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

**CHEMISTRY** **9701/01**

Paper 1 Multiple Choice

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

Analytical chemists can detect very small amounts of amino acids, down to $3 \times 10^{-21}$ mol. How many molecules of an amino acid ($M_r$ = 200) would this be?

**A** 9 **B** 200 **C** 1800 **D** 360 000

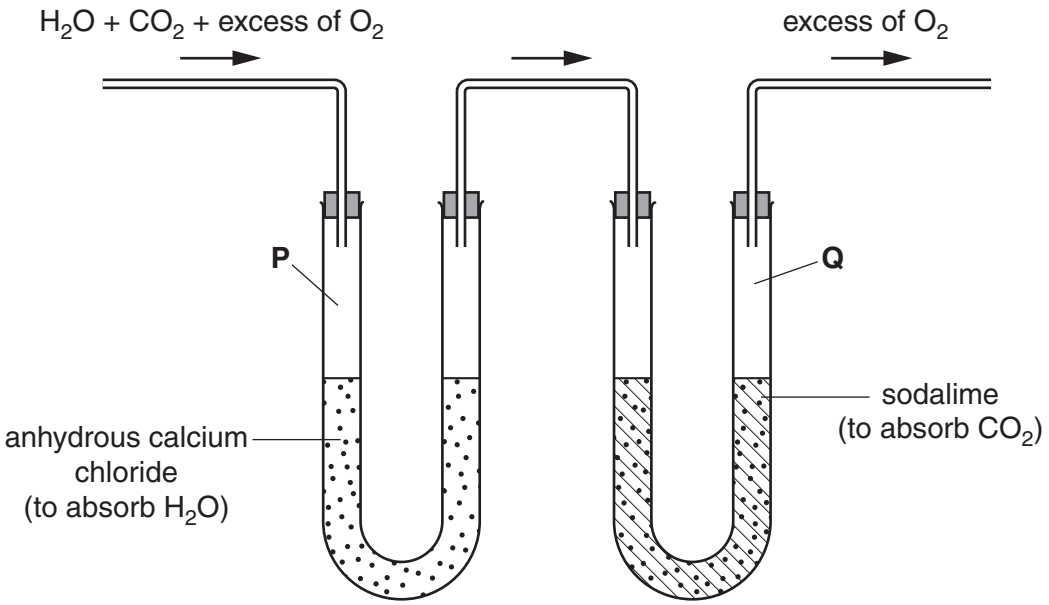
**2** *Use of the Data Booklet is relevant to this question.*

A garden fertiliser is said to have a phosphorus content of 30.0% '$P_2O_5$ soluble in water'.

What is the percentage by mass of phosphorus in the fertiliser?

**A** 6.55% **B** 13.1% **C** 26.2% **D** 30.0%

**3** A sample of the hydrocarbon $C_6H_{12}$ is completely burned in dry oxygen and the product gases are collected as shown.
[$A_r$ : H, 1 ; C, 12 ; O, 16.]




The increases in mass of the collecting vessels **P** and **Q** of the apparatus are $M_P$ and $M_Q$, respectively.

What is the ratio $M_P$ / $M_Q$?

**A** 0.41 **B** 0.82 **C** 1.2 **D** 2.4

**4** Unnilpentium is an artificial element. One of its isotopes is $^{262}_{105}$Unp.

Which of the following statements is correct?

**A** $^{262}_{105}$Unp has a nucleon number of 105.

**B** The atom $^{260}_{105}$X is an isotope of $^{262}_{105}$Unp.

**C** There are 262 neutrons in $^{262}_{105}$Unp.

**D** The proton number of $^{262}_{105}$Unp is 262.

**5** The table gives the successive ionisation energies for an element *X*.

| | 1st | 2nd | 3rd | 4th | 5th | 6th |
|---|---|---|---|---|---|---|
| ionisation energy / kJ mol$^{-1}$ | 950 | 1800 | 2700 | 4800 | 6000 | 12300 |

What could be the formula of the chloride of *X*?

**A** *XCl* **B** $XCl_2$ **C** $XCl_3$ **D** $XCl_4$

**6** Which molecule contains only six bonding electrons?

**A** $C_2H_4$ **B** $C_2F_6$ **C** $H_2O$ **D** $NF_3$

**7** Chemists have been interested in the properties of hydrogen selenide, $H_2Se$, to compare it with 'bad egg' gas hydrogen sulphide, $H_2S$.

Which set of data would the hydrogen selenide molecule be expected to have?

| | number of lone pairs on Se atom | bond angle |
|---|---|---|
| **A** | 1 | 104° |
| **B** | 2 | 104° |
| **C** | 2 | 109° |
| **D** | 2 | 180° |



**[Turn over**

**8** A substance commonly found in the house or garden has the following properties.

- It is combustible.
- It is an electrical insulator.
- It melts over a range of temperature.

What could the substance be?

**A** brass

**B** paper

**C** poly(ethene)

**D** silicon(IV) oxide

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

In an experiment using a gas syringe, 0.10 g of a gas is found to occupy 83.1 $cm^3$, measured at standard pressure ($1.0 \times 10^5$ Pa) and 27 °C.

What is the relative molecular mass of the gas?

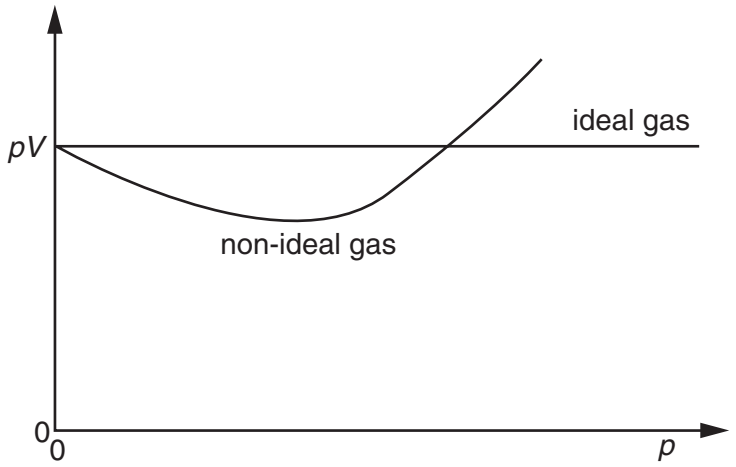
**A** $\dfrac{0.10 \times 8.31 \times 27}{1.0 \times 10^5 \times 83.1}$

**B** $\dfrac{0.10 \times 8.31 \times 300}{1.0 \times 10^5 \times 83.1}$

**C** $\dfrac{0.10 \times 8.31 \times 27}{1.0 \times 10^5 \times 83.1 \times 10^{-6}}$

**D** $\dfrac{0.10 \times 8.31 \times 300}{1.0 \times 10^5 \times 83.1 \times 10^{-6}}$

**10** The value of $pV$ is plotted against $p$ for two gases, an ideal gas and a non-ideal gas, where $p$ is the pressure and $V$ is the volume of the gas.




Which of the following gases shows the greatest deviation from ideality?

**A** ammonia

**B** ethene

**C** methane

**D** nitrogen

**11** The 'flash' produced by nineteenth century photographers to take indoor photographs was obtained from the following reaction.

$$3Mg + KClO_3 \longrightarrow 3MgO + KCl$$

The standard enthalpy changes of formation are given below.

| | $\Delta H_f^{\ominus}$ / kJ mol$^{-1}$ |
|---|---|
| MgO | –602 |
| KCl | –437 |
| $KClO_3$ | –391 |

What is the standard enthalpy change of the 'flash' reaction?

**A** –3(–602) + (–437) – (–391)

**B** (–602) + (–437) – (–391)

**C** 3(–602) + (–437) – (–391)

**D** (–602) + 3(–437) – 3(–391)



**[Turn over**

**12** Why does the exothermic reaction

$$C(\text{diamond}) \longrightarrow C(\text{graphite}) \qquad \Delta H = -3\,\text{kJ mol}^{-1}$$

**not** occur spontaneously?

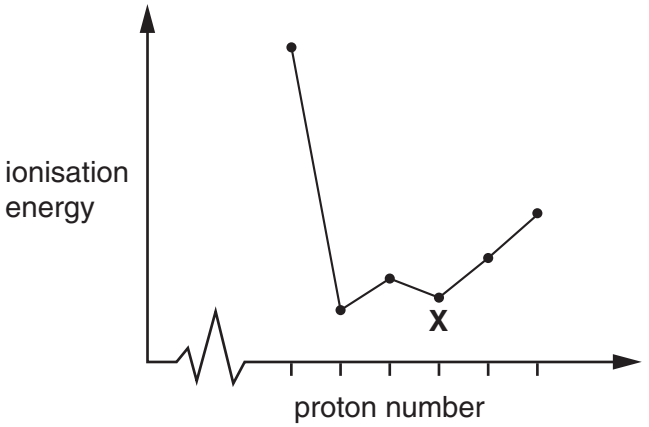
**A** A tetrahedral configuration is always more stable than a planar one.

**B** Diamond has only strong covalent bonds whereas graphite has both covalent bonds and van der Waals' forces.

**C** The change from diamond to graphite has a high activation energy.

**D** The density of graphite is less than that of diamond.

**13** The sketch below shows the variation of first ionisation energy with proton number for six elements of consecutive proton numbers between 1 and 18 (H to Ar).




What is the identity of the element **X**?

**A** Mg **B** A*l* **C** Si **D** P

**14** The metals of Group II react readily with oxygen to form compounds of general formula *M*O.

When each of these oxides is added to water, which forms the most alkaline solution?

**A** MgO **B** CaO **C** SrO **D** BaO

**15** One mole of each of the following compounds is strongly heated and any gas produced is collected at room temperature and pressure.

From which compound is 24 $dm^3$ of gas likely to be collected?
[One mole of any gas occupies 24 $dm^3$ at room temperature and pressure.]

**A** $MgCl_2$ **B** $MgCO_3$ **C** $Mg(NO_3)_2$ **D** $Mg(OH)_2$

**16** In black and white photographic film, light converts silver chloride into metallic silver. After the film has been developed, the unexposed silver chloride is removed by reaction with sodium thiosulphate to produce a 'fixed' negative.

$$AgCl + 2Na_2S_2O_3 \longrightarrow 4Na^+ + Cl^- + [Ag(S_2O_3)_2]^{3-}$$

What is the function of thiosulphate?

**A** to make the silver ions soluble

**B** to oxidise the silver ions

**C** to oxidise the silver metal

**D** to reduce silver ions

**17** In what order does the reducing power of the hydrogen halides increase?

**A** HCl, HBr, HI

**B** HCl, HI, HBr

**C** HBr, HI, HCl

**D** HI, HBr, HCl

**18** In a solution of ammonia in water, what combination of ionic and molecular forms of ammonia are present?

**A** ions only

**B** ions and simple molecules only

**C** simple molecules and hydrogen-bonded molecules only

**D** simple molecules, hydrogen–bonded molecules and ions

**19** Nitrogen is frequently used as an inert atmosphere because it is an unreactive gas.

Which is the best explanation of this unreactivity?

**A** Its molecule contains a triple bond.

**B** The bond energy of the molecule is high (994 kJ $mol^{-1}$).

**C** The bond in its molecule is very short (0.110 nm).

**D** The three p orbitals of nitrogen are half-filled.

**20** How many alcohols (including both structural isomers and stereoisomers) can have the molecular formula $C_4H_{10}O$?

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



**[Turn over**

**21** Hydrogen bromide reacts with ethene to form bromoethane.

What is the best description of the organic intermediate in this reaction?

**A** It contains carbon, hydrogen and bromine.

**B** It has a negative charge.

**C** It is an electrophile.

**D** It is a free radical.

**22** On strong heating a hydrocarbon produces ethene, propane and but-1-ene in the mole ratio 5 : 1 : 1.

What is the molecular formula of the hydrocarbon?

**A** $C_{17}H_{34}$ **B** $C_{17}H_{36}$ **C** $C_{19}H_{38}$ **D** $C_{19}H_{40}$

**23** 1,2-Dibromo-3-chloropropane (DBCP) has been used in the control of earthworms in agricultural land.

What would be the best synthesis of this compound?

**A** $CH_3CH_2CH_2Cl + 2Br_2 \rightarrow DBCP + 2HBr$

**B** $CH_3CHBrCH_2Br + Cl_2 \rightarrow DBCP + HCl$

**C** $CH_2{=}CHCH_2Cl + Br_2 \rightarrow DBCP$

**D** $ClCH_2CH{=}CH_2 + PBr_5 \rightarrow DBCP + PBr_3$

**24** Each of the following compounds is effective as a refrigerant.

The release of which one of these causes the greatest depletion of the ozone layer?

**A** $CCl_2F_2$ **B** $CH_3OCH_3$ **C** $CH_3CHF_2$ **D** $CH_3CH_2CH_3$

**25** 1,1-Dichloropropane reacts with aqueous sodium hydroxide in a series of steps to give propanal.

$$CH_3CH_2CHCl_2 \xrightarrow{NaOH(aq)} CH_3CH_2CHO$$

What is the mechanism of the first step of this reaction?

**A** electrophilic substitution

**B** elimination

**C** nucleophilic substitution

**D** oxidation

**26** Which alcohol gives only **one** oxidation product when warmed with dilute acidified potassium dichromate(VI)?

**A** butan-1-ol

**B** butan-2-ol

**C** 2-methylpropan-1-ol

**D** 2-methylpropan-2-ol

**27** What will react differently with the two isomeric pentanols, $(CH_3)_3CCH_2OH$ and $(CH_3)_2CHCH_2CH_2OH$?

**A** acidified aqueous potassium manganate(VII)

**B** concentrated sulphuric acid

**C** phosphorus pentachloride

**D** sodium

**28** How many hydrogen atoms in a molecule of glycerol, $HOCH_2CH(OH)CH_2OH$, may be substituted by deuterium on dissolving it in an excess of $D_2O$?

**A** 2 **B** 3 **C** 5 **D** 8

**29** $CH_3CH_2COCH_2CH_3$ reacts with hydrogen cyanide to form a cyanohydrin.

Which features apply to the product?

**A** It has one chiral centre.

**B** It is formed by electrophilic addition.

**C** It is formed via a C–OH intermediate.

**D** Its formation requires the use of cyanide ions as a catalyst.



**[Turn over**

**30** A compound **X** has all of the properties below.

- It is a liquid at 25 °C.
- It mixes completely with water.
- It reacts with aqueous sodium hydroxide.

What could **X** be?

**A** ethanoic acid

**B** ethanol

**C** ethene

**D** ethyl ethanoate

## 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** It is suggested that the solid deposits of ammonium compounds on the leaves of trees found in areas of high pollution are caused by the following reaction.

$$2NH_3 + SO_3 + H_2O \rightarrow (NH_4)_2SO_4$$

Which of these take place in this reaction?

**1** an acid-base reaction

**2** ionic bond formation

**3** oxidation and reduction

**32** One explanation of the explosion at the Chernobyl nuclear power plant in 1986 is that the graphite reactor overheated and reacted with the cooling water according to the following equation.

$$C(s) + H_2O(g) \rightleftharpoons H_2(g) + CO(g) \qquad \Delta H = +131\ kJ\ mol^{-1}$$

What are possible reasons why the forward reaction is more likely to occur at high temperature?

**1** Hydrogen and carbon monoxide do not react at high temperature.

**2** At lower temperature, the position of equilibrium lies too far to the left.

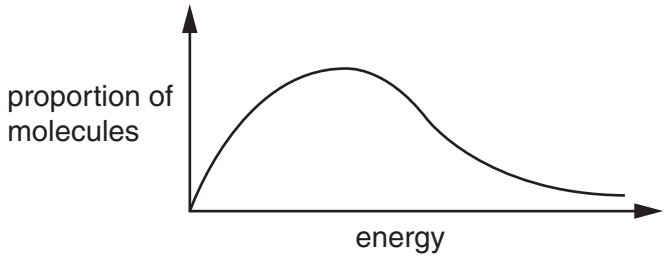
**3** The energy of activation is high.

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** The diagram represents the Boltzmann distribution of molecular energies at a given temperature.




As temperature increases, which statements are correct?

**1** The maximum of the curve is displaced to the right.

**2** The proportion of molecules with energies **above** any given value increases.

**3** The proportion of molecules **with** any given energy increases.

**34** Which statements concerning the third period elements (sodium to argon) and their compounds are correct?

**1** The elements become more electronegative from sodium to chlorine.

**2** Aluminium oxide is the only oxide which is insoluble in water.

**3** The maximum oxidation state is shown by silicon.

**35** A farmer spreads lime on land which has already been treated with a nitrogenous fertiliser.

Which reactions will occur over a period of time?

**1** $Ca(OH)_2 + CO_2 \longrightarrow CaCO_3 + H_2O$

**2** $Ca(OH)_2 + 2H^+(aq) \longrightarrow Ca^{2+}(aq) + 2H_2O$

**3** $Ca(OH)_2 + 2NH_4^+(aq) \longrightarrow Ca^{2+}(aq) + 2NH_3 + 2H_2O$

**36** Which processes involve the conversion of sulphur dioxide into sulphur trioxide?

**1** the combustion of sulphur contaminated carbonaceous fuels

**2** the Contact process for manufacturing sulphuric acid

**3** the catalytic oxidation of sulphur dioxide by oxides of nitrogen

**37** Which molecules would be present in the photochemical chlorination of methane?

**1** hydrogen

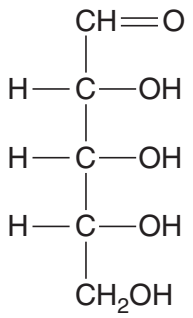
**2** hydrogen chloride

**3** dichloromethane

**38** The taste buds on the tongue are chiral and can distinguish one optical isomer from another.

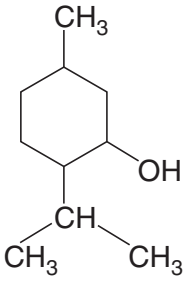
Which naturally-occurring compounds will have optical isomers that may be distinguished by taste?

**1**



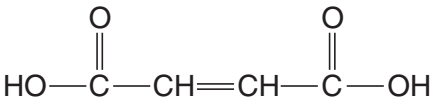
ribose

**2**



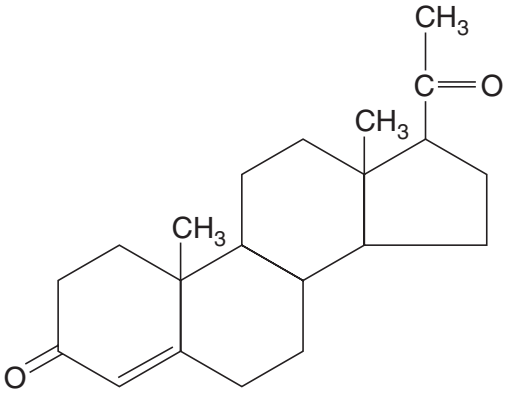
menthol

**3**



maleic acid

**39** The compound shown is a hormone produced during pregnancy to suppress ovulation.



Which reagents would give positive results with this compound?

**1** aqueous bromine

**2** 2,4-dinitrophenylhydrazine

**3** Fehling's reagent



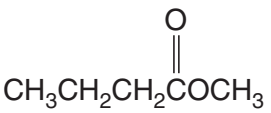
**[Turn over**

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** The flavour of pineapples is partly due to the compound **Q**.



**Q**

When **Q** is heated under reflux with NaOH(aq) and the mixture distilled, what compounds will be found in the distillate?

**1** $CH_3OH$

**2** $CH_3CH_2CH_2CO_2Na$

**3** $CH_3CH_2CH_2OH$

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