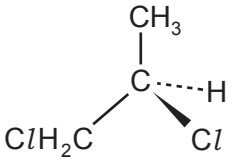
A $CH_3CH_2CH_2CH_2OH$ and $(CH_3)_2CHCH_2OH$

B $CH_3(CH_2)_4CH_3$ and $(CH_3)_2CHCH(CH_3)_2$

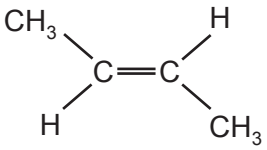
C



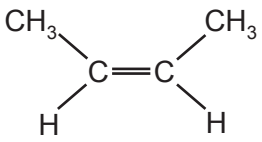
and



D



and



21 Tetramethyl-lead(IV), $(CH_3)_4Pb$, increases the rate of the reaction of methane with chlorine.

$$CH_4(g) + Cl_2(g) \rightarrow CH_3Cl(g) + HCl(g)$$

Why can tetramethyl-lead(IV) behave in this way?

A It is a source of methyl radicals.

B It releases $CH_3^+(g)$.

C It reacts with chloromethane and prevents equilibrium being established.

D Metal ions catalyse the reaction.

© UCLES 2007

22 Which reaction occurs when ethane and chlorine are mixed in diffused sunlight?

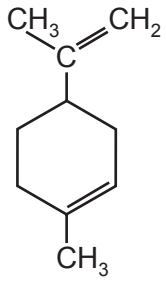
A a free-radical substitution with hydrogen given off

B a free-radical substitution with hydrogen chloride given off

C a free-radical substitution with no gas given off

D a nucleophilic substitution with hydrogen chloride given off

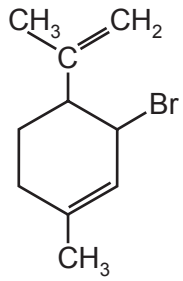
23 Limonene is an oil formed in the peel of citrus fruits.



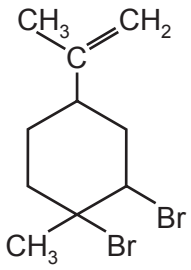
limonene

Which product is formed when molecular bromine reacts with limonene at room temperature in the dark?

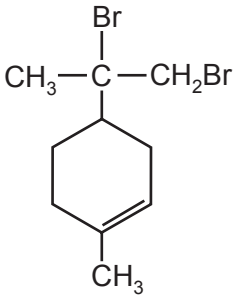
A



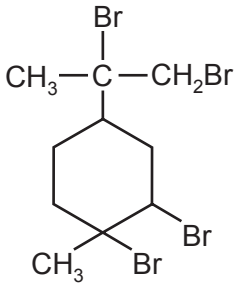
B



C



D



24 The anaesthetic *halothane,* $CF_3CHBrCl$, is made industrially as shown below.

$$CCl_2{=}CHCl \xrightarrow[\text{stage 1}]{HF} CF_3CH_2Cl \xrightarrow[\text{stage 2}]{Br_2} CF_3CHBrCl$$

Which type of reaction is occurring in stage 2?

A electrophilic addition

B electrophilic substitution

C free radical substitution

D nucleophilic addition

© UCLES 2007

25 Chlorofluoroalkanes, CFCs, can be used as refrigerants, aerosol propellants and fire extinguishers.

CFCs such as CCl_3F and CCl_2F_2 are more stable than chloroalkanes such as CCl_4.

What is the reason for their greater stability?

A Fluorine has a higher first ionisation energy than chlorine.

B Fluorine radicals are more stable than chlorine radicals.

C The C–F bond energy is larger than the C–Cl bond energy.

D The C–F bond is more polar than the C–Cl bond.

26 Butanedioic acid occurs in amber, algae, lichens, sugar cane and beets. It may be synthesised in two steps from 1,2-dibromoethane.

$$BrCH_2CH_2Br \xrightarrow{\text{step 1}} \mathbf{X} \xrightarrow{\text{step 2}} HO_2CCH_2CH_2CO_2H$$

Which reagents could be used for this synthesis?

	step 1	step 2
A	HCN(g)	HCl(aq)
B	HCO_2Na(aq)	HCl(aq)
C	KCN(aq/alcoholic)	H_2SO_4(aq)
D	NaOH(aq)	$K_2Cr_2O_7$ / H_2SO_4(aq)

27 Which reaction will distinguish between a primary and a secondary alcohol?

A warming with H^+ / MnO_4^-

B warming with $H^+ / Cr_2O_7^{2-}$

C dehydration, followed by reaction with Br_2(aq)

D oxidation, followed by reaction with Fehling's (or Tollens') reagent

© UCLES 2007

28 Hept-4-enal is present in cow's milk.

$$CH_3CH_2CH{=}CHCH_2CH_2CHO$$

hept-4-enal

What is formed when hept-4-enal is reduced with **either** hydrogen and a nickel catalyst **or** sodium borohydride?

A with H_2 / Ni $CH_3(CH_2)_5CH_2OH$

B with H_2 / Ni $CH_3(CH_2)_5CH_3$

C with $NaBH_4$ $CH_3(CH_2)_5CH_2OH$

D with $NaBH_4$ $CH_3(CH_2)_5CHO$

29 Which of these reactions is shown by butanone, $CH_3COCH_2CH_3$?

A On warming with acidified potassium dichromate(VI) the solution turns green.

B On heating with Fehling's reagent a red precipitate is formed.

C With 2,4-dinitrophenylhydrazine reagent an orange precipitate is formed.

D With hydrogen cyanide an aldehyde is formed.

30 The ester $CH_3CH_2CH_2CO_2CH_3$ is responsible for the aroma of apples.

When this ester is hydrolysed by acid in the stomach, what is the empirical formula of the organic acid produced?

A CH_4O **B** C_2H_4O **C** $C_2H_4O_2$ **D** $C_3H_7O_2$

© UCLES 2007

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 What are assumptions of the kinetic theory of gases and hence of the ideal gas equation, $PV = nRT$?

1 Molecules move without interacting with one another except for collisions.

2 Intermolecular forces are negligible.

3 Intermolecular distances are much greater than the molecular size.

32 Carbon monoxide burns readily in oxygen to form carbon dioxide.

What can be deduced from this information?

1 The +4 oxidation state of carbon is more stable than the +2 state.

2 The standard enthalpy change of formation of carbon dioxide is more negative than that of carbon monoxide.

3 The value of the equilibrium constant for the reaction, $2CO(g) + O_2(g) \rightleftharpoons 2CO_2(g)$, is likely to be high.

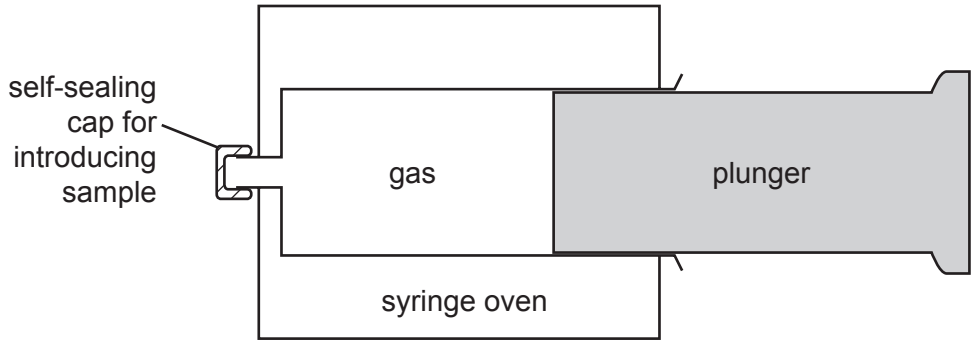
The responses **A** to **D** should be selected on the basis of

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 Phosphorus pentachloride is introduced into an empty gas syringe which has a movable, tightly-fitting plunger. The gas is allowed to expand until equilibrium is reached at a temperature at which the phosphorus pentachloride partially dissociates.

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



Which statements are correct?

1 The equilibrium pressure inside the syringe will be greater than atmospheric pressure.

2 When the plunger is pushed in the equilibrium adjusts to produce more $PCl_5(g)$.

3 The volume of gas in the syringe at equilibrium will be greater than if no dissociation had occurred.

34 Which statements are correct about the activation energy of a reaction?

1 It is different for the forward and back reactions in an exothermic process.

2 It is low for a reaction that takes place slowly.

3 It is unaffected by the presence of a catalyst.

© UCLES 2007

35 When a firework is lit a fuel and an oxidising agent react.

In such a firework, magnesium is the fuel and barium nitrate is the oxidising agent.

Which solid products are produced when the firework is lit?

1 BaO

2 MgO

3 $Mg(NO_3)_2$

36 Why is the addition of concentrated sulphuric acid to solid potassium iodide **unsuitable** for the preparation of hydrogen iodide?

1 Hydrogen iodide is not displaced by sulphuric acid.

2 Iodide ions are oxidised to iodine.

3 The product is contaminated by sulphur compounds.

37 Which mixtures, on heating, produce the gas ND_3?
[D = ^2_1H, an isotope of hydrogen]

1 CaO(s) and ND_4Cl(s)

2 CH_3CN and NaOD in D_2O

3 NDH_3Cl and NaOD in D_2O

38 Which structures show a primary alcohol that **cannot** be dehydrated to form an alkene?

1 CH_3OH

2 CH_3CH_2OH

3 $CH_3CH(OH)CH_3$

39 In the reaction between an aldehyde and HCN catalysed by NaCN, which statements about the reaction mechanism are true?

1 A new carbon-carbon bond is formed.

2 In the intermediate, the oxygen carries a negative charge.

3 The last stage involves the formation of a hydrogen-oxygen bond.

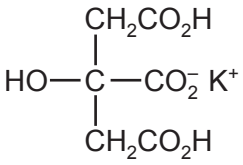
© UCLES 2007

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.

40 Monopotassium citrate is used as an emulsifying agent in powdered milk and in powdered soups. It may be represented by the formula shown.



Which statements about monopotassium citrate are correct?

1 It can form optical isomers.

2 It can act as a dibasic acid.

3 It can form esters with both acids and alcohols.

© UCLES 2007

BLANK PAGE

BLANK PAGE

Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (UCLES) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest possible opportunity.

University of Cambridge International Examinations is part of the Cambridge Assessment Group. Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.