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

CHEMISTRY 9701/01

Paper 1 Multiple Choice

May/June 2003

1 hour

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

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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Local Examinations Syndicate

[Turn over

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

What is the number of molecules in 500 cm^3 of oxygen under room conditions?

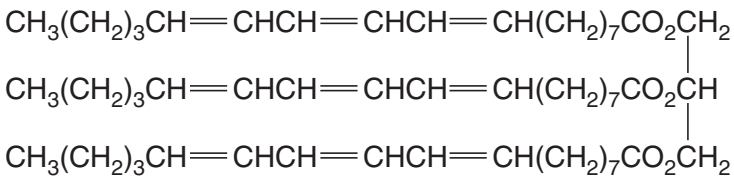
A 1.25×10^{22}

B 1.34×10^{22}

C 3.0×10^{22}

D 3.0×10^{26}

2 In the preparation of soft margarine, glyceryl trieleostearate



is suitably hydrogenated so that, on average, one of its side-chains is converted into the $CH_3(CH_2)_4CH{=}CHCH_2CH{=}CH(CH_2)_7CO_2$ residue and two side-chains are converted into the $CH_3(CH_2)_7CH{=}CH(CH_2)_7CO_2$ residue.

How many moles of hydrogen are required to convert one mole of glyceryl trieleostearate into the soft margarine?

A 4 **B** 5 **C** 6 **D** 9

3 Which isotope of an element in the third period of the Periodic Table contains the same number of neutrons as $^{32}_{16}S$?

A $^{23}_{11}Na$

B $^{24}_{12}Mg$

C $^{28}_{14}Si$

D $^{31}_{15}P$

4 The successive ionisation energies, in kJ mol^{-1}, of an element **X** are given below.

870 1800 3000 3600 5800 7000 13 200

What is **X**?

A $_{33}As$ **B** $_{40}Zr$ **C** $_{52}Te$ **D** $_{53}I$

5 Which of the following solids has a simple molecular lattice?

A magnesium oxide

B sodium

C silicon(IV) oxide

D sulphur

6 Measured values of the pressure, volume and temperature of a known mass of a gaseous compound are to be substituted into the equation

$$pV = nRT$$

in order to calculate the relative molecular mass, M_r, of the compound.

Which conditions of pressure and temperature would give the most accurate value of M_r?

	pressure	temperature
A	high	high
B	high	low
C	low	high
D	low	low

7 Gaseous phosphorus pentachloride can be decomposed into gaseous phosphorus trichloride and chlorine by heating. The table below gives the bond energies.

bond	bond energy / kJ mol^{-1}
P-C*l* (in both chlorides)	330
C*l*-C*l*	240

What is the enthalpy change in the decomposition of PCl_5 to PCl_3 and Cl_2?

A –420 kJ mol^{-1} **B** –90 kJ mol^{-1} **C** +90 kJ mol^{-1} **D** +420 kJ mol^{-1}

[Turn over

8 When ammonia is converted into nitric acid on a commercial scale, the following reactions can occur.

In which reaction does the greatest change in oxidation number of the nitrogen occur?

reaction	
A	$4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$
B	$3NO_2 + H_2O \rightarrow 2HNO_3 + NO$
C	$2NO + O_2 \rightarrow 2NO_2$
D	$4NH_3 + 6NO \rightarrow 5N_2 + 6H_2O$

9 At the age of 17, in a woodshed in Ohio, Charles Martin Hall discovered the commercial process for the production of aluminium metal by the electrolysis of a mixture of bauxite, Al_2O_3, and cryolite, Na_3AlF_6.

What is the main purpose of the cryolite?

A Al_2O_3 is covalent, and AlF_6^{3-} ions interact with it to produce Al^{3+} ions which can be discharged at the cathode.

B Cryolite is a base, forming $NaAlO_2$ with bauxite, enabling aluminium to be discharged at the anode.

C Cryolite reduces the melting point of the bauxite.

D Cryolite minimises the release of O^{2-} ions at the graphite anodes, which are otherwise burnt away to CO.

10 When 0.20 mol of hydrogen gas and 0.15 mol of iodine gas are heated at 723 K until equilibrium is established, the equilibrium mixture is found to contain 0.26 mol of hydrogen iodide.

The equation for the reaction is as follows.

$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$$

What is the correct expression for the equilibrium constant K_c?

A $\dfrac{2 \times 0.26}{0.20 \times 0.15}$

B $\dfrac{(2 \times 0.26)^2}{0.20 \times 0.15}$

C $\dfrac{(0.26)^2}{0.07 \times 0.02}$

D $\dfrac{(0.26)^2}{0.13 \times 0.13}$

11 Why is ethanoic acid a stronger acid in liquid ammonia than in aqueous solution?

A Ammonia is a stronger base than water.

B Ammonium ethanoate is completely ionised in aqueous solution.

C Ammonium ethanoate is strongly acidic in aqueous solution.

D Liquid ammonia is a more polar solvent than water.

12 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 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.

13 A mixture of the oxides of two elements of the third period is dissolved in water. The solution is approximately neutral.

What could be the constituents of the mixture?

A Al_2O_3 and MgO

B Na_2O and MgO

C Na_2O and P_4O_{10}

D SO_3 and P_4O_{10}

14 Aluminium chloride catalyses certain reactions by forming carbocations (carbonium ions) with chloroalkanes as shown.

$$RCl + AlCl_3 \rightarrow R^+ + AlCl_4^-$$

Which property makes this reaction possible?

A $AlCl_3$ is a covalent molecule.

B $AlCl_3$ exists as the dimer Al_2Cl_6 in the vapour.

C The aluminium atom in $AlCl_3$ has an incomplete octet of electrons.

D The chlorine atom in RCl has a vacant p orbital.

[Turn over

15 What are the products of the thermal decomposition of magnesium nitrate?

A magnesium nitride and oxygen

B magnesium oxide and nitrogen

C magnesium oxide, nitrogen and oxygen

D magnesium oxide, nitrogen dioxide and oxygen

16 Chlorine compounds show oxidation states ranging from –1 to +7.

What are the reagent(s) and conditions necessary for the oxidation of elemental chlorine into a compound containing chlorine in the +5 oxidation state?

A $AgNO_3(aq)$ followed by $NH_3(aq)$ at room temperature

B concentrated H_2SO_4 at room temperature

C cold dilute NaOH(aq)

D hot concentrated NaOH(aq)

17 Which gaseous hydride most readily decomposes into its elements on contact with a hot glass rod?

A ammonia

B hydrogen chloride

C hydrogen iodide

D steam

18 Which reagent, when mixed and heated with ammonium sulphate, liberates ammonia?

A aqueous bromine

B dilute hydrochloric acid

C limewater

D acidified potassium dichromate(VI)

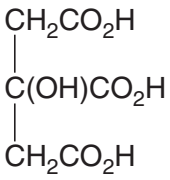
19 Which pollutant is formed in the internal combustion engine and, if not removed by the catalytic converter, may become involved in the formation of acid rain?

A C **B** C_8H_{18} **C** CO **D** NO

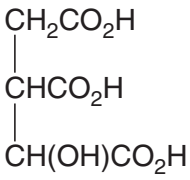
20 How many structural and *cis-trans* isomers are there for dichloropropene, $C_3H_4Cl_2$?

A 3 **B** 5 **C** 6 **D** 7

21 The isomers, citric acid and isocitric acid, are intermediates in the Krebs cycle of the oxidation of glucose in living cells.



citric acid



isocitric acid

How many chiral centres does each acid possess?

	citric acid	isocitric acid
A	0	1
B	0	2
C	1	1
D	1	2

22 The compound hex-3-en-1-ol, **P**, has a strong 'leafy' smell of newly cut grass and is used in perfumery.

$CH_3CH_2CH{=}CHCH_2CH_2OH$

P

What is produced when **P** is treated with an excess of hot concentrated acidic $KMnO_4$?

A $CH_3CH_2CH(OH)CH(OH)CH_2CH_2OH$

B $CH_3CH_2CH{=}CHCH_2CO_2H$

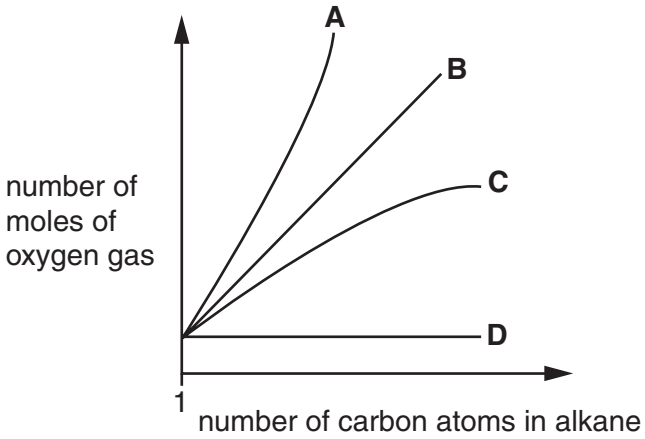
C CH_3CH_2CHO and $OCHCH_2CH_2OH$

D $CH_3CH_2CO_2H$ and $HO_2CCH_2CO_2H$

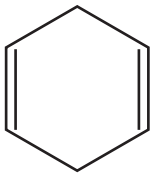
[Turn over

23 The complete combustion of alkanes to produce carbon dioxide and water is an important exothermic reaction.

Which line on the graph shows the relationship between the number of carbon atoms in the alkane and the number of moles of oxygen gas needed for complete combustion of the alkane?



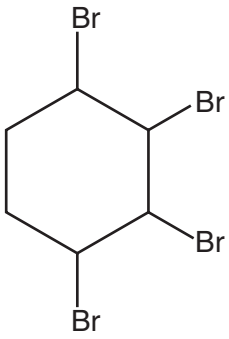
24 Cyclohexa-1,4–diene is treated with a solution of bromine in tetrachloromethane.



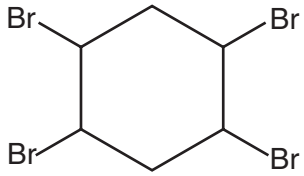
cyclohexa-1,4-diene

Which product is formed?

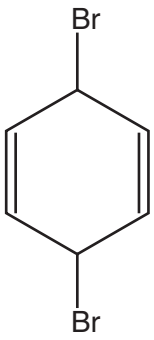
A



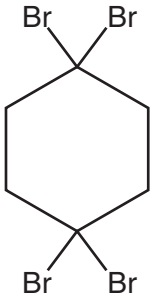
B



C



D



25 Which reaction is **not** an electrophilic addition?

A $CH_2{=}CH_2 + HI \longrightarrow CH_3CH_2I$

B $CH_3CH{=}CH_2 + Br_2 \longrightarrow CH_3CHBrCH_2Br$

C $CH_3CH{=}CH_2 + H_2O \xrightarrow{\text{conc } H_2SO_4} CH_3CH(OH)CH_3$

D $CH_3CHO + HCN \longrightarrow CH_3CH(OH)CN$

26 The reaction scheme outlines the production of one of the monomers of nylon 66 from compound **X**.

$$\text{compound } \mathbf{X} \xrightarrow[\text{in ethanol}]{\text{KCN}} NCCH_2CH_2CH_2CH_2CN \xrightarrow{\text{reduction}} H_2N(CH_2)_6NH_2$$

Which compound could be **X**?

A $BrCH_2CH_2CH_2CH_2Br$

B $CH_2{=}CHCH{=}CH_2$

C $HOCH_2CH_2CH_2CH_2OH$

D $HO_2CCH_2CH_2CH_2CH_2CO_2H$

27 Chlorofluoroalkanes, commonly known as CFCs, undergo homolytic fission by ultraviolet irradiation in the stratosphere.

Which radical could result from this irradiation of $CHFCl CF_2Cl$?

A $CHFCl\dot{C}FCl$

B $\dot{C}HCl CF_2Cl$

C $\dot{C}HFCF_2Cl$

D $\dot{C}FCl CF_2Cl$

28 In its reaction with sodium, 1 mol of a compound **X** gives 1 mol of $H_2(g)$.

Which compound might **X** be?

A $CH_3CH_2CH_2CH_2OH$

B $(CH_3)_3COH$

C $CH_3CH_2CH_2CO_2H$

D $CH_3CH(OH)CO_2H$

29 In a preparation of ethene, ethanol is added a drop at a time to a heated reagent **Y**. To purify the ethene it is bubbled through a solution **Z** and then collected.

What could reagent **Y** and solution **Z** be?

	reagent **Y**	solution **Z**
A	acidified $K_2Cr_2O_7$	dilute NaOH
B	concentrated H_2SO_4	dilute H_2SO_4
C	concentrated H_2SO_4	dilute NaOH
D	ethanolic NaOH	concentrated H_2SO_4

30 The product of the reaction between propanone and hydrogen cyanide is hydrolysed under acidic conditions.

What is the formula of the final product?

A $CH_3CH(OH)CO_2H$

B $CH_3CH_2CH_2CO_2H$

C $(CH_3)_2CHCONH_2$

D $(CH_3)_2C(OH)CO_2H$

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 Silicon tetrachloride, $SiCl_4$, is a liquid of low boiling point. In the presence of water it decomposes to form silicon(IV) oxide and hydrogen chloride.

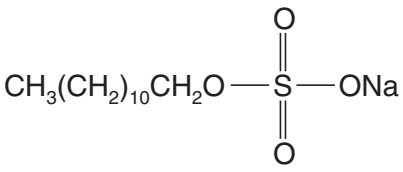
What types of bonding occur in $SiCl_4$(l)?

1 co–ordinate bonding

2 covalent bonding

3 van der Waals forces

32 Long-chain alkanes are converted on an industrial scale into alkylsulphates for use as detergents, e.g. sodium lauryl sulphate.



sodium lauryl sulphate

What deductions about the properties of this substance can be made from this structure?

1 Part of the structure is polar and is water–attracting.

2 The alkyl chain is soluble in oil droplets.

3 All the C-C-C bond angles are tetrahedral.

[Turn over

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 The conversion of graphite into diamond is an endothermic reaction ($\Delta H = +3\,\text{kJ mol}^{-1}$).

$$\text{C(graphite)} \rightarrow \text{C(diamond)}$$

Which statements are correct?

1 The enthalpy change of atomisation of diamond is smaller than that of graphite.

2 The bond energy of the C–C bonds in graphite is greater than that in diamond.

3 The enthalpy change of combustion of diamond is greater than that of graphite.

34 Which of the following statements are correct for the sequence of compounds below considered from left to right?

NaF MgO A*l*N SiC

1 The electronegativity difference between the elements in each compound increases.

2 The formula-units of these compounds are isoelectronic (have the same number of electrons).

3 The bonding becomes increasingly covalent.

35 Which statements are reasons why sulphur dioxide is used as a food preservative?

1 It is a reducing agent and therefore an anti-oxidant.

2 It prevents alcohols forming sour-tasting acids.

3 It does not smell and therefore can be used in more than trace quantities.

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 What will always be a characteristic of a compound containing a single carbon atom with four different groups bonded to it?

1 It will have an optical isomer.

2 It will have a chiral centre.

3 It will have a structural isomer.

38 Chloroethane can be formed from bromoethane in two steps.

$$C_2H_5Br \xrightarrow{\text{step } \mathbf{X}} C_2H_5OH \xrightarrow{\text{step } \mathbf{Y}} C_2H_5Cl$$

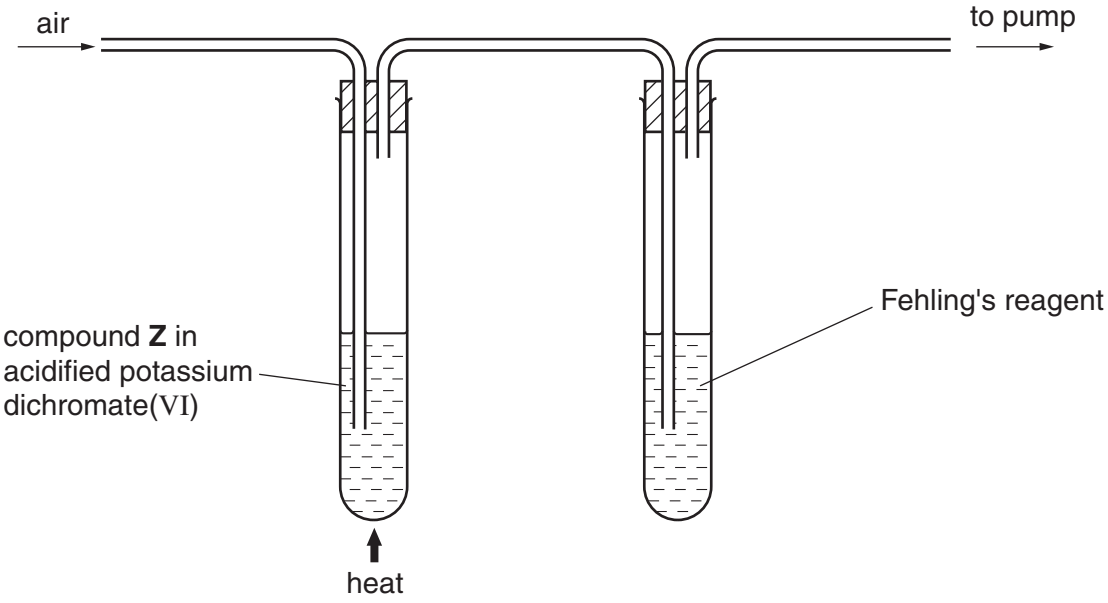
Which statements about these steps are correct?

1 Step **X** involves a nucleophilic substitution.

2 Hot aqueous sodium hydroxide is the reagent in step **X**.

3 Hot aqueous sodium chloride is the reagent in step **Y**.

39 When the apparatus below was used with compound **Z**, a brick-red precipitate formed in the right-hand tube.



Which compound could be **Z**?

1 $CH_3CH(OH)CH_3$ **2** $CH_3CH_2CH_2OH$ **3** CH_3OH

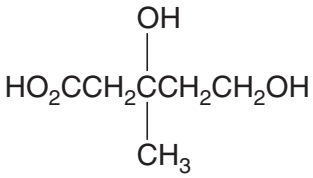
[Turn over

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 Mevalonic acid is an intermediate in the biosynthesis of cholesterol, and is shown below.



Which properties does mevalonic acid have?

1 It has only one chiral carbon atom.

2 It can be esterified both by ethanoic acid and by ethanol, in the presence of H^+ ions.

3 It contains both primary and secondary alcohol groups.

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