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

CHEMISTRY **9701/01**

Paper 1 Multiple Choice

October/November 2006

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.

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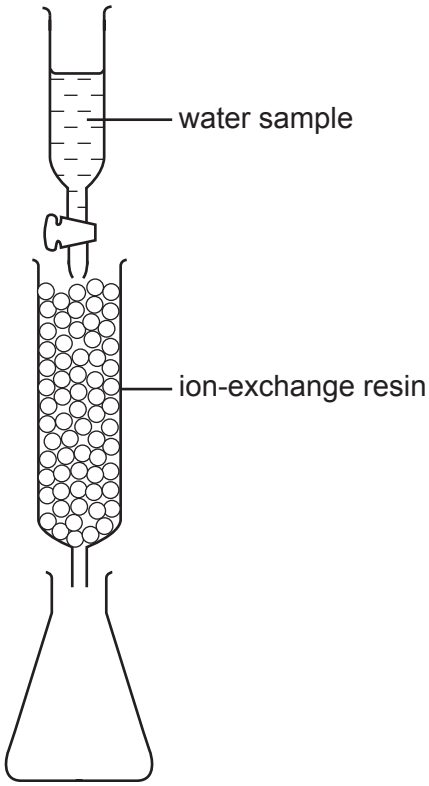
Section A

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

1 The amount of calcium ions in a sample of natural water can be determined by using an ion-exchange column as shown in the diagram.



A 50 cm^3 sample of water containing dissolved calcium sulphate was passed through the ion-exchange resin. Each calcium ion in the sample was exchanged for two hydrogen ions. The resulting acidic solution collected in the flask required 25 cm^3 of 1.0×10^{-2} mol dm^{-3} potassium hydroxide for complete neutralisation.

What was the concentration of the calcium sulphate in the original sample?

A 2.5×10^{-3} mol dm^{-3}

B 1.0×10^{-2} mol dm^{-3}

C 2.0×10^{-2} mol dm^{-3}

D 4.0×10^{-2} mol dm^{-3}

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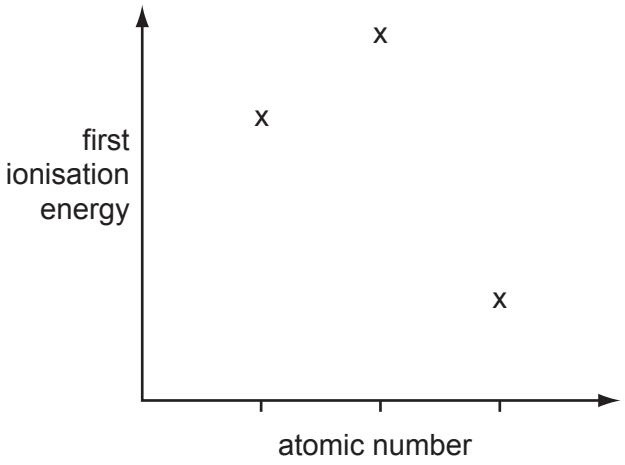
2 Three successive elements in the Periodic Table have first ionisation energies which have the pattern shown in the diagram.



What could be the first element of this sequence?

A C **B** N **C** F **D** Na

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

The electronic structures of calcium, krypton, phosphorus and an element **X** are shown.

Which electronic structure is that of element **X**?

A $1s^2 2s^2 2p^6 3s^2 3p^3$

B $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$

C $1s^2 2s^2 2p^6 3s^2 3p^6 3d^6 4s^2$

D $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6$

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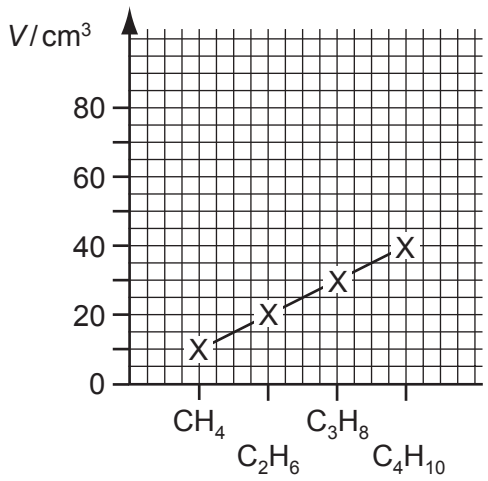
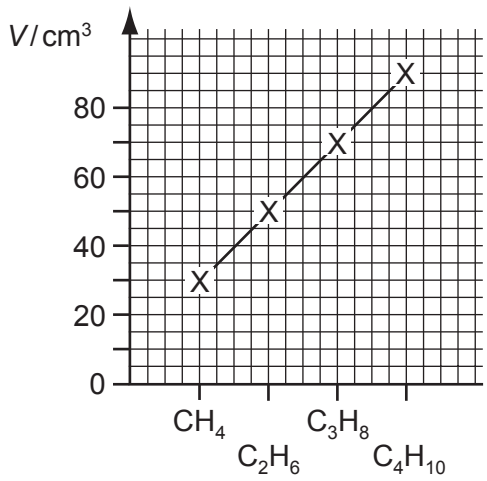
4 Samples of 10 cm^3 of each of the first four members of the alkane series are separately mixed with 70 cm^3 of oxygen. Each is then burned and the total volume, *V*, of residual gas measured again at room temperature and pressure.

Which graph represents the results that would be obtained?

A



B



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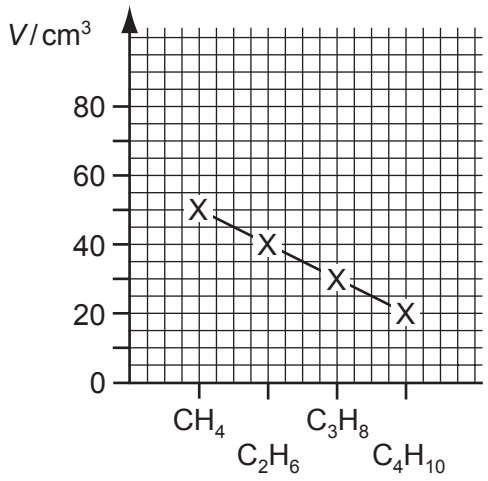

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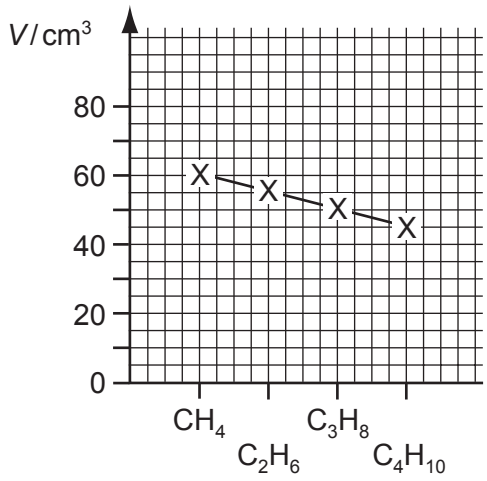

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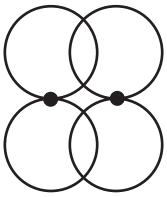
5 Which diagram describes the formation of a π bond from the overlap of its orbitals?

A



B



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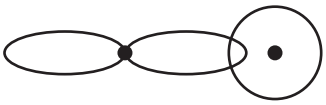

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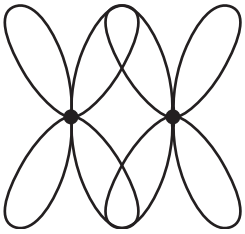
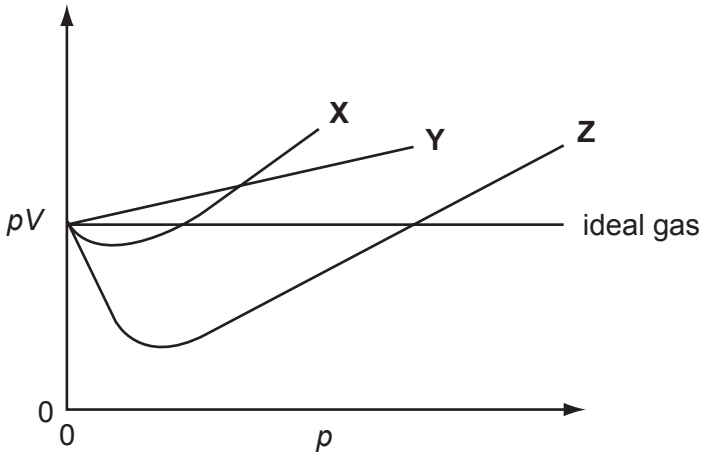


6 For an ideal gas, the plot of pV against p is a straight line. For a real gas, such a plot shows a deviation from ideal behaviour. The plots of pV against p for three real gases are shown below.

The gases represented are ammonia, hydrogen and nitrogen.



What are the identities of the gases **X**, **Y** and **Z**?

	X	Y	Z
A	ammonia	nitrogen	hydrogen
B	hydrogen	nitrogen	ammonia
C	nitrogen	ammonia	hydrogen
D	nitrogen	hydrogen	ammonia

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7 Magnesium oxide may be used for the lining of an electric furnace for making crockery.

Which properties of magnesium oxide help to explain this use?

	strong forces between particles	ionic bonding	electrical conductor
A	yes	yes	no
B	yes	no	yes
C	no	yes	no
D	no	no	yes

8 For which equation is the enthalpy change correctly described as an enthalpy change of formation?

A $2NO(g) \rightarrow N_2(g) + O_2(g)$

B $2CO(g) + O_2(g) \rightarrow 2CO_2(g)$

C $H_2O(l) + NaCl(s) \rightarrow NaCl(aq)$

D $K(s) + Mn(s) + 2O_2(g) \rightarrow KMnO_4(s)$

9 Given $CO(g) + \frac{1}{2}O_2(g) \rightarrow CO_2(g)$ $\Delta H^{\ominus} = -283\ kJ\,mol^{-1}$

$H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l)$ $\Delta H^{\ominus} = -286\ kJ\,mol^{-1}$

$H_2O(g) \rightarrow H_2O(l)$ $\Delta H^{\ominus} = -44\ kJ\,mol^{-1}$

what is the change in enthalpy, $\Delta H^{\ominus}$, for the following reaction?

$$CO_2(g) + H_2(g) \rightarrow CO(g) + H_2O(g)$$

A $-525\ kJ\,mol^{-1}$ **B** $-41\ kJ\,mol^{-1}$ **C** $+41\ kJ\,mol^{-1}$ **D** $+525\ kJ\,mol^{-1}$

10 In some early paintings, lead(II) carbonate was used as a white pigment. In the 19th century hydrogen sulphide from burning coal reacted with this pigment to form black lead(II) sulphide, PbS. The original colour of the painting may be restored by carefully treating the area with dilute hydrogen peroxide, producing lead(II) sulphate which is also white.

What is the role of the hydrogen peroxide?

A catalyst

B oxidising agent

C reducing agent

D solvent

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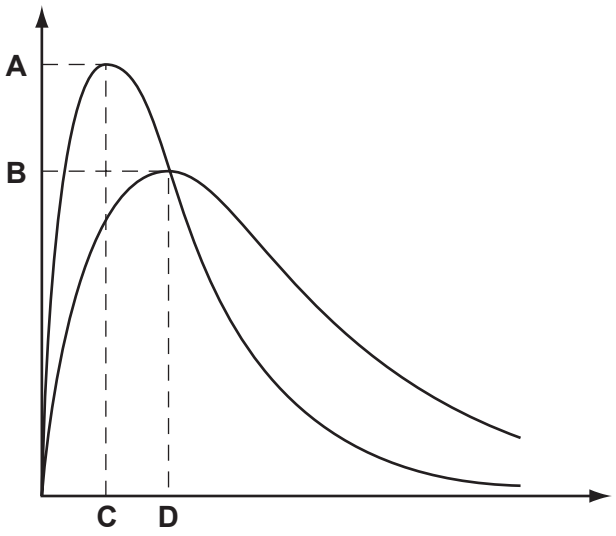
11 The equilibrium constant, K_c, for the reaction to form ethyl ethanoate from ethanol and ethanoic acid, $C_2H_5OH + CH_3CO_2H \rightleftharpoons CH_3CO_2C_2H_5 + H_2O$, at 60 °C is 4.00.

When 1.00 mol each of ethanol and 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** $\frac{3}{4}$

12 The diagram shows the Maxwell-Boltzmann energy distribution curves for molecules of a sample of a gas at two different temperatures.

Which letter on the axes represents the most probable energy of the molecules at the lower temperature?



13 Steam is passed over heated magnesium to give compound **X** and hydrogen.

What is **not** a property of compound **X**?

A It has a high melting point.

B It is a basic oxide.

C It is a white solid.

D It is very soluble in water.

14 A 5.00 g sample of an anhydrous Group II metal nitrate loses 3.29 g in mass on strong heating.

Which metal is present?

A magnesium

B calcium

C strontium

D barium

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15 Which of the following is **not** a correct statement about iodine?

A A crystal of iodine contains covalent bonds and van der Waals' forces.

B Iodine vapour is purple.

C The first ionisation energy of iodine is less than that of bromine.

D The hydride of iodine is of greater thermal stability than that of bromine.

16 Mixing aqueous silver nitrate and aqueous sodium chloride produces a precipitate.

Addition of which reagent to the mixture gives a colourless solution?

A aqueous ammonia

B aqueous potassium iodide

C dilute hydrochloric acid

D dilute nitric acid

17 Which is the complete list of all the products from the reaction of concentrated sulphuric acid with potassium bromide?

A potassium hydrogensulphate and hydrogen bromide

B potassium hydrogensulphate, hydrogen bromide and bromine

C potassium hydrogensulphate, hydrogen bromide, bromine and water

D potassium hydrogensulphate, hydrogen bromide, bromine, water and sulphur dioxide

18 Sulphur dioxide is an important food preservative.

Which property makes sulphur dioxide useful in this role?

A It is a gas.

B It is a reducing agent.

C It reacts with oxygen to form sulphur trioxide.

D It reacts with water to form an acidic solution.

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19 In the Contact process for the production of sulphuric acid, sulphur dioxide is mixed with air and passed over a vanadium(V) oxide catalyst at about 450 °C and a pressure slightly above atmospheric pressure.

$$2SO_2 + O_2 \rightleftharpoons 2SO_3 \; ; \; \Delta H \text{ negative}$$

What affects the choice of conditions for this reaction?

A A lower temperature would not raise the concentration of SO_3 at equilibrium.

B At a lower temperature of 300 °C the V_2O_5 catalyst would not be effective.

C At 450 °C nitrogen and oxygen from the air combine to form nitrogen oxides which are needed as additional catalysts.

D The heat generated by the reaction raises the temperature of the catalyst bed to 600 °C at which temperature the reaction begins to take place.

20 In which class of compound, in its general formula, is the ratio of hydrogen atoms to carbon atoms the highest?

A alcohols

B aldehydes

C carboxylic acids

D halogenoalkanes

21 What is the total number of different chloroethanes, formula $C_2H_{6-n}Cl_n$, where n can be any integer from 1 to 4?

A 4 **B** 6 **C** 7 **D** 8

22 Which reaction is an example of nucleophilic substitution?

A $CH_3CH_2Br \rightarrow CH_2{=}CH_2 + HBr$

B $CH_2{=}CH_2 + HBr \rightarrow CH_3CH_2Br$

C $C_3H_7Br + H_2O \rightarrow C_3H_7OH + HBr$

D $C_2H_6 + Br_2 \rightarrow C_2H_5Br + HBr$

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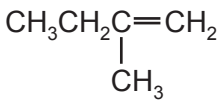
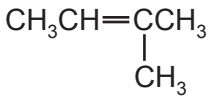
23 Which alkene could exist in *cis* and *trans* forms?

A $CH_3CH_2CH_2CH{=}CH_2$

B $CH_3CH_2CH{=}CHCH_3$

C


D


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

flammable non-flammable poisonous

Which gas is non-flammable?

A butane

B hydrogen

C oxygen

D propene

25 Which equation or statement describes what happens when poly(propene) is burned in an excess of air?

A $(C_3H_6)_n + 1\frac{1}{2}\,nO_2 \rightarrow 3nC + 3nH_2O$

B $(C_3H_6)_n + 4\frac{1}{2}\,nO_2 \rightarrow 3nCO_2 + 3nH_2O$

C $(C_3H_6)_n + 6nO_2 \rightarrow 3nCO_2 + 3nH_2O$

D Poly(propene) does not burn.

26 When (chloromethyl)benzene, $C_6H_5CH_2Cl$, is treated in succession with two reagents **X** and **Y**, it gives phenylethanoic acid, $C_6H_5CH_2CO_2H$.

What are reagents **X** and **Y**?

	X	**Y**
A	NaOH(aq)	$K_2Cr_2O_7$(aq)
B	Cl_2(aq)	NaOH(aq)
C	NaCN (in aqueous ethanol)	dilute H_2SO_4
D	NaOH(aq)	CO_2

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27 Which compound

- is unaffected by hot alkaline potassium manganate(VII);
- gives hydrogen when treated with sodium?

A $(CH_3)_2CHCOCH_3$

B $(CH_3)_3COH$

C $CH_3CH_2CH(OH)CH_3$

D $CH_3CO_2CH(CH_3)_2$

28 A common industrial solvent is a mixture of propanone, CH_3COCH_3, and pentyl ethanoate $CH_3CO_2(CH_2)_4CH_3$.

Which reagent would have no effect on this solvent?

A Na(s)

B $NaBH_4$

C NaOH(aq)

D 2,4-dinitrophenylhydrazine reagent

29 Apples, the fruit of trees of the genus *Malus*, are rich in malic acid. Malic acid may be synthesised in the laboratory in two steps.

$$NCCH_2CHO \xrightarrow{\text{step 1}} X \xrightarrow{\text{step 2}} HO_2CCH_2CH(OH)CO_2H$$

malic 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)	HC*l*(aq)

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30 Which pair of compounds is formed when the ester $C_2H_5CO_2CH_3$ is boiled with aqueous sodium hydroxide?

A $C_2H_5CO_2H$ CH_3OH

B $C_2H_5CO_2Na$ CH_3ONa

C $C_2H_5CO_2Na$ CH_3OH

D C_2H_5OH CH_3CO_2Na

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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 The chlorine oxide free radical, $ClO^{\bullet}$, is formed during the depletion of the ozone layer by chlorofluoroalkanes (CFCs).

$$Cl^{\bullet} + O_3 \rightarrow ClO^{\bullet} + O_2$$

Which features are present in the chlorine oxide free radical?

1 an odd number of electrons

2 a single covalent bond

3 a dative covalent bond from oxygen to chlorine

32 Concentrated sulphuric acid behaves as a strong acid when it reacts with water.

$$H_2SO_4(l) + aq \rightarrow H^+(aq) + HSO_4^-(aq)$$

The HSO_4^- ion formed behaves as a weak acid.

$$HSO_4^-(aq) \rightleftharpoons H^+(aq) + SO_4^{2-}(aq)$$

Which statements are true for $1.0\,mol\,dm^{-3}$ sulphuric acid?

1 $[H^+(aq)]$ is high

2 $[SO_4^{2-}(aq)]$ is high

3 $[HSO_4^-(aq)] = [SO_4^{2-}(aq)]$

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.

33 A reversible reaction is catalysed.

Which statements about the effects of the catalyst on this system are correct?

1 The catalyst alters the mechanism of the reaction.

2 The catalyst reduces the energy of activation (the energy barrier) for both the forward and the backward reaction.

3 The catalyst alters the composition of the equilibrium mixture.

34 Which magnesium compounds lose mass when heated by a Bunsen flame?

1 magnesium carbonate

2 magnesium nitrate

3 magnesium oxide

35 What happens when chlorine is bubbled through aqueous sodium hydroxide solution?

1 In cold solution, $Cl O^-(aq)$ ions are formed.

2 In hot solution, $ClO_3^-(aq)$ ions are formed.

3 Disproportionation of chlorine occurs in both cold and hot aqueous solutions.

36 Which fertilisers, when washed out of soil by rain, cause excessive growth of river plants and algae with the result that fish in the river die?

1 K_2SO_4

2 NH_4NO_3

3 $NaNO_3$

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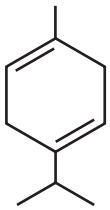
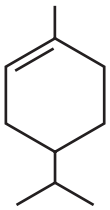
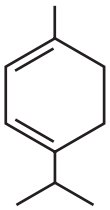
37 The following three hydrocarbons all occur naturally.

Which of these will be split into two organic compounds, both containing a ketone group, when treated with hot acidified potassium manganate(VII)?

1 

2 

3 

38 Which are properties of fluoroalkanes?

1 They are less reactive than the corresponding chloroalkanes.

2 They are non-flammable.

3 The C-F bond is stronger than a C-C*l* bond.

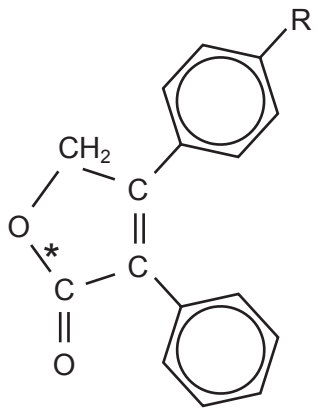
39 Which compounds are able to react with concentrated sulphuric acid to give a product that will decolourise acidic potassium manganate(VII)?

1 $(CH_3)_3COH$

2 $CH_3CH_2CH(OH)CH_3$

3 CH_3CO_2H

40 Rofecoxib, an efficient drug against arthritis, has the following structure. R is an inert group.



Which reactions are possible with this structure?

1 The bond marked * is hydrolysed by heating with aqueous sodium hydroxide.

2 Aqueous bromine is decolourised.

3 An orange precipitate is formed with 2,4-dinitrophenylhydrazine reagent.

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