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

CHEMISTRY **9701/01**

Paper 1 Multiple Choice

October/November 2005

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.
You may use a calculator.

This document consists of **13** printed pages and **3** 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 The petrol additive tetraethyl-lead(IV), $Pb(C_2H_5)_4$, is now banned in many countries. When it is completely burned in air, lead(II) oxide, CO_2 and H_2O are formed.

How many moles of oxygen are required to burn one mole of $Pb(C_2H_5)_4$?

A 9.5 **B** 11 **C** 13.5 **D** 27

2 Which ion has more electrons than protons and more protons than neutrons?

[H = $^{1}_{1}H$; D = $^{2}_{1}H$; O = $^{16}_{8}O$]

A D^- **B** H_3O^+ **C** OD^- **D** OH^-

3 What is the electronic configuration of an element with a **second** ionisation energy higher than that of each of its neighbours in the Periodic Table?

A $1s^2 2s^2 2p^6 3s^2$

B $1s^2 2s^2 2p^6 3s^2 3p^1$

C $1s^2 2s^2 2p^6 3s^2 3p^2$

D $1s^2 2s^2 2p^6 3s^2 3p^3$

4 Which compound has a boiling point that is influenced by hydrogen bonding?

A CH_3CHO

B CH_3OCH_3

C HCO_2H

D HCO_2CH_3

5 Which gas is likely to deviate most from ideal gas behaviour?

A HCl **B** He **C** CH_4 **D** N_2

6 Given $S(s) + O_2(g) \rightarrow SO_2(g)$, $\Delta H_f^{\ominus} = -297\,kJ\,mol^{-1}$
and $S(s) + 1\frac{1}{2}O_2(g) \rightarrow SO_3(g)$ $\Delta H_f^{\ominus} = -395\,kJ\,mol^{-1}$

what is the enthalpy change of reaction, $\Delta H^{\ominus}$, of $2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$?

A $-196\,kJ\,mol^{-1}$ **B** $-98\,kJ\,mol^{-1}$ **C** $+98\,kJ\,mol^{-1}$ **D** $+196\,kJ\,mol^{-1}$

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7 The table shows the enthalpy change of neutralisation per mole of water formed, ΔH, for various acids and bases.

acid	base	ΔH / kJ mol^{-1}
hydrochloric acid	sodium hydroxide	–57.0
P	sodium hydroxide	–54.0
hydrochloric acid	**Q**	–52.0
nitric acid	**R**	–57.0

What are **P**, **Q** and **R**?

	P	**Q**	**R**
A	ethanoic acid	ammonia	potassium hydroxide
B	ethanoic acid	sodium hydroxide	ammonia
C	sulphuric acid	ammonia	potassium hydroxide
D	sulphuric acid	sodium hydroxide	ammonia

8 During the electrolysis of brine using a diaphragm cell, which reaction occurs at the cathode?

A $2Cl^-(aq) \rightarrow Cl_2(g) + 2e^-$

B $4OH^-(aq) \rightarrow O_2(g) + 2H_2O(l) + 4e^-$

C $2H_2O(l) + 2e^- \rightarrow H_2(g) + 2OH^-(aq)$

D $Na^+(aq) + e^- \rightarrow Na(s)$

9 Chlorine dioxide is produced on a large scale as it is used for bleaching paper pulp. It is made by the following reaction.

$$2ClO_3^-(aq) + SO_2(g) \rightarrow 2ClO_2(g) + SO_4^{2-}(aq)$$

How do the oxidation numbers of chlorine and sulphur change in this reaction?

	chlorine	sulphur
A	decreases by 1	increases by 1
B	decreases by 1	increases by 2
C	decreases by 3	increases by 1
D	decreases by 3	increases by 2

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10 An experiment is set up to measure the rate of hydrolysis of methyl ethanoate.

$$CH_3CO_2CH_3 + H_2O \rightleftharpoons CH_3CO_2H + CH_3OH$$

The hydrolysis is found to be slow in neutral aqueous solution but it proceeds at a measurable rate when the solution is acidified with hydrochloric acid.

What is the function of the hydrochloric acid?

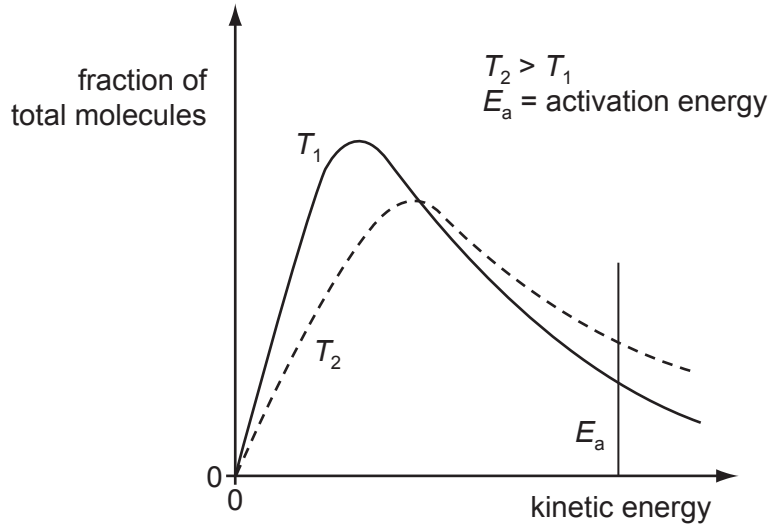
A to dissolve the methyl ethanoate

B to ensure that the reaction reaches equilibrium

C to increase the reaction rate by catalytic action

D to suppress ionisation of the ethanoic acid formed

11 The distribution of molecular kinetic energies within a gas at temperature T_1 and T_2 are shown in the diagram.



Which statement correctly explains why a small increase in temperature leads to a significant increase in the rate of a gaseous reaction?

A The frequency of collisions between molecules is greater at a higher temperature.

B The activation energy of the reaction is less when the gases are at a higher temperature.

C The frequency of collisions between molecules with kinetic energy greater than the activation energy is greater at higher temperature.

D The proportion of molecules with more kinetic energy than the activation energy is lower at a higher temperature.

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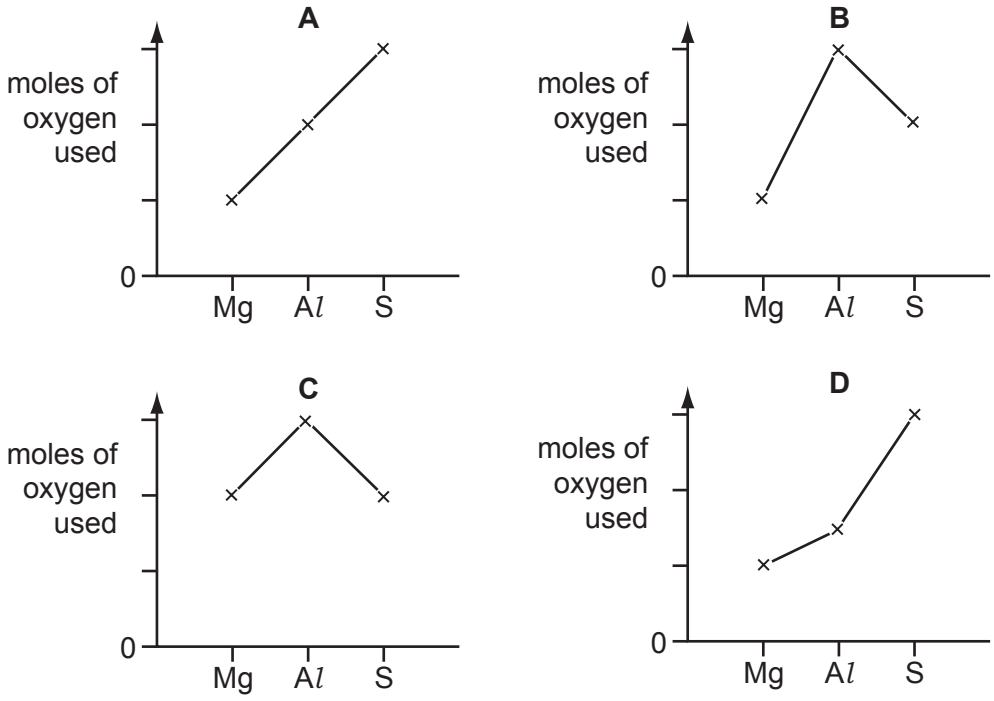
12 One mole of magnesium, aluminium and sulphur are each completely burned in an excess of oxygen gas.

Which graph shows the moles of oxygen used in each case?



13 In 1999, researchers working in the USA believed that they had made a new element and that it had the following electronic structure.

$$[Rn]\ 5f^{14}6d^{10}7s^{2}7p^{6}$$

In which Group of the Periodic Table would you expect to find this element?

A II **B** IV **C** VI **D** 0

14 Consecutive elements *X*, *Y*, *Z* are in Period 3 of the Periodic Table. Element *Y* has the highest first ionisation energy and the lowest melting point.

What could be the identities of *X*, *Y* and *Z*?

A sodium, magnesium, aluminium

B magnesium, aluminium, silicon

C aluminium, silicon, phosphorus

D silicon, phosphorus, sulphur

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

What volume of oxygen, measured under room conditions, can be obtained from the thermal decomposition of 8.2 g of calcium nitrate (M_r = 164)?

A 150 cm^3 **B** 300 cm^3 **C** 600 cm^3 **D** 1200 cm^3

16 When a mineral was heated in a Bunsen flame to constant mass, a colourless gas that turned lime water milky was evolved. The remaining solid was cooled and then added to aqueous hydrochloric acid. Vigorous effervescence was seen.

What was the mineral?

A aragonite, $CaCO_3$

B artinite, $MgCO_3.Mg(OH)_2.3H_2O$

C barytocalcite, $BaCO_3.CaCO_3$

D dolomite, $CaCO_3.MgCO_3$

17 How does ammonia behave when its aqueous solution is used to dissolve silver chloride, AgCl?

A as a base

B as a ligand with the Ag^+ ion

C as a ligand with the Cl^- ion

D as a reducing agent

18 Lime, CaO, is used to reduce the acidity of soil, and ammonium sulphate is a nitrogenous fertiliser.

Why can they **not** be used in a mixed form?

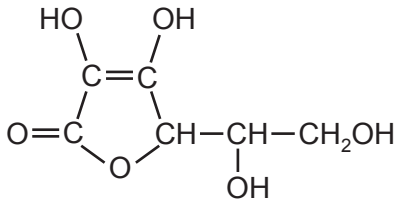
A The dry mixture is explosive.

B $CaSO_4$, formed on mixing, causes hard water.

C When dampened, ammonia is given off.

D Sulphuric acid will form.

19 The diagram shows the structure of vitamin C.



How many chiral centres are there in one molecule?

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

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20 What is the number of isomers of $C_2H_2Cl_2$ including *cis-trans* isomers?

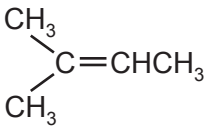
A 2 **B** 3 **C** 4 **D** 5

21 Which hydrocarbon, on treatment with hot acidified potassium manganate(VII), would give ethanoic acid **only**?

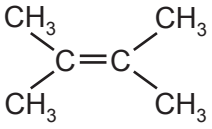
A $CH_3CH=CH_2$

B $CH_3CH=CHCH_3$

C



D



22 In the upper atmosphere chlorofluoroalkanes (CFCs) are broken down to give chlorine radicals but not fluorine radicals.

What is the best explanation for this?

A Fluorine is more electronegative than chlorine.

B Fluorine radicals are less stable than chlorine radicals.

C The C–F bond is stronger than the C–Cl bond.

D The chlorine atom is larger than the fluorine atom.

23 An amine is produced in the following reaction.

$$C_2H_5I + 2NH_3 \rightarrow C_2H_5NH_2 + NH_4I$$

What is the mechanism?

A electrophilic addition

B electrophilic substitution

C nucleophilic addition

D nucleophilic substitution

24 Compound **X** on reaction with hot concentrated sulphuric acid gave a mixture of **three** alkenes.

What could **X** be?

A butan-2-ol

B propan-2-ol

C 2-methylbutan-2-ol

D 2-methylpropan-2-ol

25 Compounds *X*, *Y* and *Z* all react with PCl_5 to release hydrogen chloride, but only one of them reacts with 2,4-dinitrophenylhydrazine reagent.

Which one of the following combinations could be *X*, *Y* and *Z*?

	X	*Y*	*Z*
A	CH_2OH | CH_2OH	CHO | CHO	CO_2H | CO_2H
B	CH_2OH | CH_2OH	CH_2OH | CHO	CHO | CO_2H
C	CH_2OH | CHO	CH_2OH | CO_2H	CHO | CO_2H
D	CH_2OH | CO_2H	CHO | CO_2H	CO_2H | CO_2H

26 In 1903 Arthur Lapworth became the first chemist to investigate a reaction mechanism. The reaction he investigated was that of hydrogen cyanide with propanone.

What do we now call the mechanism of this reaction?

A electrophilic addition

B electrophilic substitution

C nucleophilic addition

D nucleophilic substitution

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27 What is formed when propanone is refluxed with an anhydrous solution of $NaBH_4$?

A propanal

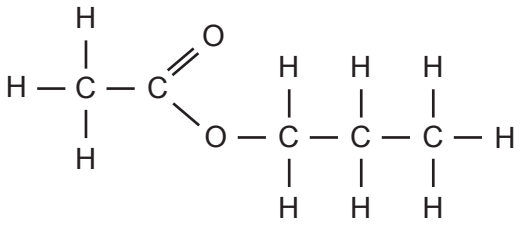
B propan-1-ol

C propan-2-ol

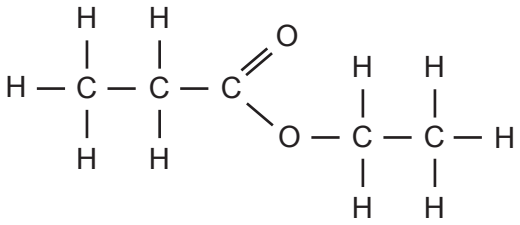
D propane

28 What is the structure of the ester formed from propanoic acid and ethanol?

A



B



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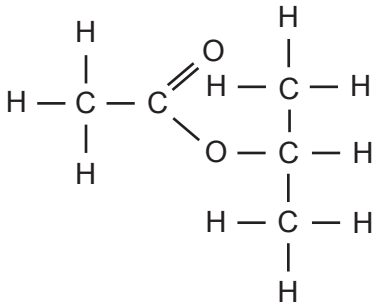

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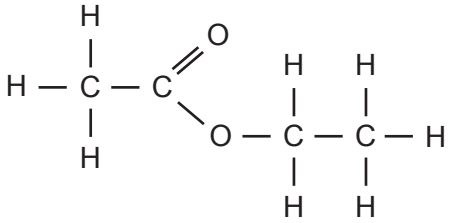
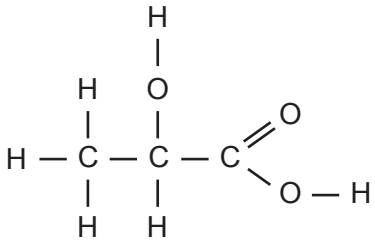


29 Lactic acid occurs naturally, for example in sour milk.

Its displayed formula is shown.



Which reaction occurs with lactic acid?

A It decolourises aqueous bromine rapidly.

B It is insoluble in water.

C It reduces Fehling's reagent.

D Two molecules react with each other in the presence of a strong acid.

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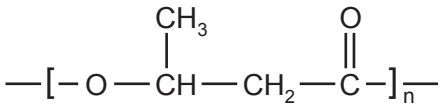
30 PHB (polyhydroxybutyric acid) is a natural polymer produced by a range of micro-organisms. It can also be manufactured from sugar. PHB is readily biodegradable.



PHB (polyhydroxybutyric acid)

What type of reaction will cause PHB to break down?

A addition

B hydrolysis

C reduction

D substitution

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 relative molecular mass of a molecule of chlorine is 72.

Which properties of the atoms in this molecule are the same?

1 radius

2 nucleon number

3 relative isotopic mass

32 Which molecules are planar?

1 BCl_3

2 NH_3

3 PH_3

33 Boron is a non-metallic element which is placed above aluminium in Group III of the Periodic Table. It forms a compound with nitrogen known as boron nitride which has a graphite structure.

Which of the following conclusions can be drawn from this information?

1 The empirical formula of boron nitride is BN.

2 The boron and nitride atoms are likely to be arranged alternately in a hexagonal pattern.

3 Boron nitride has a layer structure with van der Waals' forces between the layers.

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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.

34 Hydroxyapatite, $Ca_5(PO_4)_3OH$, is the main constituent of tooth enamel. In the presence of saliva, the following equilibria exist.

$$Ca_5(PO_4)_3OH(s) \rightleftharpoons 5Ca^{2+}(aq) + 3PO_4^{3-}(aq) + OH^-(aq)$$

$$HPO_4^{2-}(aq) \rightleftharpoons H^+(aq) + PO_4^{3-}(aq)$$

Which of the following statements help to explain why tooth enamel is dissolved more readily when saliva is acidic?

1 The hydroxide ions are neutralised by the acid.

2 The phosphate ion $PO_4^{3-}(aq)$ accepts $H^+(aq)$

3 Calcium ions react with acids.

35 What properties enable magnesium oxide to be used as a refractory lining in a furnace?

1 It has a high melting point.

2 It has a low thermal conductivity.

3 It does not react with basic slags.

36 Chlorine reacts with hot concentrated aqueous sodium hydroxide according to the equation below.

$$3Cl_2(g) + 6NaOH(aq) \rightarrow NaClO_3(aq) + 5NaCl(aq) + 3H_2O(l)$$

Which conclusions can be drawn from this information?

1 The oxidation state of the chlorine in one of the products is +5.

2 The chlorine undergoes disproportionation.

3 The sodium hydroxide acts as a reducing agent.

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37 Which equations represent stages in the Contact process for manufacturing sulphuric acid?

1 $S + O_2 \rightarrow SO_2$

2 $H_2O + SO_2 \rightarrow H_2SO_3$

3 $H_2SO_3 + \frac{1}{2}O_2 \rightarrow H_2SO_4$

38 For the reaction

$$(CH_3)_3SiCl + C_2H_5O^- \rightarrow (CH_3)_3SiOC_2H_5 + Cl^-$$

which statements are likely to be true?

1 It involves nucleophilic attack by $C_2H_5O^-$.

2 Cl^- is displaced by $C_2H_5O^-$.

3 The oxygen-carbon bond is not broken.

39 Modern cars are fitted with catalytic converters. These remove carbon monoxide, unburnt hydrocarbons and oxides of nitrogen from exhaust gases.

Which of these pollutant gases are removed by oxidation?

1 carbon monoxide

2 hydrocarbons

3 nitrogen oxides

40 The sex-attractant of the house-fly is muscalure, with the following formula.

$$CH_3(CH_2)_7CH=CH(CH_2)_{12}CH_3$$

Which statements about muscalure are correct?

1 It will decolourise aqueous bromine.

2 It will be oxidised by cold aqueous alkaline $KMnO_4$ to give a diol.

3 It will be optically active.

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