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

CHEMISTRY **9701/01**

Paper 1 Multiple Choice

May/June 2004

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.

Section A

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

1 Which of these samples of gas contains the same number of atoms as 1g of hydrogen (M_r : H_2, 2)?

A 22 g of carbon dioxide (M_r : CO_2, 44)

B 8 g of methane (M_r : CH_4, 16)

C 20 g of neon (M_r : Ne, 20)

D 8 g of ozone (M_r : O_3, 48)

2 Self-igniting flares contain Mg_3P_2. With water this produces diphosphane, P_2H_4, which is spontaneously flammable in air.

Which equation that includes the formation of diphosphane is balanced?

A $Mg_3P_2 + 6H_2O \rightarrow 3Mg(OH)_2 + P_2H_4$

B $Mg_3P_2 + 6H_2O \rightarrow 3Mg(OH)_2 + P_2H_4 + H_2$

C $2Mg_3P_2 + 12H_2O \rightarrow 6Mg(OH)_2 + P_2H_4 + 2PH_3$

D $2Mg_3P_2 + 12H_2O \rightarrow 6Mg(OH)_2 + 3P_2H_4$

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

Most modern cars are fitted with airbags. These work by decomposing sodium azide to liberate nitrogen gas, which inflates the bag.

$$2NaN_3 \rightarrow 3N_2 + 2Na$$

A typical driver's airbag contains 50 g of sodium azide.

Calculate the volume of nitrogen this will produce at room temperature.

A 9.2 dm^3 **B** 13.9 dm^3 **C** 27.7 dm^3 **D** 72.0 dm^3

4 What is the order of increasing energy of the listed orbitals in the atom of titanium?

A 3s 3p 3d 4s

B 3s 3p 4s 3d

C 3s 4s 3p 3d

D 4s 3s 3p 3d

5 Which of the following particles would, on losing an electron, have a half-filled set of p orbitals?

A C^- **B** N **C** N^- **D** O^+

6 Magnesium oxide is used to line industrial furnaces because it has a very high melting point.

Which type of bond needs to be broken for magnesium oxide to melt?

A co-ordinate

B covalent

C ionic

D metallic

7 Which solid exhibits more than one kind of chemical bonding?

A brass

B copper

C diamond

D ice

8 The standard enthalpy changes of formation of iron(II) oxide, FeO(s), and aluminium oxide, Al_2O_3(s), are –266 kJ mol^{-1} and –1676 kJ mol^{-1} respectively.

What is the enthalpy change under standard conditions for the following reaction?

$$3FeO(s) + 2Al(s) \rightarrow 3Fe(s) + Al_2O_3(s)$$

A +878 kJ **B** –878 kJ **C** –1942 kJ **D** –2474 kJ

9 Which substance, in 1 mol dm^{-3} aqueous solution, would have the same hydrogen ion concentration as 1 mol dm^{-3} of hydrochloric acid?

A ethanoic acid

B nitric acid

C sodium hydroxide

D sulphuric acid

10 When vanadium(II) compounds are dissolved in water, the following equilibrium is established.

$$V^{2+} + H_2O \rightleftharpoons V^{3+} + \tfrac{1}{2}H_2 + OH^-$$

What would alter the composition of the equilibrium mixture in favour of the V^{2+} ions?

A adding an acid

B adding a reagent that selectively precipitates V^{3+} ions

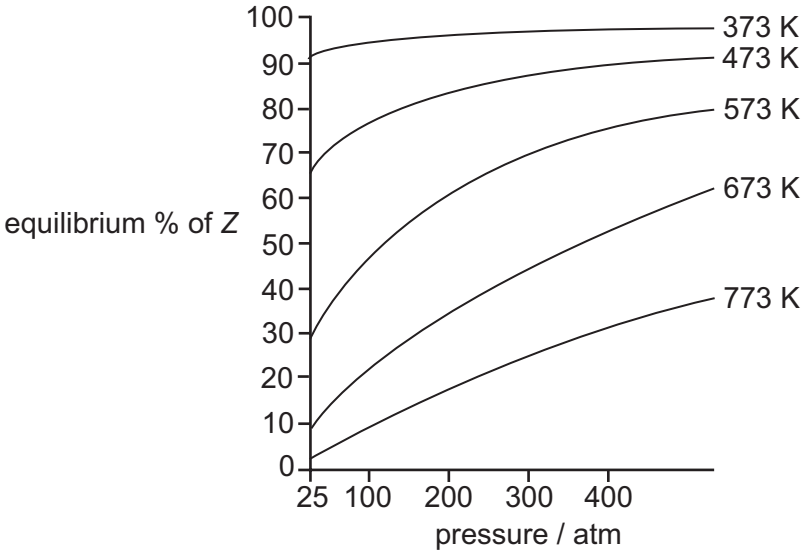
C allowing the hydrogen to escape as it forms

D making the solution more alkaline

11 In an industrial process, two gases *X* and *Y* react together to form a single gaseous product *Z*.

$$X(g) + Y(g) \rightleftharpoons Z(g)$$

The percentage yield of product *Z* varies according to the pressure and the temperature as shown in the graphs.



Which statement about this equilibrium reaction is correct?

A Decreasing the temperature decreases the value of the equilibrium constant.

B Decreasing the temperature increases the rate of this reaction.

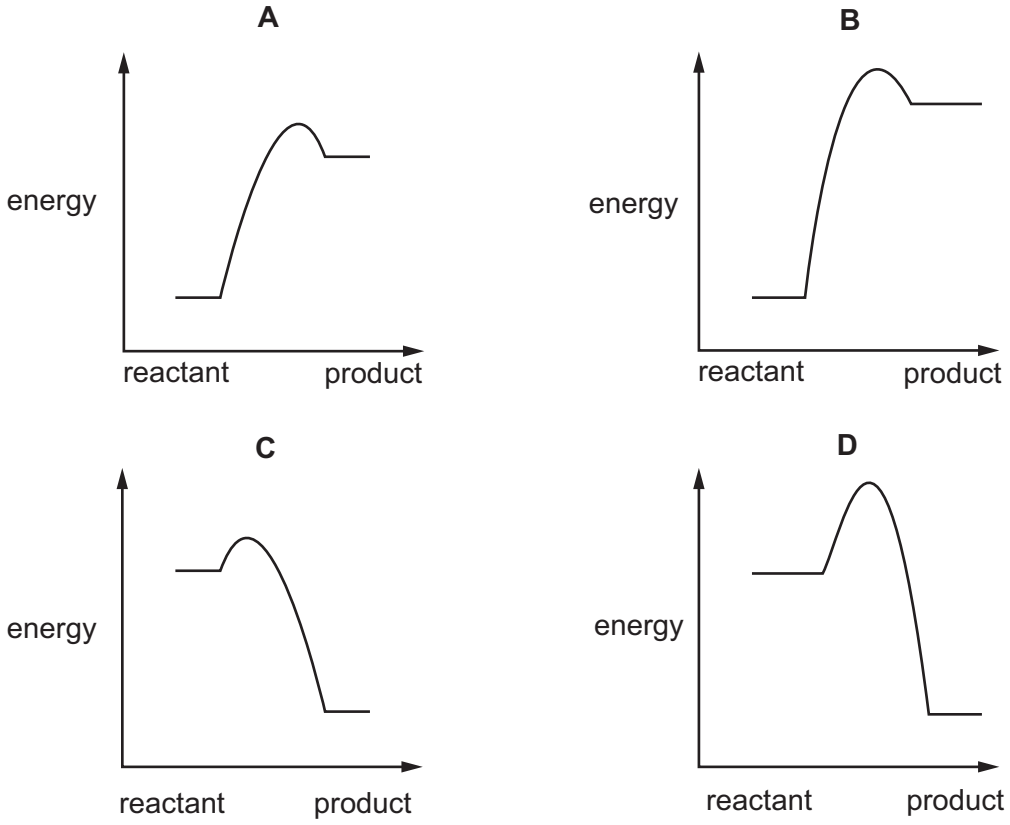
C Increasing the pressure increases the value of the equilibrium constant.

D The reaction is exothermic in the forward direction.

12 Four reactions of the type shown are studied at the same temperature.

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

Which is the correct reaction pathway diagram for the reaction that would proceed most rapidly and with good yield?



13 Which of these equations represents the reaction of sulphur dioxide with an excess of aqueous sodium hydroxide?

A $SO_2 + NaOH \rightarrow NaHSO_3$

B $SO_2 + 2NaOH \rightarrow Na_2SO_3 + H_2O$

C $SO_2 + 2NaOH \rightarrow Na_2SO_4 + H_2O$

D $SO_2 + 2NaOH \rightarrow Na_2SO_4 + H_2$

14 Which ion is most polarising?

A Al^{3+}

B Ba^{2+}

C Mg^{2+}

D Na^{+}

15 Which element has the same oxidation number in all of its known compounds?

A beryllium

B chlorine

C nitrogen

D sulphur

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 only burns slowly in oxygen.

D Lithium reacts violently with cold water, liberating hydrogen.

17 Which statement is most likely to be true for astatine, which is below iodine in Group VII of the Periodic Table?

A Astatine and aqueous potassium chloride react to form aqueous potassium astatide and chlorine.

B Potassium astatide and hot dilute sulphuric acid react to form white fumes of only hydrogen astatide.

C Silver astatide reacts with dilute aqueous ammonia in excess to form a solution of a soluble complex.

D Sodium astatide and hot concentrated sulphuric acid react to form astatine.

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

In the commercial electrolysis of brine, the products are chlorine, hydrogen and sodium hydroxide.

What is the maximum yield of each of these products when 58.5 kg of sodium chloride are electrolysed as brine?

	yield of chlorine / kg	yield of hydrogen / kg	yield of sodium hydroxide / kg
A	35.5	1	40
B	35.5	2	40
C	71	1	40
D	71	2	80

19 Nitrogen dioxide and sulphur dioxide have some properties in common.

Which property is shown by **one** of these compounds, but **not** by the other?

A forms 'acid-rain'

B is a reducing agent

C is insoluble in water

D is used as a food-preservative

20 Which molecule is planar?

A NF_3

B C_2Cl_4

C C_3H_6

D C_3H_8

21 Which of these always applies to a nucleophile?

A It attacks a double bond.

B It has a lone pair of electrons.

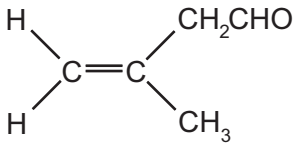
C It is a single atom.

D It is negatively charged.

22 Compound **P** displays *cis-trans* isomerism and gives a red-brown precipitate with Fehling's solution.

What is **P**?

A



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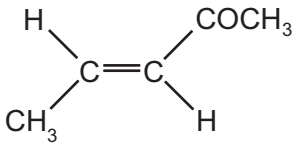

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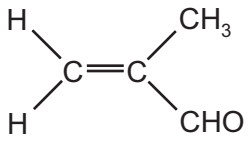
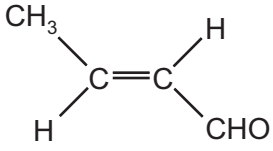


D



23 Which compound could **not** be obtained from cracking a sample of nonane, $CH_3(CH_2)_7CH_3$?

A $CH_3CH=CHCH=CHCH_2CH_2CH_2CH_3$

B $CH_3CH_2CH_2CH_2CH_3$

C $CH_3CH_2CH_2CH_2CH_2CH=CH_2$

D $(CH_3CH_2CH_2)_3CH$

24 In which way are ethene and propane similar?

$CH_2=CH_2$	$CH_3CH_2CH_3$
ethene	propane

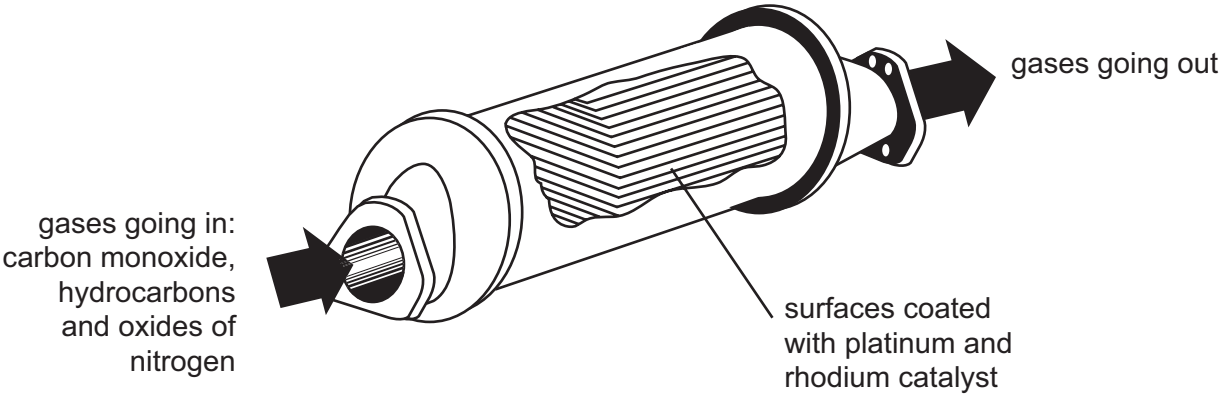
A They are both obtained by the dehydration of alcohols.

B They are both neutral to an indicator solution.

C They can both be hydrogenated using a suitable catalyst.

D They can both undergo polymerisation under suitable conditions.

25 Which reaction in the catalytic converter does **not** remove hazardous and polluting gases from the exhaust fumes of a motor car?



These equations are qualitative and unbalanced.
[HC = unburnt hydrocarbons; NO_x = oxides of nitrogen]

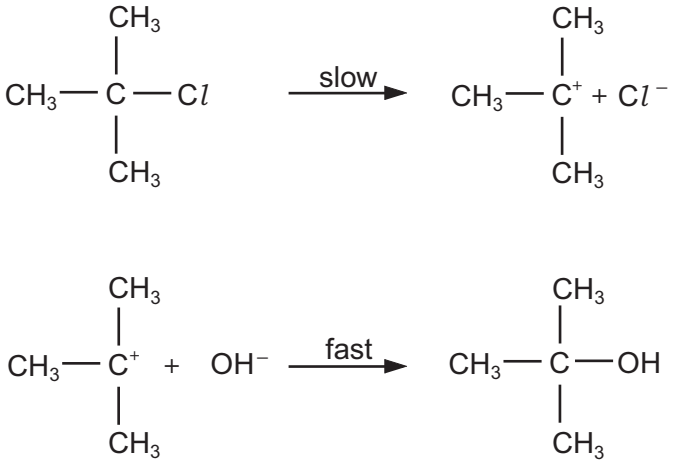
A $HC + NO_x \rightarrow H_2O + CO + N_2$

B $CO + NO_x \rightarrow CO_2 + N_2$

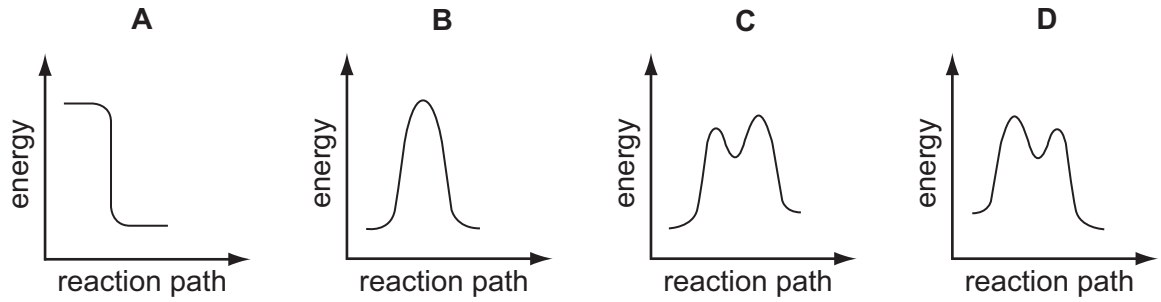
C $HC + NO_x \rightarrow H_2O + CO_2 + N_2$

D $CO + O_2 \rightarrow CO_2$

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



Which diagram represents the reaction profile for this mechanism?



27 Ethene reacts with aqueous bromine to give two products, CH_2BrCH_2Br and CH_2BrCH_2OH.

Which statement is correct for these products?

A Both products are obtained in this reaction by electrophilic substitution.

B Both products are obtained in this reaction by nucleophilic addition.

C Both products can be hydrolysed to form the same diol.

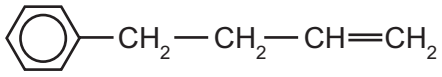
D Both products can form hydrogen bonds with water.

28 Compound **X**

- has the molecular formula $C_{10}H_{14}O$;
- is unreactive towards mild oxidising agents.

What is the structure of the compound formed by dehydration of **X**?

A



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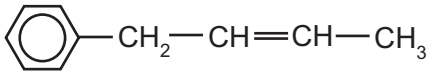

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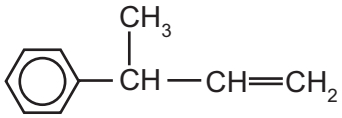

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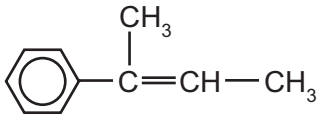


29 For which pair of compounds can the members be distinguished by means of Tollens' test (the use of a solution containing $Ag(NH_3)_2^+$)?

A CH_3CHO and CH_3COCH_3

B CH_3COCH_3 and $C_2H_5COCH_3$

C CH_3COCH_3 and $CH_3CO_2CH_3$

D CH_3CO_2H and $CH_3CO_2CH_3$

30 Compound **X** changes the colour of acidified sodium dichromate(VI) from orange to green. 1 mol of **X** reacts with 2 mol of HCN(g).

What could **X** be?

A $CH_3COCH_2COCH_3$

B $CH_3CH_2CH_2CHO$

C $H_2C{=}CHCH_2CHO$

D $OHCCH_2CH_2CHO$

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 The isotope cobalt-60 ($^{60}_{27}Co$) is used to destroy cancer cells in the human body.

Which statements about an atom of cobalt-60 are correct?

1 It contains 33 neutrons.

2 Its nucleus has a relative charge of 27+.

3 It has a different number of neutrons from the atoms of other isotopes of cobalt.

32 The conversion of graphite has only a small positive value of ΔH.

$$C\ (graphite) \rightarrow C\ (diamond) \qquad \Delta H = +2.1\ kJ\ mol^{-1}$$

However, the production of synthetic diamonds using this reaction is very difficult.

Which statements help to explain this?

1 The activation energy of the reaction is large.

2 An equilibrium exists between diamond and graphite.

3 Only exothermic reactions can be made to occur readily.

33 Which statements about the properties of a catalyst are correct?

1 A catalyst increases the average kinetic energy of the reacting particles.

2 A catalyst increases the rate of the reverse reaction.

3 A catalyst has no effect on the enthalpy change $\Delta H^{\ominus}$ of the reaction.

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 pairs of compounds contain one that is giant ionic and one that is simple molecular?

1 Al_2O_3 and Al_2Cl_6

2 SiO_2 and $SiCl_4$

3 P_4O_{10} and PCl_3

35 When coal is burnt, gaseous oxides of carbon and sulphur are formed which pollute the atmosphere. One method of preventing such pollution involves adding calcium carbonate to the burning coal. The temperature of the process causes the decomposition of the calcium carbonate into calcium oxide.

Which reactions will be important in helping to reduce atmospheric pollution?

1 Calcium oxide reacts with sulphur dioxide to form calcium sulphite.

2 Calcium oxide reacts with sulphur dioxide and more air to form calcium sulphate.

3 Calcium oxide reacts with carbon monoxide to form calcium carbonate.

36 When a hot glass rod is placed in a gas jar of hydrogen iodide, there is an immediate reaction as the hydrogen iodide decomposes.

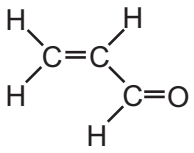
Which statements about this reaction are correct?

1 Hydrogen iodide is purple coloured.

2 The hot rod provides the activation energy.

3 One of the products is a solid.

37 Acrolein is produced in photochemical smog. It has a strong smell, irritates eyes and mucous membranes and is carcinogenic.



acrolein

What can be deduced from this structure?

1 All bond angles are approximately 120°.

2 It will undergo electrophilic addition reactions.

3 It will undergo nucleophilic addition reactions.

38 What can be produced when an aqueous solution of butan-1-ol is heated with dilute acidified potassium manganate(VII)?

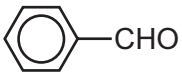
1 butanal

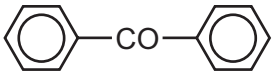
2 butanoic acid

3 butanone

39 Which carbonyl compounds could be easily oxidised to carboxylic acids that are readily soluble in cold water?

1 CH_3CH_2CHO

2 

3 

40 Which properties of poly(alkenes) and of pvc can cause their disposal to be difficult?

1 Poly(alkenes) are highly flammable.

2 Poly(alkenes) are non–biodegradable.

3 pvc produces harmful combustion products.

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