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

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

Paper 1 Multiple Choice **October/November 2012**

**1 hour**

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

* 5 2 0 0 3 1 9 8 4 3 *

**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 **13** printed pages and **3** blank pages.


© UCLES 2012

## Section A

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

**1** In which reaction does an element undergo the largest change in oxidation state?

**A** $Cl_2 + 2OH^- \rightarrow OCl^- + Cl^- + H_2O$

**B** $3Cl_2 + 6OH^- \rightarrow ClO_3^- + 5Cl^- + 3H_2O$

**C** $Cr_2O_7^{2-} + 6Fe^{2+} + 14H^+ \rightarrow 2Cr^{3+} + 6Fe^{3+} + 7H_2O$

**D** $3MnO_4^{2-} + 4H^+ \rightarrow MnO_2 + 2MnO_4^- + 2H_2O$

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

The $^{68}Ge$ isotope is medically useful because it undergoes a natural radioactive process to give a gallium isotope, $^{68}Ga$, which can be used to detect tumours. This transformation of $^{68}Ge$ occurs when an electron enters the nucleus, changing a proton into a neutron.

Which statement about the composition of an atom of the $^{68}Ga$ isotope is correct?

**A** It has 4 electrons in its outer p subshell.

**B** It has 13 electrons in its outer shell.

**C** It has 37 neutrons.

**D** Its proton number is 32.

**3** Sodium borohydride, $NaBH_4$, and boron trifluoride, $BF_3$, are compounds of boron.

What are the shapes around boron in the borohydride ion and in boron trifluoride?

| | borohydride ion | boron trifluoride |
|---|---|---|
| **A** | square planar | pyramidal |
| **B** | square planar | trigonal planar |
| **C** | tetrahedral | pyramidal |
| **D** | tetrahedral | trigonal planar |

© UCLES 2012

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

A reaction which causes the presence of oxides of nitrogen in car exhausts is the formation of NO.

$$N_2 + O_2 \rightarrow 2NO \qquad \Delta H = +180\,kJ\,mol^{-1}$$

What is the bond energy in $kJ\,mol^{-1}$ of the bond between the atoms in NO?

**A** 655 **B** 835 **C** 1310 **D** 1670

**5** In the table below,

- '+' means that this type of standard enthalpy change can **only** have positive values,
- '–' means that this type of standard enthalpy change can **only** have negative values,
- '+/–' means that **either** positive **or** negative values are possible.

Which row is correct?

| | atomisation | formation | solution |
|---|---|---|---|
| **A** | + | + | +/– |
| **B** | + | +/– | +/– |
| **C** | – | +/– | – |
| **D** | – | – | + |

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

The volume of a sample of ammonia is measured at a temperature of 60 °C and a pressure of 103 kPa. The volume measured is $5.37 \times 10^{-3}\,m^3$.

What is the mass of the sample of ammonia, given to two significant figures?

**A** 0.00019 g **B** 0.0034 g **C** 0.19 g **D** 3.4 g

**7** Aluminium is extracted by the electrolysis of a molten mixture containing aluminium oxide. By a similar method, magnesium is extracted by the electrolysis of a molten mixture containing magnesium chloride.

Which statement about the extraction of magnesium is correct?

**A** Magnesium ions travel to the anode and are oxidised to magnesium metal.

**B** Magnesium ions travel to the anode and are reduced to magnesium metal.

**C** Magnesium ions travel to the cathode and are oxidised to magnesium metal.

**D** Magnesium ions travel to the cathode and are reduced to magnesium metal.

© UCLES 2012

**8** Some car paints contain small flakes of silica, $SiO_2$.

In the structure of solid $SiO_2$

- each silicon atom is bonded to **x** oxygen atoms,
- each oxygen atom is bonded to **y** silicon atoms,
- each bond is a **z** type bond.

What is the correct combination of **x**, **y** and **z** in this statement?

| | x | y | z |
|---|---|---|---|
| **A** | 2 | 1 | covalent |
| **B** | 2 | 1 | ionic |
| **C** | 4 | 2 | covalent |
| **D** | 4 | 2 | ionic |

**9** John Dalton's atomic theory, published in 1808, contained four predictions about atoms.

Which of his predictions is still considered to be correct?

**A** All atoms are very small in size.

**B** All the atoms of a particular element have the same mass.

**C** All the atoms of one element are different in mass from all the atoms of other elements.

**D** No atom can be split into simpler parts.

**10** A student calculated the standard enthalpy change of formation of ethane, $C_2H_6$, using a method based on standard enthalpy changes of combustion.

He used correct values for the standard enthalpy change of combustion of ethane ($-1560\ kJ\ mol^{-1}$) and hydrogen ($-286\ kJ\ mol^{-1}$) but he used an incorrect value for the standard enthalpy change of combustion of carbon. He then performed his calculation correctly. His final answer was $-158\ kJ\ mol^{-1}$.

What did he use for the standard enthalpy change of combustion of carbon?

**A** $-1432\ kJ\ mol^{-1}$

**B** $-860\ kJ\ mol^{-1}$

**C** $-430\ kJ\ mol^{-1}$

**D** $-272\ kJ\ mol^{-1}$

© UCLES 2012

**11** Which process could be used to calculate the bond energy for the covalent bond X-Y by dividing its $\Delta H$ by n?

**A** $XY_n(g) \rightarrow X(g) + nY(g)$

**B** $2XY_n(g) \rightarrow 2XY_{n-1}(g) + Y_2(g)$

**C** $Y(g) + XY_{n-1}(g) \rightarrow XY_n(g)$

**D** $nXY(g) \rightarrow nX(g) + \frac{n}{2}Y_2(g)$

**12** In which pair do the molecules have the same shape as each other?

**A** $H_2O$ and $CO_2$

**B** $H_2O$ and $SCl_2$

**C** $NH_3$ and $BH_3$

**D** $SCl_2$ and $BeCl_2$

**13** Why is the ionic radius of a chloride ion larger than the ionic radius of a sodium ion?

**A** A chloride ion has one more occupied electron shell than a sodium ion.

**B** Chlorine has a higher proton number than sodium.

**C** Ionic radius increases regularly across the third period.

**D** Sodium is a metal, chlorine is a non-metal.

**14** What are the trends in the stated properties as Group II is descended from magnesium to barium?

| | decomposition temperature of the carbonate | first ionisation energy |
|---|---|---|
| **A** | decreases | decreases |
| **B** | decreases | increases |
| **C** | increases | decreases |
| **D** | increases | increases |

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

The nitrates of beryllium, calcium, magnesium, and strontium all decompose in the same way when heated. When 2.00 g of one of these anhydrous nitrates is decomposed, 1.32 g of gas is produced.

What is the nitrate?

**A** beryllium nitrate

**B** calcium nitrate

**C** magnesium nitrate

**D** strontium nitrate

**16** In a car engine, non-metallic element *X* forms a pollutant oxide *Y*. *Y* can be further oxidised to *Z*. Two students made the following statements.

| | |
|---|---|
| Student P | The molecule of *Y* contains lone pairs of electrons. |
| Student Q | The oxidation number of *X* increases by 1 from *Y* to *Z*. |

*X* could be carbon or nitrogen or sulfur.

Which student could be correct if *X* were any of these elements?

**A** P only

**B** Q only

**C** both P and Q

**D** neither P nor Q

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

1.15 g of a metallic element reacts with 300 $cm^3$ of oxygen at 298 K and 1 atm pressure, to form an oxide which contains $O^{2-}$ ions.

What could be the identity of the metal?

**A** calcium

**B** magnesium

**C** potassium

**D** sodium

© UCLES 2012

**18** Elements **X** and **Y** are both in period three.

When the chloride of **X** is added to water, it reacts and a solution of pH 2 is produced.

When the chloride of **Y** is added to water, it dissolves and a solution of pH 7 is produced.

Which statement explains these observations?

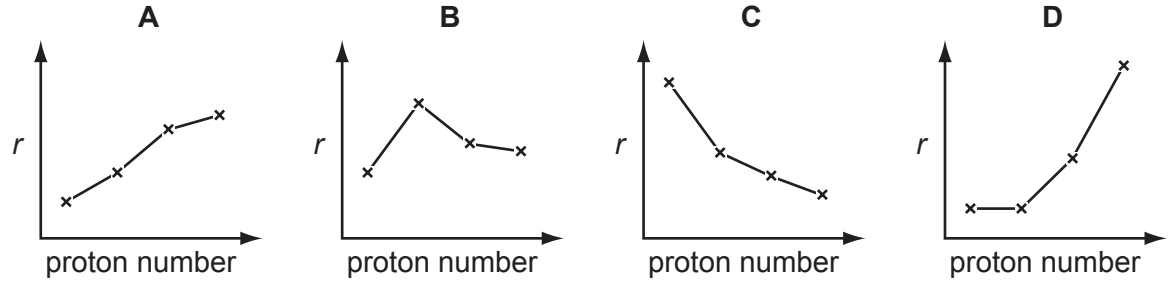
**A** Both chlorides hydrolyse in water.

**B** **X** is phosphorus and **Y** is aluminium.

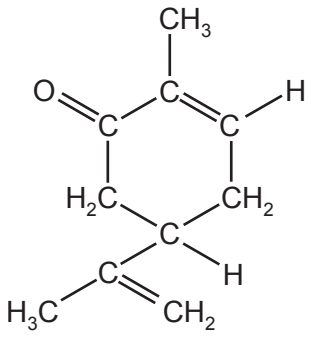
**C** **X** is silicon and **Y** is sodium.

**D** **X** is sodium and **Y** is phosphorus.

**19** Which diagram shows the variation of the metallic radius *r* of the Group I elements, Li, Na, K and Rb, with increasing proton (atomic) number?




**20** Carvone is found in spearmint.




carvone

How many σ and π bonds are present in this molecule?

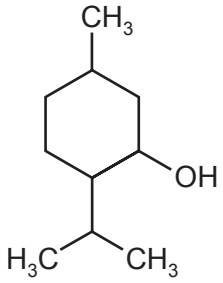
| | σ | π |
|---|---|---|
| **A** | 13 | 3 |
| **B** | 22 | 3 |
| **C** | 22 | 6 |
| **D** | 25 | 3 |

**21** An alkene has the formula $CH_3CH{=}CRCH_2CH_3$ and does **not** possess *cis-trans* isomers.

What is *R*?

**A** H **B** Cl **C** $CH_3$ **D** $C_2H_5$

**22** Menthol is an important compound extracted from the peppermint plant.




menthol

How many chiral centres are there in one molecule of menthol?

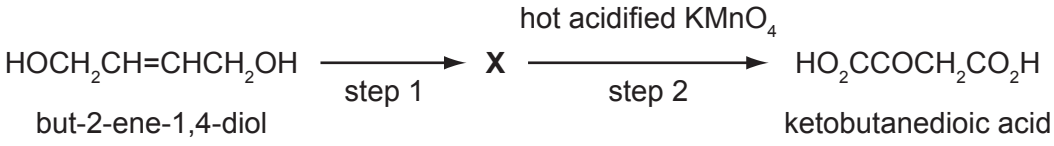
**A** 1 **B** 2 **C** 3 **D** 4

**23** The cracking of a single hydrocarbon molecule, $C_nH_{2n+2}$, produces two hydrocarbon molecules only. Each hydrocarbon product contains the same number of carbon atoms in one molecule. Each hydrocarbon product has non-cyclic structural isomers.

What is the value of n?

**A** 4 **B** 6 **C** 8 **D** 9

**24** But-2-ene-1,4-diol is converted in two steps through an intermediate **X** into ketobutanedioic acid.




but-2-ene-1,4-diol ketobutanedioic acid

What could be the reagent for step 1 and the intermediate **X**?

| | reagent for step 1 | **X** |
|---|---|---|
| **A** | cold acidified $KMnO_4$ | $HOCH_2CH_2CH(OH)CH_2OH$ |
| **B** | hot acidified $KMnO_4$ | $OHCCH(OH)CH_2CHO$ |
| **C** | steam and concentrated $H_2SO_4$ | $HOCH_2CH(OH)CH_2CH_2OH$ |
| **D** | warm acidified $K_2Cr_2O_7$ | $HO_2CCH{=}CHCO_2H$ |

© UCLES 2012

**25** One of the reactions taking place in a catalytic converter in a car exhaust system is between nitrogen oxide and octane (unburned petrol). The products of this reaction are non-toxic.

Which is the correct equation for the reaction?

**A** $C_8H_{16} + 16NO \rightarrow 8CO + 8N_2 + 8H_2O$

**B** $C_8H_{16} + 24NO \rightarrow 8CO_2 + 12N_2 + 8H_2O$

**C** $C_8H_{18} + 17NO \rightarrow 8CO + 8\frac{1}{2}N_2 + 9H_2O$

**D** $C_8H_{18} + 25NO \rightarrow 8CO_2 + 12\frac{1}{2}N_2 + 9H_2O$

**26** High-energy radiation in the stratosphere produces free-radicals from chlorofluoroalkanes, commonly known as CFCs.

Which free-radical is most likely to result from the irradiation of $CHFCl\dot{C}F_2C\mathit{l}$?

**A** $CHFCl\dot{C}FC\mathit{l}$

**B** $\dot{C}HCl\dot{C}F_2C\mathit{l}$

**C** $\dot{C}HFCF_2C\mathit{l}$

**D** $\dot{C}FCl\dot{C}F_2C\mathit{l}$

**27** Which reagent reacts with ethanol and also reacts with ethanoic acid?

**A** acidified potassium dichromate(VI)

**B** sodium

**C** sodium carbonate

**D** sodium hydroxide

**28** 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

© UCLES 2012

**29** Many, but not all, organic reactions need to be heated before reaction occurs.

Which reaction occurs at a good rate at **room** temperature (20 °C)?

**A** $CH_3OH + PCl_5 \rightarrow CH_3Cl + POCl_3 + HCl$

**B** $CH_3CH_2Br + KCN \rightarrow CH_3CH_2CN + KBr$

**C** $CH_3CH_2OH \rightarrow C_2H_4 + H_2O$

**D** $CH_3CH_2CN + 2H_2O \rightarrow CH_3CH_2CO_2H + NH_3$

**30** Compound **X**, $C_6H_{12}O$, is oxidised by acidified sodium dichromate(VI) to compound **Y**.

Compound **Y** reacts with ethanol in the presence of a little concentrated sulfuric acid to give liquid **Z**.

What is the formula of **Z**?

**A** $CH_3(CH_2)_4COCH_2CH_3$

**B** $CH_3(CH_2)_4CO_2CH_2CH_3$

**C** $CH_3CH_2CO_2(CH_2)_4CH_3$

**D** $CH_3CO_2(CH_2)_5CH_3$

© UCLES 2012

## 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** How may nitrogen exist in compounds?

**1** bonded by a triple covalent bond

**2** as part of a cation

**3** having lost 3 electrons to form an anion

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

The isotope $^{99}$Tc is radioactive and has been found in lobsters and seaweed adjacent to nuclear fuel reprocessing plants.

Which statements are correct about an atom of $^{99}$Tc?

**1** It has 13 more neutrons than protons.

**2** It has 43 protons.

**3** It has 99 nucleons.

**33** Which of these substances have a giant structure?

**1** silicon(IV) oxide

**2** baked clay found in crockery

**3** phosphorus(V) oxide

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** The element astatine, At, is below iodine in Group VII of the Periodic Table.

Which statements concerning At will be correct?

**1** It is a dark-coloured solid at room temperature.

**2** It is a more powerful oxidising agent than iodine.

**3** Its hydride is thermally stable.

**35** Which equations represent stages in the Contact process for manufacturing sulfuric acid?

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

**2** $SO_2 + H_2O \rightarrow H_2SO_3$

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

**36** When added to water, which oxides will **not** cause a change in pH?

**1** $Al_2O_3$

**2** $SiO_2$

**3** $P_4O_{10}$

**37** Which reagents and conditions will convert propane into 1-chloropropane?

**1** $Cl_2$ and sunlight

**2** conc. HCl, reflux

**3** $PCl_5$

© UCLES 2012

**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 nucleophilic substitution.

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

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

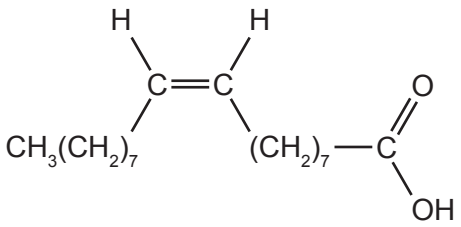
**39** Which reagents react with butanone, $C_2H_5COCH_3$?

**1** Tollens' reagent

**2** sodium borohydride

**3** 2,4-dinitrophenylhydrazine reagent

**40** Oleic acid is found in olive oil. It has the following formula.



Which reagents will give a positive result with oleic acid?

**1** aqueous bromine

**2** acidified potassium dichromate(VI)

**3** Fehling's reagent

© UCLES 2012

**BLANK PAGE**

**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.

© UCLES 2012