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

CHEMISTRY **9701/01**

Paper 1 Multiple Choice **October/November 2008**

1 hour

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

* 8 8 0 1 4 6 4 6 2 4 *

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

Titanium(IV) oxide, TiO_2, is brilliantly white and much of the oxide produced is used in the manufacture of paint.

What is the maximum amount of TiO_2 obtainable from 19.0 tonnes of the ore ilmenite, $FeTiO_3$?

A 10.0 tonnes **B** 12.7 tonnes **C** 14.0 tonnes **D** 17.7 tonnes

2 Carbon disulphide vapour burns in oxygen according to the following equation.

$$CS_2(g) + 3O_2(g) \rightarrow CO_2(g) + 2SO_2(g)$$

A sample of 10 cm^3 of carbon disulphide was burned in 50 cm^3 of oxygen. After measuring the volume of gas remaining, the product was treated with an excess of aqueous sodium hydroxide and the volume of gas measured again. All measurements were made at the same temperature and pressure, under such conditions that carbon disulphide was gaseous.

What were the measured volumes?

	volume of gas after burning / cm^3	volume of gas after adding NaOH(aq) / cm^3
A	30	0
B	30	20
C	50	20
D	50	40

3 In which pair do both atoms have one electron only in an s orbital in their ground states?

A Ca, Sc **B** Cu, Be **C** H, He **D** Li, Cr

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

Hard water contains calcium ions and hydrogencarbonate ions arising from dissolved calcium hydrogencarbonate, $Ca(HCO_3)_2$.

How many electrons are present in the hydrogencarbonate anion?

A 30 **B** 31 **C** 32 **D** 33

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5 Which quantity would best indicate the relative strengths of the hydrogen bonds between the molecules in liquid hydrogen halides?

A bond dissociation energies

B enthalpy changes of solution

C enthalpy changes of formation

D enthalpy changes of vaporisation

6 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

7 Which of the following would behave most like an ideal gas at room temperature?

A carbon dioxide

B helium

C hydrogen

D nitrogen

8 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 combustion of lead and enthalpy change of formation of Pb_3O_4

B enthalpy change of combustion of PbO 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

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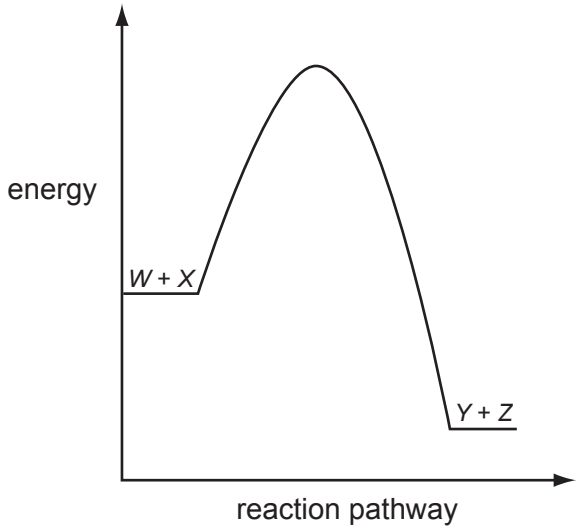
9 The diagram represents the reaction pathway for the following reaction.

$$W(g) + X(g) \rightarrow Y(g) + Z(g)$$



What statement can be made about the reverse reaction, $Y(g) + Z(g) \rightarrow W(g) + X(g)$?

A It will have a larger activation energy and a positive ΔH.

B It will have a larger activation energy and a negative ΔH.

C It will have a smaller activation energy and a positive ΔH.

D It will have a smaller activation energy and a negative ΔH.

10 For the equilibrium $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$, what will change the value of K_p?

A adding a catalyst

B adding more O_2

C increasing the pressure

D increasing the temperature

11 Dinitrogen tetroxide dissociates into nitrogen dioxide on heating.

$$N_2O_4(g) \rightleftharpoons 2NO_2(g)$$

In an experiment the partial pressures of the gases at equilibrium were found to be NO_2, 0.33 atm; N_2O_4, 0.67 atm.

What is the numerical value of K_p at the temperature of the experiment?

A 0.16 **B** 0.49 **C** 0.65 **D** 2.03

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12 Crotonaldehyde, $CH_3CH=CHCHO$, can be obtained by oxidising butadiene, $CH_2=CHCH=CH_2$, using air or oxygen. One method is to pass a mixture of butadiene and oxygen through a hot aqueous solution of palladium(II) ions, $Pd^{2+}(aq)$, which catalyse the reaction.

Which statement is **not** correct about the action of the $Pd^{2+}(aq)$ ions?

A Changing the concentration of the $Pd^{2+}(aq)$ will have an effect on the rate of the reaction.

B $Pd^{2+}(aq)$ increases the energy of the reacting molecules.

C $Pd^{2+}(aq)$ lowers the activation energy for the reaction.

D When $Pd^{2+}(aq)$ is used, the reaction proceeds by a different route.

13 Which oxide, when mixed with water, will produce the most acidic solution?

A CO **B** CO_2 **C** SiO_2 **D** P_2O_5

14 Which salt is produced by adding aqueous ammonia to aqueous sulphur dioxide until just alkaline?

A NH_4SO_3 **B** NH_4SO_4 **C** $(NH_4)_2SO_3$ **D** $(NH_4)_2SO_4$

15 Aluminium chloride catalyses certain reactions by forming carbocations (carbonium ions) with chloroalkanes as shown.

$$RCl + AlCl_3 \rightarrow R^+ + AlCl_4^-$$

Which property makes this reaction possible?

A $AlCl_3$ exists as the dimer Al_2Cl_6 in the vapour.

B $AlCl_3$ is a covalent molecule.

C The aluminium atom in $AlCl_3$ has an incomplete octet of electrons.

D The chlorine atom in RCl has a vacant p orbital.

16 Due to their similar ionic radii, the reactions of lithium and magnesium and their corresponding compounds are very similar.

Which statement concerning the reactions of lithium and its compounds is correct?

A Lithium carbonate decomposes on heating at a relatively low temperature, forming lithium oxide and carbon dioxide.

B Lithium nitrate decomposes on heating, forming lithium nitrite and oxygen.

C Lithium burns only slowly in oxygen.

D Lithium reacts violently with cold water, liberating hydrogen.

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17 A student observed the reactions when sodium chloride and sodium iodide were each reacted separately with concentrated sulphuric acid and concentrated phosphoric acid. The observations are recorded in the table.

	sodium chloride	sodium iodide
conc. H_2SO_4	colourless acidic gas formed	purple vapour formed
conc. H_3PO_4	colourless acidic gas formed	colourless acidic gas formed

Which deduction can be made from these observations?

A Concentrated phosphoric acid is a stronger oxidising agent than concentrated sulphuric acid.

B Concentrated phosphoric acid is a stronger oxidising agent than iodine.

C Concentrated sulphuric acid is a stronger oxidising agent than chlorine.

D Concentrated sulphuric acid is a stronger oxidising agent than iodine.

18 When gaseous chemicals are transported by road or by rail they are classified as follows.

flammable non-flammable poisonous

Which gas is poisonous?

A butane

B carbon dioxide

C hydrogen

D sulphur dioxide

19 Which statement explains the observation that magnesium hydroxide dissolves in aqueous ammonium chloride, but not in aqueous sodium chloride?

A The ionic radius of the NH_4^+ ion is similar to that of Mg^{2+} but not that of Na^+.

B NH_4Cl dissociates less fully than $NaCl$.

C The Na^+ and Mg^{2+} ions are isoelectronic (have the same number of electrons).

D The NH_4^+ ion acts as an acid.

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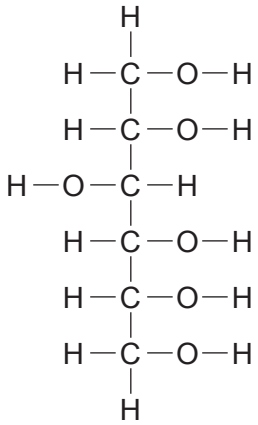
20 Sorbitol is a naturally-occurring compound with a sweet taste. It is often used as a substitute for sucrose by the food industry.

The diagram shows its structure.



How many chiral centres are present in sorbitol?

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

21 The compound 'leaf alcohol' is partly responsible for the smell of new-mown grass.

$CH_3CH_2CH{=}CHCH_2CH_2OH$

leaf alcohol

Which two compounds will be formed when 'leaf alcohol' is oxidised using hot, concentrated manganate(VII) ions?

A CH_3CO_2H and $HOCH_2CH_2CH_2CO_2H$

B CH_3CO_2H and $HO_2CCH_2CH_2CO_2H$

C $CH_3CH_2CO_2H$ and $HO_2CCH_2CO_2H$

D $CH_3CH_2CO_2H$ and $HOCH_2CH_2CO_2H$

22 Which hydrocarbon can form a monochloro-substitution derivative which shows **both** chirality **and** *cis-trans* isomerism?

A $CH_3CH{=}CH_2$

B $(CH_3)_2C{=}CH_2$

C $CH_3CH{=}C(CH_3)_2$

D $CH_3CH{=}CHCH_2CH_3$

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23 Four drops of 1-chlorobutane, 1-bromobutane and 1-iodobutane were put separately into three test-tubes containing 1.0 cm^3 of aqueous silver nitrate at 60 °C.

A hydrolysis reaction occurred. (R represents the butane chain C_4H_9– and *X* the halogen atom.)

$$H_2O(l) + R–X(l) + Ag^+(aq) \rightarrow R–OH(aq) + AgX(s) + H^+(aq)$$

The rate of formation of cloudiness in the tubes was in the order RC*l* < RBr < RI.

Why is this?

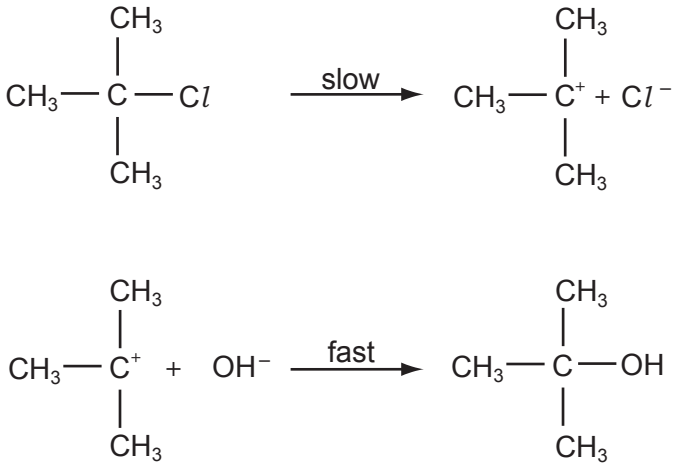
A The R–*X* bond polarity decreases from RC*l* to RI.

B The solubility of Ag*X*(s) decreases from AgC*l* to AgI.

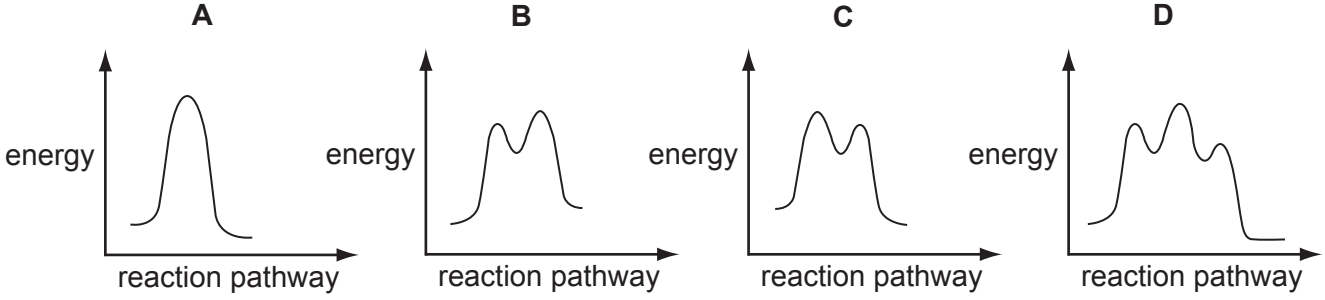
C The ionisation energy of the halogen decreases from C*l* to I.

D The bond energy of R–*X* decreases from RC*l* to RI.

24 A possible mechanism of the exothermic hydrolysis of 2-chloro-2-methylpropane is shown.



Which diagram represents the reaction profile for this mechanism?



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25 The functional group in a primary alcohol is $-CH_2OH$.

Which reagent reacts with a primary alcohol, under suitable conditions, to give an organic product with the same number of oxygen atoms as the alcohol?

A Al_2O_3 **B** CH_3CO_2H **C** HBr **D** Na

26 Ethyl phenylethanoate, $C_6H_5CH_2CO_2C_2H_5$, gives a characteristic flowery aroma to honey.

Which sequence of reagents, with heating in each case, leads to the preparation of $C_6H_5CH_2CO_2C_2H_5$ from $C_6H_5CH_2Br$?

A $C_6H_5CH_2Br \xrightarrow{NaOH(aq)} \xrightarrow{C_2H_5COCl}$

B $C_6H_5CH_2Br \xrightarrow{NaOH(aq)} \xrightarrow{C_2H_5CO_2H,\ conc.\ H_2SO_4}$

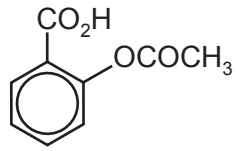
C $C_6H_5CH_2Br \xrightarrow{NaCN(alcoholic)} \xrightarrow{H^+(aq)} \xrightarrow{C_2H_5OH,\ conc.\ H_2SO_4}$

D $C_6H_5CH_2Br \xrightarrow{NaOH(aq)} \xrightarrow{conc.\ MnO_4^-,\ H^+(aq)} \xrightarrow{C_2H_5OH,\ conc.\ H_2SO_4}$

27 The stomach wall can become sensitive to acidic compounds.

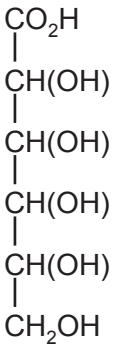
Which is the most acidic compound?

A



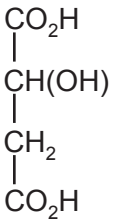
aspirin

B



gluconic acid

C



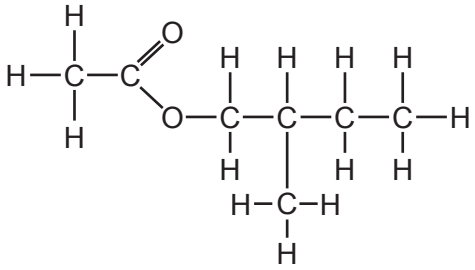
malic acid

D

$CH_3CH(OH)CO_2H$

lactic acid

28 Bees use 2-methylbutyl ethanoate as an 'alarm' pheromone. When disturbed, individual bees on guard will raise their abdomen and emit the alarm pheromone, fanning their wings to aid its dispersal. This alerts other bees to a danger and makes them ready to sting when required.



2-methylbutyl ethanoate

Which starting materials would be required to synthesise 2-methylbutyl ethanoate?

A CH_3CH_2OH and $CH_3CH_2CH(CH_3)CO_2H$

B CH_3CO_2H and $CH_3CH_2CH(CH_3)CH_2OH$

C CH_3CH_2OH and $CH_3CH_2CH(CH_3)CH_2CO_2H$

D CH_3CO_2H and $CH_3CH_2CH(CH_3)CH_2CO_2H$

29 The product of the reaction between propanone and hydrogen cyanide is hydrolysed under acidic conditions.

What is the formula of the final product?

A $CH_3CH(OH)CO_2H$

B $CH_3CH_2CH_2CO_2H$

C $(CH_3)_2CHCONH_2$

D $(CH_3)_2C(OH)CO_2H$

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

Ethyl ethanoate can be obtained from ethanoic acid and ethanol by the following reaction.

$$CH_3CH_2OH + CH_3CO_2H \rightleftharpoons CH_3CO_2CH_2CH_3 + H_2O$$

Ethanol (30 g) and ethanoic acid (30 g) are heated under reflux together, and 22 g of ethyl ethanoate are obtained.

What is the yield of the ester?

A 25 % **B** 38 % **C** 50 % **D** 77 %

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Section B

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

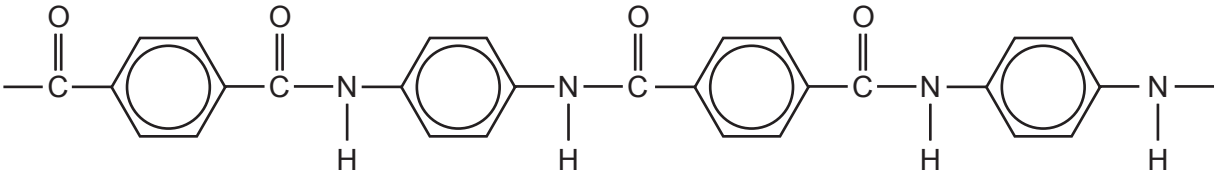
Decide whether each of the statements is or is not correct (you may find it helpful to put a tick against the statements that you consider to be correct).

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 *Kevlar* has the structure below.



Compared to a steel rope of similar dimensions, a *Kevlar* rope is both lighter and stronger.

Which properties of *Kevlar* help to explain these facts?

1 The fibres of *Kevlar* align due to hydrogen bonding.

2 The mass per unit length is less in a *Kevlar* rope than in a steel rope.

3 The *Kevlar* molecule has no permanent dipole.

32 Which of the following can act as a Bronsted-Lowry acid?

1 H_3O^+

2 NH_4^+

3 H_2O

33 Under given conditions, what governs the rate of a forward reaction?

1 the activation energy of the reaction

2 the enthalpy change of the reaction

3 the equilibrium constant of the reaction

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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.

34 Which statements concerning the Group II elements magnesium, calcium and barium are correct?

1 Their reactivity increases with increasing relative atomic mass.

2 The oxidation number exhibited in their stable compounds is +2.

3 On strong heating, their nitrates give off oxygen only.

35 Chlorine is a greenish-yellow gas, bromine is a dark red liquid and iodine is a dark grey solid.

What causes these differences in volatility?

1 the halogen-halogen bond energy

2 the magnitude of the van der Waals' forces between the molecules

3 the number of electrons in the halogen molecule

36 Which statements about the Haber process for the industrial production of ammonia are correct?

1 The equilibrium constant K_p increases with pressure.

2 As the temperature increases, the equilibrium constant for the forward reaction becomes smaller.

3 The process is usually carried out at between 450 °C and 550 °C at a pressure of at least 150 atm.

37 Which statements about alkenes are correct?

1 They are formed when higher alkanes are cracked.

2 They are used as monomers for polymerisation.

3 They are less reactive than alkanes towards electrophiles.

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38 Which of the following would be suitable for use in a fire extinguisher?

1 $CBrF_3$

2 $CH_3(CH_2)_5CH_2Br$

3 HCl

39 During the bromination of methane, the free radical $\dot{C}H_3$ is generated and a possible terminating step of this reaction is the formation of C_2H_6 by the combination of two free radicals.

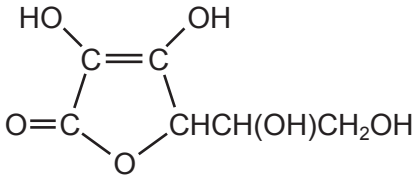
What could be produced in a terminating step during the bromination of propane?

1 $CH_3CH_2CH_2\underset{\displaystyle CH_3}{\underset{|}{C}}HCH_3$

2 $CH_3\underset{\displaystyle CH_3}{\underset{|}{C}}H\underset{\displaystyle CH_3}{\underset{|}{C}}HCH_3$

3 $CH_3CH_2\underset{\displaystyle CH_3}{\underset{|}{C}}HCH_2CH_3$

40 The structure of the antioxidant vitamin C is shown in the diagram.



On the basis of this structure, which properties is vitamin C likely to have?

1 It is soluble in water.

2 It decolourises aqueous bromine rapidly.

3 It reduces Fehling's reagent.

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