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

CHEMISTRY **9701/13**

Paper 1 Multiple Choice **October/November 2010**

1 hour

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

6196456143

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.

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Section A

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

1 A simple ion X^+ contains eight protons.

What is the electronic configuration of X^+?

A $1s^2\ 2s^1\ 2p^6$

B $1s^2\ 2s^2\ 2p^3$

C $1s^2\ 2s^2\ 2p^5$

D $1s^2\ 2s^2\ 2p^7$

2 Equations involving four enthalpy changes are shown.

$Na(g) \rightarrow Na^+(g) + e^-$ $\Delta H = W$

$Na(g) \rightarrow Na^{2+}(g) + 2e^-$ $\Delta H = X$

$Na(s) \rightarrow Na(g)$ $\Delta H = Y$

$Na(s) \rightarrow Na^{2+}(g) + 2e^-$ $\Delta H = Z$

What is the second ionisation energy of sodium?

A 2W **B** X – W **C** Y – W **D** Z – Y

3 Which ion has more electrons than protons and more protons than neutrons?
[H = ${}^{1}_{1}H$; D = ${}^{2}_{1}H$; O = ${}^{16}_{8}O$]

A D^- **B** H_3O^+ **C** OD^- **D** OH^-

4 Sulfur dioxide, SO_2, is added to wines to prevent oxidation of ethanol by air. To determine the amount of SO_2, a sample of wine is titrated with iodine, I_2. In this reaction, **one** mole of SO_2 is oxidised by **one** mole of I_2.

What is the change in oxidation number of sulfur in this reaction?

A +2 to +4 **B** +2 to +6 **C** +4 to +5 **D** +4 to +6

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

Nickel makes up 20 % of the total mass of a coin. The coin has a mass of 10.0 g.

How many nickel atoms are in the coin?

A 2.05×10^{22} **B** 4.30×10^{22} **C** 1.03×10^{23} **D** 1.20×10^{24}

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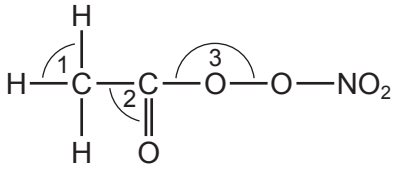
6 Organic nitrates in photochemical smog can cause breathing difficulties.

The diagram shows an example of an organic nitrate molecule.



What is the correct order of the bond angles shown in ascending order (smallest first)?

A $1 \rightarrow 2 \rightarrow 3$ **B** $2 \rightarrow 1 \rightarrow 3$ **C** $3 \rightarrow 1 \rightarrow 2$ **D** $3 \rightarrow 2 \rightarrow 1$

7 Every year millions of tonnes each of chlorine and sodium hydroxide are manufactured by the electrolysis of brine using a 'diaphragm cell'.

What is the purpose of the diaphragm in such a cell?

A to prevent chlorine gas escaping into the factory

B to prevent the build up of pressure in the electrolysis cell

C to provide a large surface area of electrode

D to stop the products of electrolysis from reacting together

8 Which statement describes the halogens chlorine, bromine and iodine?

A Their bond energies decrease with increasing proton number.

B Their first ionisation energies increase with increasing proton number.

C They are all coloured gases at room temperature.

D They are all good reducing agents.

9 Chile saltpetre, $NaNO_3$, contains sodium iodide as an impurity.

Aqueous silver nitrate is added to an aqueous solution of Chile saltpetre. Concentrated aqueous ammonia is then added.

Which observations are made?

	with acidified silver nitrate	with concentrated aqueous ammonia
A	no precipitate	no further reaction
B	no precipitate	precipitate forms
C	precipitate forms	precipitate dissolves
D	precipitate forms	precipitate remains

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10 The value of the equilibrium constant, K_c, for the reaction to form ethyl ethanoate from ethanol and ethanoic acid is 4.0 at 60 °C.

$$C_2H_5OH + CH_3CO_2H \rightleftharpoons CH_3CO_2C_2H_5 + H_2O$$

When 1.0 mol of ethanol and 1.0 mol of ethanoic acid are allowed to reach equilibrium at 60 °C, what is the number of moles of ethyl ethanoate formed?

A $\frac{1}{3}$ **B** $\frac{2}{3}$ **C** $\frac{1}{4}$ **D** $\frac{3}{4}$

11 Enthalpy changes of combustion can be used to determine enthalpy changes of formation. The following equation represents the enthalpy change of formation of butane.

$$4C(s) + 5H_2(g) \rightarrow C_4H_{10}(g)$$

By using the following standard enthalpy of combustion data, what is the value of the standard enthalpy change of formation, $\Delta H_f^{\ominus}$, for this reaction?

compound	$\Delta H_c^{\ominus}$ / kJ mol^{-1}
carbon	–394
hydrogen	–286
butane	–2877

A –5883 kJ mol^{-1}

B –129 kJ mol^{-1}

C +129 kJ mol^{-1}

D +2197 kJ mol^{-1}

12 In a calorimetric experiment 1.60 g of a fuel is burnt. 45 % of the energy released is absorbed by 200 g of water whose temperature rises from 18 °C to 66 °C. The specific heat capacity of water is 4.2 J g^{-1} K^{-1}.

What is the total energy released per gram of fuel burnt?

A 25 200 J **B** 56 000 J **C** 89 600 J **D** 143 360 J

13 Which equation represents the change corresponding to the enthalpy change of atomisation of iodine?

A $\frac{1}{2} I_2(g) \rightarrow I(g)$

B $I_2(g) \rightarrow 2I(g)$

C $\frac{1}{2} I_2(s) \rightarrow I(g)$

D $I_2(s) \rightarrow 2I(g)$

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14 Camphor is a white solid which was used to make the early plastic celluloid. Camphor contains the same percentage by mass of hydrogen and oxygen.

What is the molecular formula of camphor?

A $C_{10}H_6O_6$ **B** $C_{10}H_8O$ **C** $C_{10}H_{16}O$ **D** $C_{10}H_{10}O_2$

15 Ammonium sulfate in nitrogenous fertilisers in the soil can be slowly oxidised by air producing sulfuric acid, nitric acid and water.

How many moles of oxygen gas are needed to oxidise completely one mole of ammonium sulfate?

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

16 Why is the first ionisation energy of phosphorus greater than the first ionisation energy of silicon?

A A phosphorus atom has one more proton in its nucleus.

B The atomic radius of a phosphorus atom is greater.

C The outer electron in a phosphorus atom is more shielded.

D The outer electron in a phosphorus atom is paired.

17 When magnesium nitrate, $Mg(NO_3)_2.7H_2O$, is heated, which three gases are given off?

A dinitrogen oxide, oxygen, water vapour

B hydrogen, nitrogen, oxygen

C hydrogen, nitrogen dioxide, oxygen

D nitrogen dioxide, oxygen, water vapour

18 Sulfur dioxide is used to bleach wood pulp in the production of paper. It is also used as an additive in the production of jam and marmalade, often in the form of sulfite compounds. When it is present in quantities greater than 10 mg / kg it is required to be listed as an ingredient of the jam.

Why is sulfur dioxide added to jam?

A It is a bleaching agent and removes the undesirable colours from the fruit used in the jam.

B It is a preservative that destroys unwanted bacteria and enzymes.

C It is a reducing agent and removes the acids that give the jam a sharp taste.

D It is an acidic gas and maintains the pH of the jam at a suitable value to give it a sharp taste.

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19 Which property of beryllium and its compounds is typical of the elements below it in Group II?

A Be does not react with hot water.

B $BeCl_2$ is covalent.

C $Be(NO_3)_2$ produces BeO on thermal decomposition.

D BeO dissolves in alkalis.

20 A compound Y 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 Y be?

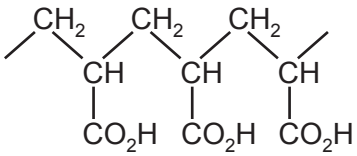
A ethanoic acid

B ethanol

C ethene

D ethyl ethanoate

21 One of the characteristics of addition polymerisation is that the empirical formulae of the polymer and of its monomer are the same. The absorbent material in babies' disposable nappies is made from the addition polymer shown.



From which monomer could this addition polymer be obtained?

A $CH_3CH(OH)CO_2H$

B $HOCH_2CH_2CO_2H$

C $H_2C{=}CHCO_2H$

D $HO_2CCH{=}CHCO_2H$

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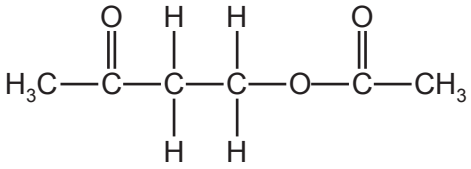
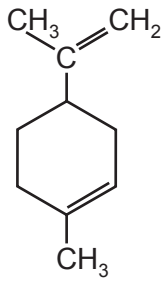
22 Compound X reacts with ethanoic acid in the presence of an H^+ catalyst to produce the compound below.



What is the molecular formula of compound X?

A $C_2H_6O_2$ **B** $C_2H_6O_3$ **C** C_4H_8O **D** $C_4H_8O_2$

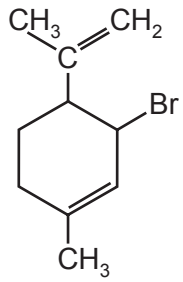
23 Limonene is an oil formed in the peel of citrus fruits.



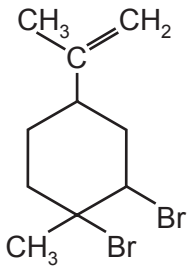
limonene

Which product is formed when an excess of bromine, $Br_2(l)$, reacts with limonene at room temperature in the dark?

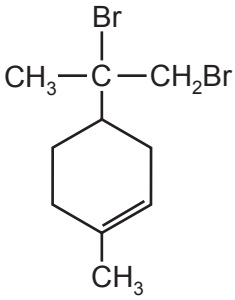
A



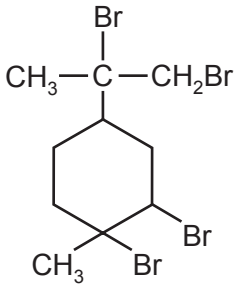
B



C



D



24 Tartaric acid is present in some wines. It may be synthesised in the laboratory in two steps.

$$OHCCHO \xrightarrow{\text{step 1}} \text{intermediate} \xrightarrow{\text{step 2}} HO_2CCH(OH)CH(OH)CO_2H$$

tartaric acid

Which reagents could be used for this synthesis?

	step 1	step 2
A	HC*l*(aq)	HCN(g)
B	HCN, NaCN(aq/alcoholic)	H_2SO_4(aq)
C	H_2SO_4(aq)	$K_2Cr_2O_7$ / H_2SO_4(aq)
D	KCN(aq/alcoholic)	$K_2Cr_2O_7$ / H_2SO_4(aq)

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

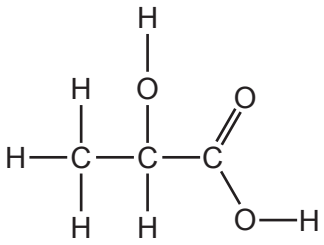
A butan-1-ol

B butan-2-ol

C 2-methylpropan-1-ol

D 2-methylpropan-2-ol

26 Lactic acid occurs naturally, for example in sour milk.



lactic acid

What is a property of lactic acid?

A It decolourises aqueous bromine rapidly.

B It is insoluble in water.

C It reduces Fehling's reagent.

D Two molecules react with each other in the presence of a strong acid.

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27 Which compound would undergo nucleophilic addition?

A bromoethane, C_2H_5Br

B ethanal, CH_3CHO

C ethane, C_2H_6

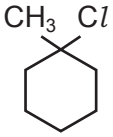
D ethene, C_2H_4

28 Which compound undergoes an S_N1 substitution reaction?

A $CH_3CH_2CH_2Br$

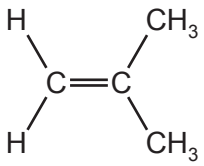
B $(CH_3)_3CCH_2I$

C



D CH_2=CHCl

29 The compound 2-methylpropene, C_4H_8, is a monomer used in the production of synthetic rubber.



In addition to 2-methylpropene there are x other isomers of C_4H_8, structural or otherwise, which contain a double bond.

What is the value of x?

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

30 Which environmental problem is **not** made worse by the release of oxides of nitrogen from car engines?

A acidification of lakes

B corrosion of buildings

C photochemical smog

D the hole in the ozone layer

Section B

For each of the questions in this section, one or more of the three numbered statements **1** to **3** may be correct.

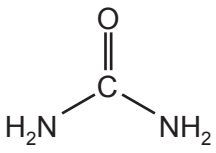
Decide whether each of the statements is or is not correct (you may find it helpful to put a tick against the statements that you consider to be correct).

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 types of intermolecular forces can exist between adjacent urea molecules?



urea

1 hydrogen bonding

2 permanent dipole-dipole forces

3 temporary induced dipole-dipole forces

32 Ethanol is manufactured by reacting ethene gas and steam in the presence of phosphoric(V) acid.

$$C_2H_4(g) + H_2O(g) \rightleftharpoons C_2H_5OH(g) \qquad \Delta H = -45\,kJ\,mol^{-1}$$

The reaction is carried out at 570 K and 60 atm.

What would be the consequences of carrying out the reaction at the same temperature but at a pressure of 200 atm?

1 The manufacturing costs would increase.

2 The maximum yield at equilibrium would be higher.

3 The reaction would proceed at a faster rate.

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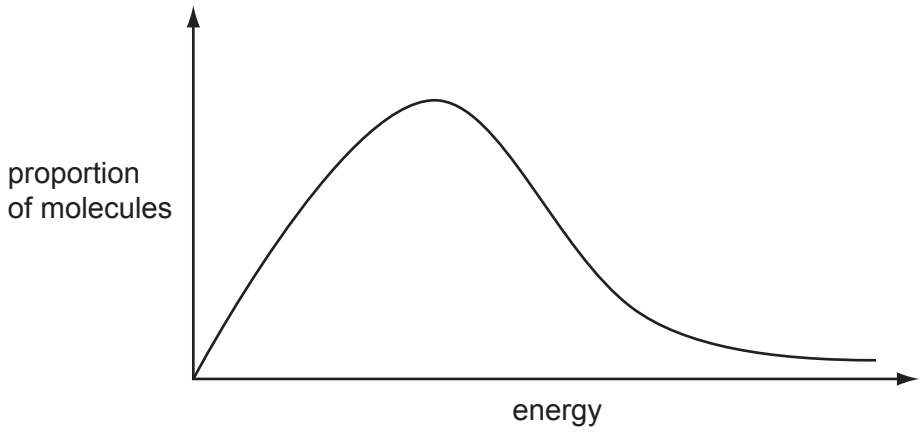
33 The diagram represents the Boltzmann distribution of molecular energies at a given temperature.



Which of the factors that affect the rate of a reaction can be explained using such a Boltzmann distribution?

1 increasing the concentration of reactants

2 increasing the temperature

3 the addition of a catalyst

34 Disproportionation is the term used to describe a reaction in which a reactant is simultaneously both oxidised and reduced.

To which incomplete equations does the term disproportionation apply?

1 $Cl_2(g) + 2OH^-(aq) \rightarrow H_2O(l) + Cl^-(aq) + \ldots\ldots$

2 $3Cl_2(g) + 6OH^-(aq) \rightarrow 3H_2O(l) + ClO_3^-(aq) + \ldots\ldots$

3 $2NO_2(g) + H_2O(l) \rightarrow HNO_3(aq) + \ldots\ldots$

35 Samples of calcium and barium are separately added to beakers of cold water containing a few drops of litmus solution.

Which observations will be made with **only** the calcium and **not** with the barium?

1 A white suspension appears in the water.

2 The solution turns blue.

3 A gas is evolved.

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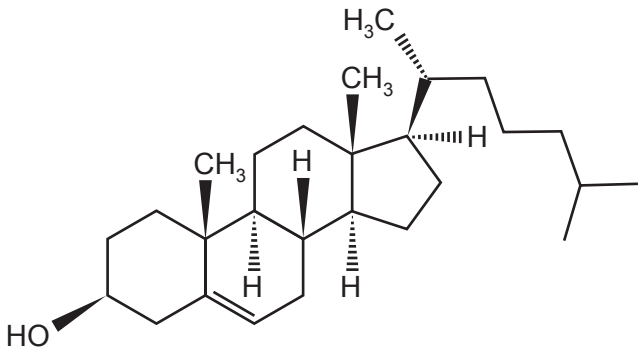
The responses **A** to **D** should be selected on the basis of

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.

36 The diagram shows the structure of the naturally-occurring molecule cholesterol.



cholesterol

Which statements about cholesterol are correct?

1 The molecule contains a secondary alcohol group.

2 The molecule contains two π bonds.

3 All carbon atoms in the four rings lie in the same plane.

37 Element X is a solid. It occurs as a contaminant of carbonaceous fuels.

Its oxide Y is formed in car engines.

Further oxidation of Y to Z can occur in the atmosphere.

Which statements about Y and Z are correct?

1 Molecule Y has lone pairs of electrons.

2 The atmospheric oxidation of Y to Z is a catalysed reaction.

3 Y is a colourless gas.

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38 An organic compound decolourises aqueous bromine and reacts with sodium to produce hydrogen.

Which molecular formula could represent this compound?

1 C_3H_6O

2 $C_3H_4O_2$

3 C_3H_8O

39 Textiles for use in aircraft are treated with a finish containing a halogenoalkane.

What is the reason for this?

1 The textile burns less easily, improving safety.

2 The fabric forms hydrogen bonds to water more readily, making the fabric easier to wash.

3 The halogenoalkane undergoes addition polymerisation, stiffening the fabric.

40 Glyceraldehyde, $HOCH_2CH(OH)CHO$, is formed during photosynthesis, and contains a chiral carbon atom.

Which reagents will react with glyceraldehyde to produce an organic product **without** a chiral carbon atom?

1 warmed acidified $K_2Cr_2O_7$

2 $NaBH_4$

3 Tollens' reagent

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