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

**CHEMISTRY** **9701/12**

Paper 1 Multiple Choice **May/June 2012**

**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.**

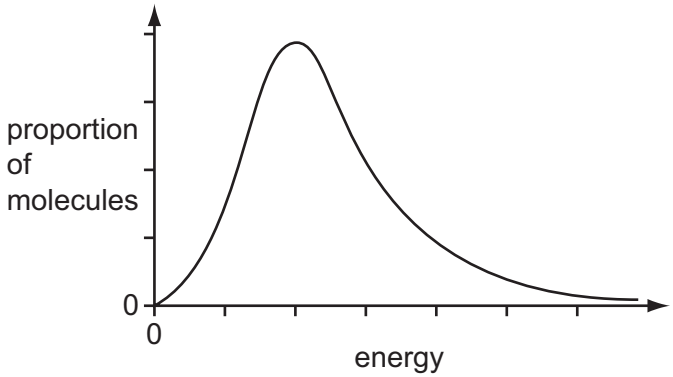
Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.

This document consists of **14** printed pages and **2** blank pages.

## Section A

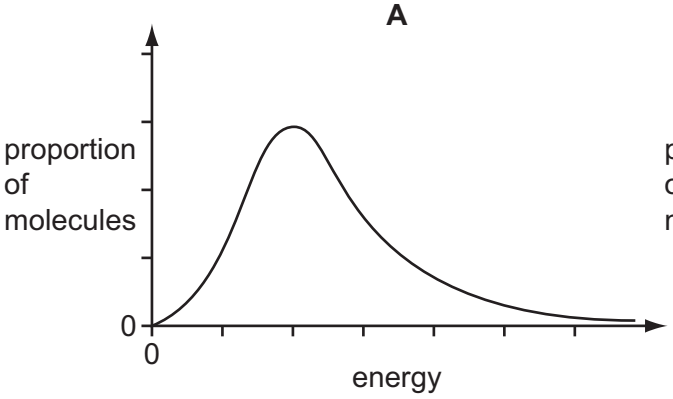
For each question there are four possible answers, **A**, **B**, **C**, and **D**. Choose the **one** you consider to be correct.

**1** The molecular energy distribution curve represents the variation in energy of the molecules of a gas at room temperature.




Which curve applies for the same gas at a lower temperature?

**A**

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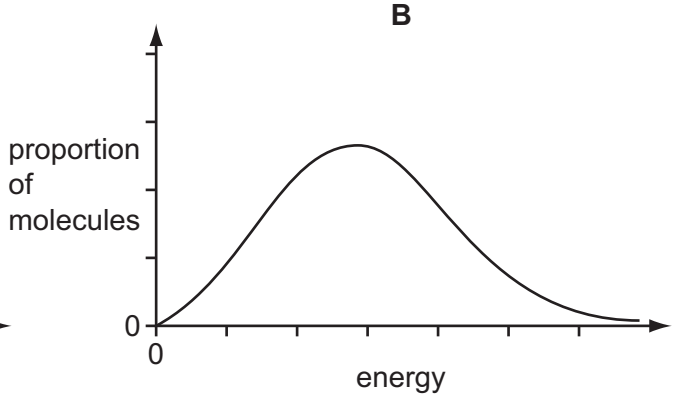
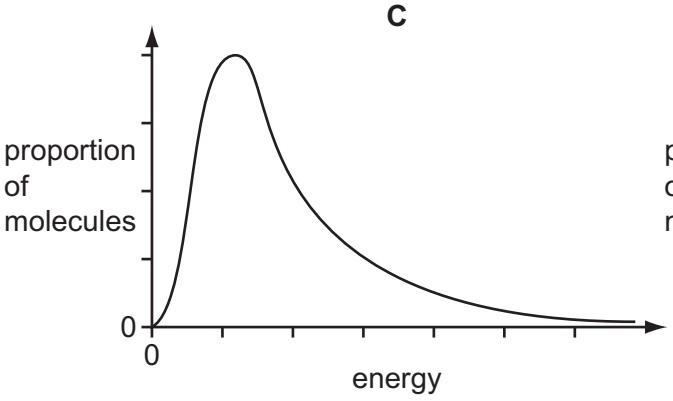
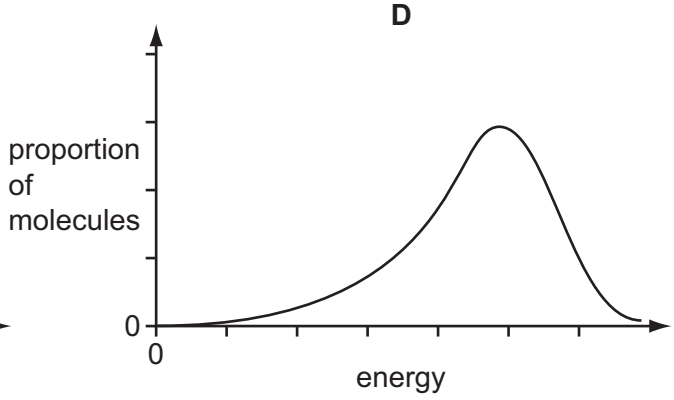



**C**




**D**

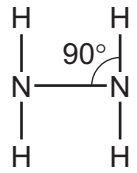



**2** In which species are the numbers of protons, neutrons and electrons all different?

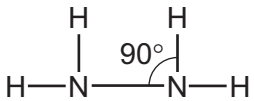
**A** $^{11}_{5}B$ **B** $^{19}_{9}F^{-}$ **C** $^{23}_{11}Na^{+}$ **D** $^{24}_{12}Mg^{2+}$

**3** What is the **most** likely shape of a molecule of hydrazine, $N_2H_4$?

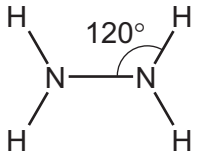
**A**



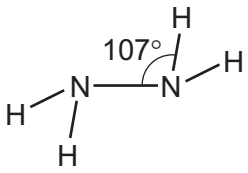

**B**




**C**




**D**




**4** In which species does the underlined atom have an incomplete outer shell?

**A** $\underline{Al}_2Cl_6$ **B** $\underline{C}H_3^+$ **C** $Cl_2\underline{O}$ **D** $H_2\underline{Cl}C\bullet$

**5** Which solid contains more than one kind of bonding?

**A** iodine

**B** silicon dioxide

**C** sodium chloride

**D** zinc

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

The gas laws can be summarised in the ideal gas equation.

$$pV = nRT$$

0.96 g of oxygen gas is contained in a glass vessel of volume 7000 $cm^3$ at a temperature of 30 °C.

What is the pressure in the vessel?

**A** 1.1 kPa **B** 2.1 kPa **C** 10.8 kPa **D** 21.6 kPa

**7** Two moles of compound P were placed in a vessel. The vessel was heated and compound P was partly decomposed to produce Q and R. A dynamic equilibrium between chemicals P, Q and R was established.

At equilibrium $x$ moles of R were present and the total number of moles present was $(2 + \frac{x}{2})$.

What is the equation for this equilibrium reaction?

**A** $P \rightleftharpoons 2Q + R$

**B** $2P \rightleftharpoons 2Q + R$

**C** $2P \rightleftharpoons Q + R$

**D** $2P \rightleftharpoons Q + 2R$





[Turn over

**8** The value of the third ionisation energy of aluminium is 2740 kJ mol$^{-1}$.

Which correctly represents this statement?

**A** $Al(g) \rightarrow Al^{3+}(g) + 3e^-$ $\Delta H^\ominus = -2740\,kJ\,mol^{-1}$

**B** $Al^{2+}(g) \rightarrow Al^{3+}(g) + e^-$ $\Delta H^\ominus = -2740\,kJ\,mol^{-1}$

**C** $Al(g) \rightarrow Al^{3+}(g) + 3e^-$ $\Delta H^\ominus = +2740\,kJ\,mol^{-1}$

**D** $Al^{2+}(g) \rightarrow Al^{3+}(g) + e^-$ $\Delta H^\ominus = +2740\,kJ\,mol^{-1}$

**9** Methanol is manufactured by reacting carbon dioxide and hydrogen.

$$CO_2(g) + 3H_2(g) \rightleftharpoons CH_3OH(g) + H_2O(g) \qquad \Delta H = -49\,kJ\,mol^{-1}$$

What would increase the equilibrium yield of methanol in this process?

**A** adding a catalyst

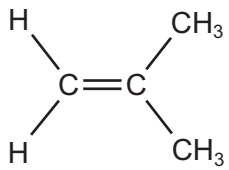
**B** adding an excess of steam

**C** increasing the pressure

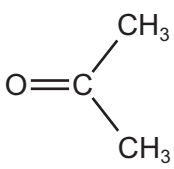
**D** increasing the temperature

**10** Which molecule has the largest overall dipole?

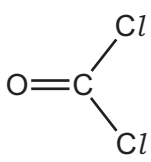
**A**



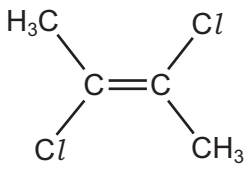
**B**



**C**



**D**



**11** In which substance does nitrogen exhibit the highest oxidation state?

**A** NO **B** $N_2O$ **C** $N_2O_4$ **D** $NaNO_2$

**12** Red lead oxide, $Pb_3O_4$, is used in metal priming paints. It can be made by heating PbO in air.

$$6PbO(s) + O_2(g) \rightarrow 2Pb_3O_4(s)$$

Which two values are needed to calculate the enthalpy change for this reaction?

**A** enthalpy change of atomisation of $O_2$ and enthalpy change of formation of $Pb_3O_4$

**B** enthalpy change of formation of $O_2$ and enthalpy change of formation of $Pb_3O_4$

**C** enthalpy change of formation of PbO and enthalpy change of atomisation of $O_2$

**D** enthalpy change of formation of PbO and enthalpy change of formation of $Pb_3O_4$

**13** Which gas is present in the exhaust fumes of a car engine in a much greater amount than any other gas?

**A** carbon dioxide

**B** carbon monoxide

**C** nitrogen

**D** water vapour

**14** Slaked lime, $Ca(OH)_2$, may be made from limestone, $CaCO_3$.

On heating in a lime kiln at 1000 °C, limestone decomposes as follows.

reaction 1 $CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$

Water is then reacted with calcium oxide, CaO, as follows.

reaction 2 $CaO(s) + H_2O(l) \rightarrow Ca(OH)_2(s)$

What are the enthalpy changes of these reactions?

| | reaction 1 | reaction 2 |
|---|---|---|
| **A** | endothermic | endothermic |
| **B** | endothermic | exothermic |
| **C** | exothermic | endothermic |
| **D** | exothermic | exothermic |

**15** The period 4 elements gallium (Ga), germanium (Ge), arsenic (As) and selenium (Se) are the elements below aluminium, silicon, phosphorus and sulfur in the Periodic Table, a portion of which is shown below.

| | | | | |
|---|---|---|---|---|
| period 3 elements | Al | Si | P | S |
| period 4 elements | Ga | Ge | As | Se |

The properties of each period 4 element resemble those of the period 3 element directly above it.

Which period 4 elements form oxides that dissolve in water to give an acid solution?

**A** As and Se **B** Ga and Ge **C** Ga and Se **D** Se only





[Turn over

**16** Chlorine shows oxidation states ranging from –1 to +7 in its compounds.

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** What can be seen when a piece of magnesium ribbon is placed in cold water?

**A** A vigorous effervescence occurs.

**B** Bubbles of gas form slowly on the magnesium.

**C** The magnesium floats on the surface of the water and reacts quickly.

**D** The magnesium glows and a white solid is produced.

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

Sodium and sulfur react together to form sodium sulfide, $Na_2S$.

How do the atomic radius and ionic radius of sodium compare with those of sulfur?

| | atomic radius | ionic radius |
|---|---|---|
| **A** | sodium > sulfur | sodium > sulfur |
| **B** | sodium > sulfur | sodium < sulfur |
| **C** | sodium < sulfur | sodium > sulfur |
| **D** | sodium < sulfur | sodium < sulfur |

**19** Which substance does **not** produce a poisonous gas, when burnt in a limited amount of air?

**A** hydrogen

**B** methane

**C** propene

**D** sulfur

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

A sample of propyl ethanoate is hydrolysed by heating under reflux with aqueous sodium hydroxide. The two organic products of the hydrolysis are separated, purified and weighed.

Out of the total mass of products obtained, what is the percentage by mass of each product?

**A** 32.4 % and 67.6 %

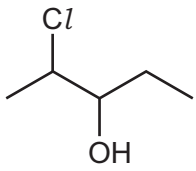
**B** 38.3 % and 61.7 %

**C** 42.3 % and 57.7 %

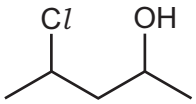
**D** 50.0 % and 50.0 %

**21** Which diagram gives the skeletal formula of 2-chloropentan-3-ol?

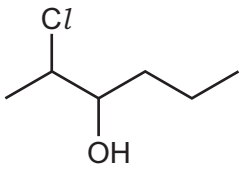
**A**



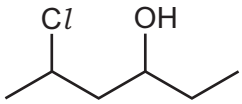

**B**




**C**




**D**

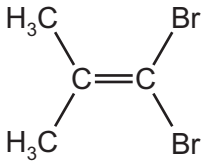



**22** When 1-bromopropane is treated in succession with two reagents, X and Y, it produces propanoic acid.

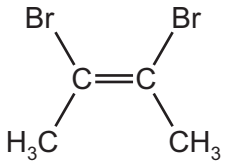
What are reagents X and Y?

| | X | Y |
|---|---|---|
| **A** | NaOH(aq) | $H^+ / Cr_2O_7^{2-}$(aq) |
| **B** | NaOH(aq) | $CO_2$ |
| **C** | KCN in ethanol | HCl(aq) |
| **D** | KCN in ethanol | NaOH(aq) |

**23** Isomers **X** and **Y** both react with HBr.



**X**



**Y**

A mixture of **X** and **Y** is reacted with HBr.

Which three structures represent three **different** possible products of this reaction?

| | | | |
|---|---|---|---|
| **A** | $(CH_3)_2CHCBr_3$ | $(CH_3)_2CBrCHBr_2$ | $CH_3CHBrCHBrCH_3$ |
| **B** | $(CH_3)_2CHCBr_3$ | $(CH_3)_2CBrCHBr_2$ | $CH_3CBr_2CHBrCH_3$ |
| **C** | $(CH_3)_2CBrCBr_3$ | $(CH_3)_2CHCBr_3$ | $CH_3CBr_2CHBrCH_3$ |
| **D** | $(CH_3)_2CBrCHBr_2$ | $CHBr_2CBr(CH_3)CH_3$ | $CH_3CHBrCBr_2CH_3$ |

**24** Oct-1-ene, $CH_3(CH_2)_5CH{=}CH_2$, is subjected to thermal cracking.

Which combination of compounds W, X, Y and Z can be obtained?

| $CH_2{=}CH_2$ | $CH_3CH{=}CH_2$ | $CH_3CH_2CH_3$ | $CH_2{=}CHCH{=}CH_2$ |
|---|---|---|---|
| W | X | Y | Z |

**A** W, X, Y and Z

**B** W, X and Y only

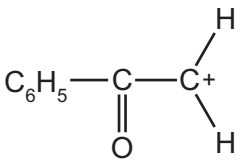
**C** W, X and Z only

**D** W and X only

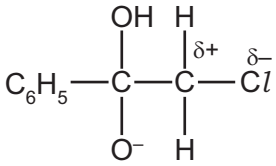
**25** When phenacyl chloride, $C_6H_5COCH_2Cl$, is reacted with aqueous NaOH, the substitution reaction follows an $S_N2$ mechanism.

Which structure represents a species formed during the reaction?

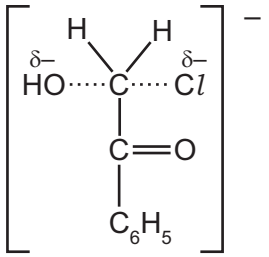
**A**



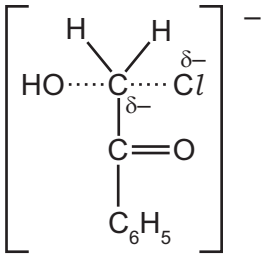
**B**



**C**



**D**



**26** Complete combustion of compound X gives carbon dioxide and water only. A sample of X is mixed with aqueous potassium(V) dichromate and boiled under reflux for one hour. The mixture is then distilled and the only organic substance present is collected.

The organic substance collected reacts with sodium to give hydrogen, but does not react with 2,4-dinitrophenylhydrazine reagent and does not react with ethanol in the presence of concentrated sulfuric acid to give an ester.

What can be deduced from this information?

**A** X is a carboxylic acid.

**B** X is a ketone.

**C** X is an alcohol.

**D** X is an alkane.





[Turn over

**27** A compound **Y** has the following properties.

- It is a liquid at room temperature and atmospheric pressure.
- It does not mix completely with water.
- It does not give steamy fumes with $PCl_5$.

What could **Y** be?

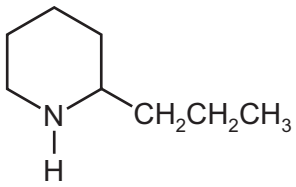
**A** ethane

**B** ethanoic acid

**C** ethanol

**D** ethyl ethanoate

**28** Coniine is the major constituent of the poison 'oil of hemlock'.




coniine

Coniine can be synthesised by reacting ammonia with a dibromo compound, **X**.

$$NH_3 + C_8H_{16}Br_2 \rightarrow \text{coniine} + 2HBr$$

**X**

What is the name of compound **X**?

**A** 1,1-dibromo-2-propylcyclopentane

**B** 1,2-dibromo-2-propylcyclopentane

**C** 1,4-dibromooctane

**D** 1,5-dibromooctane

**29** A common industrial solvent is a mixture of propanone, $CH_3COCH_3$, and pentyl ethanoate $CH_3CO_2(CH_2)_4CH_3$.

Which reagent would have **no** reaction with this industrial solvent?

**A** $HCl$(aq)

**B** HCN(aq) with a little KCN

**C** Na(s)

**D** $NaBH_4$

**30** An organic compound will decolorise dilute acidified aqueous potassium manganate(VII) on warming, but will not decolorise bromine water.

What could the organic compound be?

**A** butane

**B** ethanol

**C** ethene

**D** ethanoic acid





**[Turn over**

## 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** Which of the following molecules and ions have a regular trigonal planar shape?

**1** $BF_3$

**2** $CH_3^+$

**3** $AlCl_3$

**32** Ammonia and chlorine react in the gas phase.

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

Which statements are correct?

**1** Each nitrogen atom is oxidised.

**2** Each chlorine atom is reduced.

**3** Ammonia behaves as a base.

**33** Concentrated sulfuric acid behaves as a strong acid when it reacts with water.

$$H_2SO_4(l) + aq \rightarrow H^+(aq) + HSO_4^-(aq)$$

The $HSO_4^-$ ion formed behaves as a weak acid.

$$HSO_4^-(aq) \rightleftharpoons H^+(aq) + SO_4^{2-}(aq)$$

Which statements are true for 1.0 mol $dm^{-3}$ sulfuric acid?

**1** $[H^+(aq)]$ is high

**2** $[SO_4^{2-}(aq)]$ is high

**3** $[HSO_4^-(aq)] = [SO_4^{2-}(aq)]$

**34** Silver chloride dissolves in aqueous ammonia.

What happens in this process?

**1** A co-ordinate bond is formed.

**2** The oxidation number of nitrogen is unchanged.

**3** Ammonia acts as a Brønsted-Lowry base.

**35** Compared with the HC*l* molecule, the bond ……**X**…… of the HBr molecule is ……**Y**……

Which pairs of words correctly complete the above sentence?

| | **X** | **Y** |
|---|---|---|
| **1** | energy | less |
| **2** | polarity | less |
| **3** | length | greater |

**36** Which statements are true about the Haber process for the manufacture of ammonia?

**1** At higher temperatures, the yield goes down but the rate of production of ammonia is faster.

**2** At higher pressures, the yield goes down but the rate of production of ammonia is faster.

**3** In the presence of a catalyst, the yield goes down but the rate of production of ammonia is faster.

**37** Which compounds can be obtained from propene in a **single** reaction?

**1** $CH_2OHCHOHCH_3$

**2** $(CH_2CH(CH_3))_n$

**3** $CH_2BrCH_2CH_2Br$

**38** What are the same for a pair of optical isomers?

**1** their empirical formula

**2** their functional groups

**3** their structural formula

**39** Which statements about the photochemical chlorination of ethane are correct?

**1** Hydrogen gas is one of the products.

**2** A propagation step in the mechanism is $C_2H_6 + Cl\bullet \rightarrow C_2H_5\bullet + HCl$.

**3** The initiation step is the homolytic fission of chlorine.





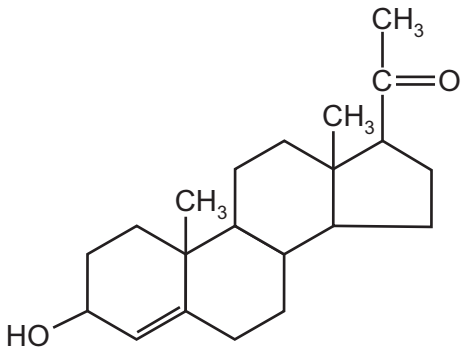
[Turn over

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 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

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