



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

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**CHEMISTRY**

**9701/01**

Paper 1 Multiple Choice

**October/November 2007**

**1 hour**

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



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**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.

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

When a sports medal with a total surface area of  $150 \text{ cm}^2$  was evenly coated with silver, using electrolysis, its mass increased by  $0.216 \text{ g}$ .

How many atoms of silver were deposited per  $\text{cm}^2$  on the surface of the medal?

- A  $8.0 \times 10^{18}$
- B  $1.8 \times 10^{19}$
- C  $1.2 \times 10^{21}$
- D  $4.1 \times 10^{22}$

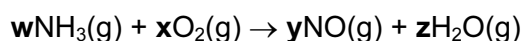
2 *Use of the Data Booklet is relevant to this question.*

In forming ionic compounds, elements generally form an ion with the electronic structure of a noble gas.

Which ion does **not** have a noble gas electronic structure?

- A  $\text{I}^-$
- B  $\text{Rb}^+$
- C  $\text{Sn}^{2+}$
- D  $\text{Sr}^{2+}$

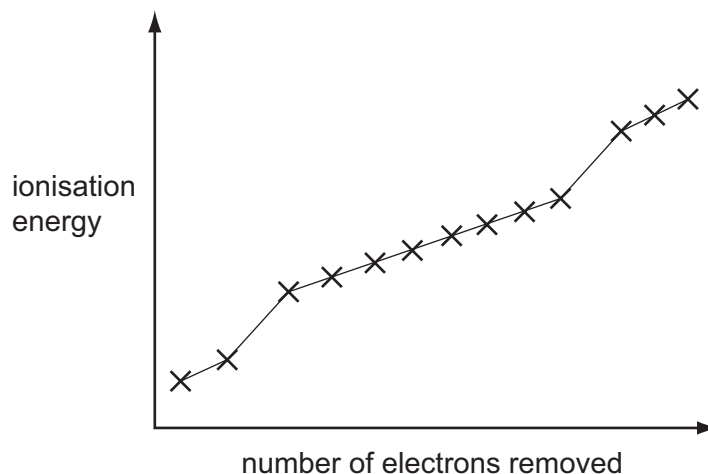
3 The first stage in the manufacture of nitric acid is the oxidation of ammonia by oxygen.



Which values for **w**, **x**, **y** and **z** are needed to balance the equation?

|          | <b>w</b> | <b>x</b> | <b>y</b> | <b>z</b> |
|----------|----------|----------|----------|----------|
| <b>A</b> | 4        | 5        | 4        | 6        |
| <b>B</b> | 4        | 6        | 4        | 5        |
| <b>C</b> | 5        | 6        | 5        | 4        |
| <b>D</b> | 6        | 5        | 6        | 4        |

- 4 The graph shows the first thirteen ionisation energies for element **X**.

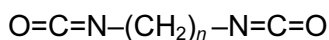


What can be deduced about element **X** from the graph?

- A** It is in the second period (Li to Ne) of the Periodic Table.  
**B** It is a d-block element.  
**C** It is in Group II of the Periodic Table.  
**D** It is in Group III of the Periodic Table.
- 5 Hydrogen bonding can occur between molecules of methanal, HCHO, and molecules of liquid **Y**.

What could liquid **Y** be?

- A** CH<sub>3</sub>OH  
**B** CH<sub>3</sub>CHO  
**C** CH<sub>3</sub>COCH<sub>3</sub>  
**D** CH<sub>3</sub>CO<sub>2</sub>CH<sub>3</sub>
- 6 *Lycra*<sup>®</sup> is a polyurethane fibre used in the fashion industry. It is a polymer made from two monomers, one of which has the following formula.



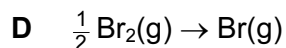
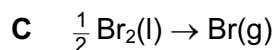
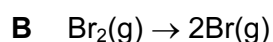
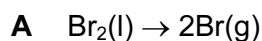
What is the O–C–N bond angle in this molecule?

- A** 90°      **B** 109°      **C** 120°      **D** 180°

7 What are the lattice structures of solid diamond, iodine and silicon(IV) oxide?

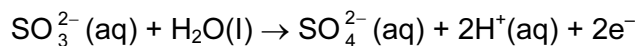
|          | giant molecular            | simple molecular           |
|----------|----------------------------|----------------------------|
| <b>A</b> | diamond, silicon(IV) oxide | iodine                     |
| <b>B</b> | diamond, iodine            | silicon(IV) oxide          |
| <b>C</b> | iodine                     | diamond, silicon(IV) oxide |
| <b>D</b> | silicon(IV) oxide          | diamond, iodine            |

8 Which equation represents the standard enthalpy change of atomisation of bromine?



9 In an experiment,  $50.0 \text{ cm}^3$  of a  $0.10 \text{ mol dm}^{-3}$  solution of a metallic salt reacted exactly with  $25.0 \text{ cm}^3$  of  $0.10 \text{ mol dm}^{-3}$  aqueous sodium sulphite.

The half-equation for oxidation of sulphite ion is shown below.



If the original oxidation number of the metal in the salt was +3, what would be the new oxidation number of the metal?

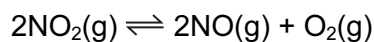
**A** +1

**B** +2

**C** +4

**D** +5

10 Nitrogen dioxide decomposes on heating according to the following equation.



When 4 mol of nitrogen dioxide were put into a  $1 \text{ dm}^3$  container and heated to a constant temperature, the equilibrium mixture contained 0.8 mol of oxygen.

What is the value of the equilibrium constant,  $K_c$ , at the temperature of the experiment?

**A**  $\frac{0.8^2 \times 0.8}{4^2}$

**B**  $\frac{1.6 \times 0.8}{2.4^2}$

**C**  $\frac{1.6^2 \times 0.8}{4^2}$

**D**  $\frac{1.6^2 \times 0.8}{2.4^2}$

- 11 It is often said that the rate of a typical reaction is roughly doubled by raising the temperature by 10 °C.

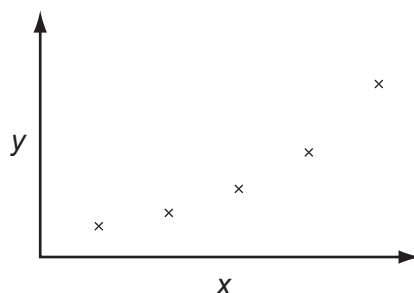
What explains this observation?

- A Raising the temperature by 10 °C doubles the average kinetic 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.
- 12 When dangerous chemicals are transported by road, vehicles must carry signs that indicate what measures should be taken in the event of a spillage of the chemical carried.

Which material must be used if there were a spillage of metallic sodium?

- A ethanol  
 B jets of water  
 C sand  
 D water spray
- 13 Which species has the largest radius?  
 A  $P^{3-}$       B  $Cl^{-}$       C Ar      D  $K^{+}$
- 14 *Use of the Data Booklet is relevant to this question.*

The sketch graph shows the variation of one physical or chemical property with another for the Group II elements.



What are the correct labels for the axes?

|          | x-axis                  | y-axis        |
|----------|-------------------------|---------------|
| <b>A</b> | atomic number           | mass number   |
| <b>B</b> | atomic number           | melting point |
| <b>C</b> | first ionisation energy | atomic number |
| <b>D</b> | first ionisation energy | atomic radius |

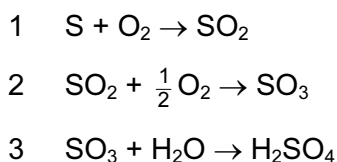
- 15 The chemical properties of an element at the top of a group in the Periodic Table are often different from those of the rest of the elements in the group.

Of the following properties of beryllium and its compounds, which property **is** typical of the elements below it in Group II?

- A Be does not react with hot water.  
B  $\text{BeCl}_2$  is covalent.  
C  $\text{Be}(\text{NO}_3)_2$  produces BeO on thermal decomposition.  
D BeO dissolves in alkalis.
- 16 Compound **X** on refluxing with aqueous sodium hydroxide gave mixture **Y** which on distillation with acidified potassium dichromate(VI) produced propanone. Mixing **Y** with dilute nitric acid and aqueous silver nitrate gave a cream precipitate.

What could compound **X** be?

- A  $\text{CH}_3\text{CHBrCH}_3$   
B  $\text{CH}_3\text{CHICH}_3$   
C  $\text{CH}_3\text{CH}_2\text{CH}_2\text{Br}$   
D  $\text{CH}_3\text{CH}_2\text{CH}_2\text{I}$
- 17 There are three stages in the Contact process for the production of sulphuric acid.



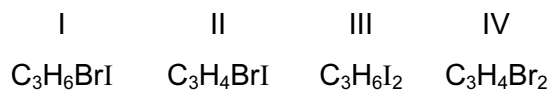
Which statement about this process is correct?

- A In the first stage a large excess of air under high pressure is used to improve the yield.  
B Two of the three stages are equilibria.  
C All three stages are exothermic.  
D In the final stage  $\text{SO}_3$  is absorbed by water droplets.
- 18 Gaseous nitrogen is less reactive than gaseous fluorine.

What is the reason for this difference in reactivity?

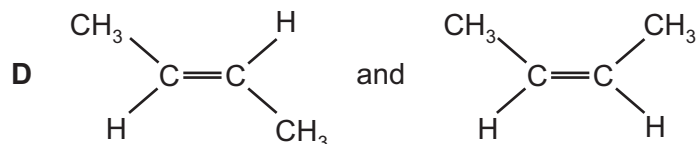
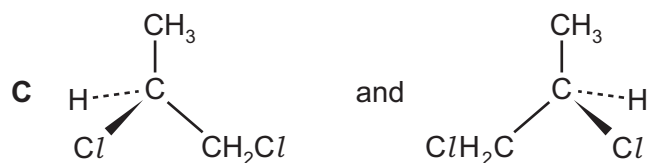
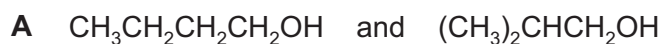
- A The boiling point of nitrogen is lower than that of fluorine.  
B The relative molecular mass of nitrogen is lower than that of fluorine.  
C The atomic radius of nitrogen is greater than that of fluorine.  
D The bond strength in the molecule is greater in nitrogen than in fluorine.

19 Which molecules, each with a linear carbon chain, can have an optically active isomer?

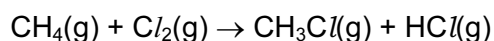


- A I and II only  
 B I, II and III only  
 C II and III only  
 D I, II and IV only

20 In which pair do the isomers have identical boiling points?



21 Tetramethyl-lead(IV),  $(CH_3)_4Pb$ , increases the rate of the reaction of methane with chlorine.



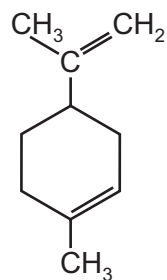
Why can tetramethyl-lead(IV) behave in this way?

- A It is a source of methyl radicals.  
 B It releases  $CH_3^+(g)$ .  
 C It reacts with chloromethane and prevents equilibrium being established.  
 D Metal ions catalyse the reaction.

22 Which reaction occurs when ethane and chlorine are mixed in diffused sunlight?

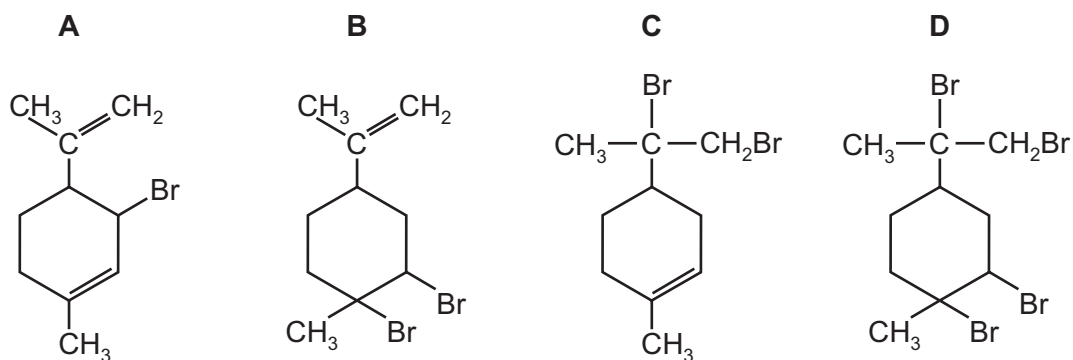
- A a free-radical substitution with hydrogen given off
- B a free-radical substitution with hydrogen chloride given off
- C a free-radical substitution with no gas given off
- D a nucleophilic substitution with hydrogen chloride given off

23 Limonene is an oil formed in the peel of citrus fruits.

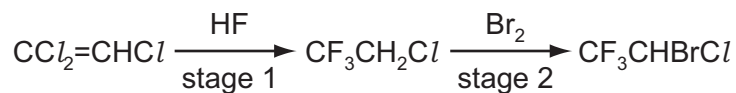


limonene

Which product is formed when molecular bromine reacts with limonene at room temperature in the dark?



24 The anaesthetic *halothane*,  $\text{CF}_3\text{CHBrCl}$ , is made industrially as shown below.



Which type of reaction is occurring in stage 2?

- A electrophilic addition
- B electrophilic substitution
- C free radical substitution
- D nucleophilic addition

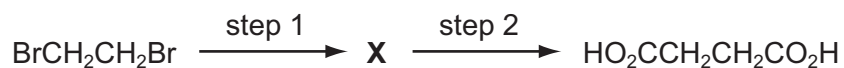


- 25 Chlorofluoroalkanes, CFCs, can be used as refrigerants, aerosol propellants and fire extinguishers.

CFCs such as  $\text{CCl}_3\text{F}$  and  $\text{CCl}_2\text{F}_2$  are more stable than chloroalkanes such as  $\text{CCl}_4$ .

What is the reason for their greater stability?

- A Fluorine has a higher first ionisation energy than chlorine.  
 B Fluorine radicals are more stable than chlorine radicals.  
 C The C–F bond energy is larger than the C–Cl bond energy.  
 D The C–F bond is more polar than the C–Cl bond.
- 26 Butanedioic acid occurs in amber, algae, lichens, sugar cane and beets. It may be synthesised in two steps from 1,2-dibromoethane.



Which reagents could be used for this synthesis?

|   | step 1                                   | step 2   |
|---|--|--|
| A | $\text{HCN}(\text{g})$                   | $\text{HCl}(\text{aq})$  |
| B | $\text{HCO}_2\text{Na}(\text{aq})$       | $\text{HCl}(\text{aq})$  |
| C | $\text{KCN}(\text{aq}/\text{alcoholic})$ | $\text{H}_2\text{SO}_4(\text{aq})$                                 |
| D | $\text{NaOH}(\text{aq})$                 | $\text{K}_2\text{Cr}_2\text{O}_7/\text{H}_2\text{SO}_4(\text{aq})$ |

- 27 Which reaction will distinguish between a primary and a secondary alcohol?

- A warming with  $\text{H}^+/\text{MnO}_4^-$   
 B warming with  $\text{H}^+/\text{Cr}_2\text{O}_7^{2-}$   
 C dehydration, followed by reaction with  $\text{Br}_2(\text{aq})$   
 D oxidation, followed by reaction with Fehling's (or Tollens') reagent

28 Hept-4-enal is present in cow's milk.



hept-4-enal

What is formed when hept-4-enal is reduced with **either** hydrogen and a nickel catalyst **or** sodium borohydride?

- A** with  $\text{H}_2/\text{Ni}$   $\text{CH}_3(\text{CH}_2)_5\text{CH}_2\text{OH}$
- B** with  $\text{H}_2/\text{Ni}$   $\text{CH}_3(\text{CH}_2)_5\text{CH}_3$
- C** with  $\text{NaBH}_4$   $\text{CH}_3(\text{CH}_2)_5\text{CH}_2\text{OH}$
- D** with  $\text{NaBH}_4$   $\text{CH}_3(\text{CH}_2)_5\text{CHO}$
- 29 Which of these reactions is shown by butanone,  $\text{CH}_3\text{COCH}_2\text{CH}_3$ ?
- A** On warming with acidified potassium dichromate(VI) the solution turns green.
- B** On heating with Fehling's reagent a red precipitate is formed.
- C** With 2,4-dinitrophenylhydrazine reagent an orange precipitate is formed.
- D** With hydrogen cyanide an aldehyde is formed.
- 30 The ester  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CO}_2\text{CH}_3$  is responsible for the aroma of apples.

When this ester is hydrolysed by acid in the stomach, what is the empirical formula of the organic acid produced?

- A**  $\text{CH}_4\text{O}$       **B**  $\text{C}_2\text{H}_4\text{O}$       **C**  $\text{C}_2\text{H}_4\text{O}_2$       **D**  $\text{C}_3\text{H}_7\text{O}_2$

## 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** What are assumptions of the kinetic theory of gases and hence of the ideal gas equation,  $PV = nRT$ ?

- 1 Molecules move without interacting with one another except for collisions.
- 2 Intermolecular forces are negligible.
- 3 Intermolecular distances are much greater than the molecular size.

**32** Carbon monoxide burns readily in oxygen to form carbon dioxide.

What can be deduced from this information?

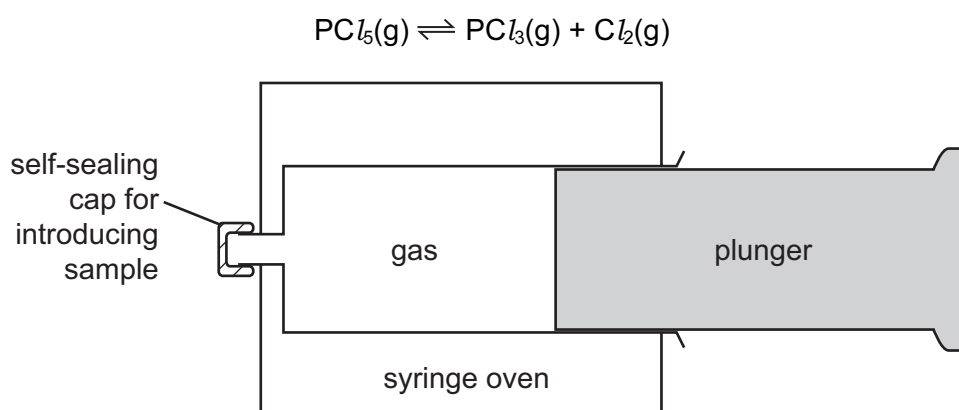
- 1 The +4 oxidation state of carbon is more stable than the +2 state.
- 2 The standard enthalpy change of formation of carbon dioxide is more negative than that of carbon monoxide.
- 3 The value of the equilibrium constant for the reaction,  $2\text{CO}(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{CO}_2(\text{g})$ , is likely to be high.

The responses **A** to **D** should be selected on the basis of

| <b>A</b>               | <b>B</b>                 | <b>C</b>                 | <b>D</b>          |
|------------------------|--------------------------|--------------------------|-------------------|
| 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** Phosphorus pentachloride is introduced into an empty gas syringe which has a movable, tightly-fitting plunger. The gas is allowed to expand until equilibrium is reached at a temperature at which the phosphorus pentachloride partially dissociates.



Which statements are correct?

- 1 The equilibrium pressure inside the syringe will be greater than atmospheric pressure.
  - 2 When the plunger is pushed in the equilibrium adjusts to produce more  $\text{PCl}_5(\text{g})$ .
  - 3 The volume of gas in the syringe at equilibrium will be greater than if no dissociation had occurred.
- 34** Which statements are correct about the activation energy of a reaction?
- 1 It is different for the forward and back reactions in an exothermic process.
  - 2 It is low for a reaction that takes place slowly.
  - 3 It is unaffected by the presence of a catalyst.

35 When a firework is lit a fuel and an oxidising agent react.

In such a firework, magnesium is the fuel and barium nitrate is the oxidising agent.

Which solid products are produced when the firework is lit?

- 1 BaO
- 2 MgO
- 3  $\text{Mg}(\text{NO}_3)_2$

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 Which mixtures, on heating, produce the gas  $\text{ND}_3$ ?

[D =  $^2_1\text{H}$ , an isotope of hydrogen]

- 1  $\text{CaO}(\text{s})$  and  $\text{ND}_4\text{Cl}(\text{s})$
- 2  $\text{CH}_3\text{CN}$  and NaOD in  $\text{D}_2\text{O}$
- 3  $\text{NDH}_3\text{Cl}$  and NaOD in  $\text{D}_2\text{O}$

38 Which structures show a primary alcohol that **cannot** be dehydrated to form an alkene?

- 1  $\text{CH}_3\text{OH}$
- 2  $\text{CH}_3\text{CH}_2\text{OH}$
- 3  $\text{CH}_3\text{CH}(\text{OH})\text{CH}_3$

39 In the reaction between an aldehyde and HCN catalysed by NaCN, which statements about the reaction mechanism are true?

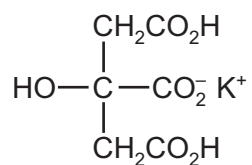
- 1 A new carbon-carbon bond is formed.
- 2 In the intermediate, the oxygen carries a negative charge.
- 3 The last stage involves the formation of a hydrogen-oxygen bond.

The responses **A** to **D** should be selected on the basis of

| <b>A</b>               | <b>B</b>                 | <b>C</b>                 | <b>D</b>          |
|------------------------|--------------------------|--------------------------|-------------------|
| 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** Monopotassium citrate is used as an emulsifying agent in powdered milk and in powdered soups. It may be represented by the formula shown.



Which statements about monopotassium citrate are correct?

- 1** It can form optical isomers.
- 2** It can act as a dibasic acid.
- 3** It can form esters with both acids and alcohols.



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