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

CHEMISTRY **9701/01**

Paper 1 Multiple Choice

May/June 2005

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.
You may use a calculator.

IB05 06_9701_01/3RP
© UCLES 2005

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 pure hydrocarbon is used in bottled gas for cooking and heating.

When 10 cm^3 of the hydrocarbon is burned in 70 cm^3 of oxygen (an excess), the final gaseous mixture contains 30 cm^3 of carbon dioxide and 20 cm^3 of unreacted oxygen. All gaseous volumes were measured under identical conditions.

What is the formula of the hydrocarbon?

A C_2H_6 **B** C_3H_6 **C** C_3H_8 **D** C_4H_{10}

2 On collision, airbags in cars inflate rapidly due to the production of nitrogen.

The nitrogen is formed according to the following equations.

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

$$10Na + 2KNO_3 \rightarrow K_2O + 5Na_2O + N_2$$

How many moles of nitrogen gas are produced from 1 mol of sodium azide, NaN_3?

A 1.5 **B** 1.6 **C** 3.2 **D** 4.0

3 The first six ionisation energies of four elements, **A** to **D**, are given.

Which element is most likely to be in Group IV of the Periodic Table?

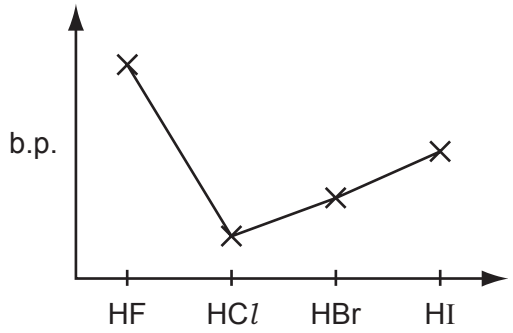
ionisation energy / kJ mol^{-1}	1st	2nd	3rd	4th	5th	6th
A	494	4560	6940	9540	13400	16600
B	736	1450	7740	10500	13600	18000
C	1090	2350	4610	6220	37800	47000
D	1400	2860	4590	7480	9400	53200

4 In which species are the numbers of electrons and neutrons equal?

A $^{9}_{4}Be$ **B** $^{19}_{9}F$ **C** $^{23}_{11}Na^{+}$ **D** $^{18}_{8}O^{2-}$

© UCLES 2005

5 The diagram shows the variation of the boiling points of the hydrogen halides.



What explains the higher boiling point of hydrogen fluoride?

A The bond energy of HF molecules is greater than in other hydrogen halides.

B The effect of nuclear shielding is much reduced in fluorine which polarises the HF molecule.

C The electronegativity of fluorine is much higher than for other elements in the group.

D There is hydrogen bonding between HF molecules.

6 Three substances, *R*, *S*, *T*, have physical properties as shown.

substance	mp / °C	bp / °C	electrical conductivity	
			of solid	of liquid
R	801	1413	poor	good
S	2852	3600	poor	good
T	3550	4827	good	not known

What could be the identities of *R*, *S* and *T* ?

	R	*S*	*T*
A	NaF	KCl	Cu
B	NaBr	BaO	SiO_2
C	NaCl	MgO	C [graphite]
D	NaBr	CaO	C [diamond]

© UCLES 2005

7 Iodine trichloride, ICl_3, is made by reacting iodine with chlorine.

$$I_2(s) + Cl_2(g) \rightarrow 2ICl(s) \;\; ; \;\; \Delta H^{\ominus} = +14\,kJ\,mol^{-1}$$

$$ICl(s) + Cl_2(g) \rightarrow ICl_3(s) \;\; ; \;\; \Delta H^{\ominus} = -88\,kJ\,mol^{-1}$$

By using the data above, what is the enthalpy change of the formation for solid iodine trichloride?

A $-60\,kJ\,mol^{-1}$

B $-74\,kJ\,mol^{-1}$

C $-81\,kJ\,mol^{-1}$

D $-162\,kJ\,mol^{-1}$

8 In the extraction of aluminium by electrolysis, why is it necessary to dissolve aluminium oxide in molten cryolite?

A to reduce the very high melting point of the electrolyte

B cryolite provides the ions needed to carry the current

C cryolite reacts with the aluminium oxide to form ions

D molten aluminium oxide alone would not conduct electricity

9 A cheap carbon monoxide detector for a gas heater consists of a patch containing palladium chloride crystals. When carbon monoxide is present, the crystals turn from orange to black as the following reaction takes place.

$$\underset{\text{orange}}{CO(g) + PdCl_2(s)} + H_2O(l) \rightarrow CO_2(g) + \underset{\text{black}}{Pd(s)} + 2HCl(aq)$$

Which is the element whose oxidation number **decreases** in this reaction?

A carbon

B chlorine

C hydrogen

D palladium

© UCLES 2005

10 The dissociation of dinitrogen tetraoxide into nitrogen dioxide is represented by the equation below.

$$N_2O_4(g) \rightleftharpoons 2NO_2(g); \qquad \Delta H^{\ominus} = +57\,kJ\,mol^{-1}$$

If the temperature of an equilibrium mixture of the gases is increased at constant pressure, will the volume of the mixture increase or decrease and why?

A The volume will increase, but only because of a shift of equilibrium towards the right.

B The volume will increase, both because of a shift of equilibrium towards the right and also because of thermal expansion.

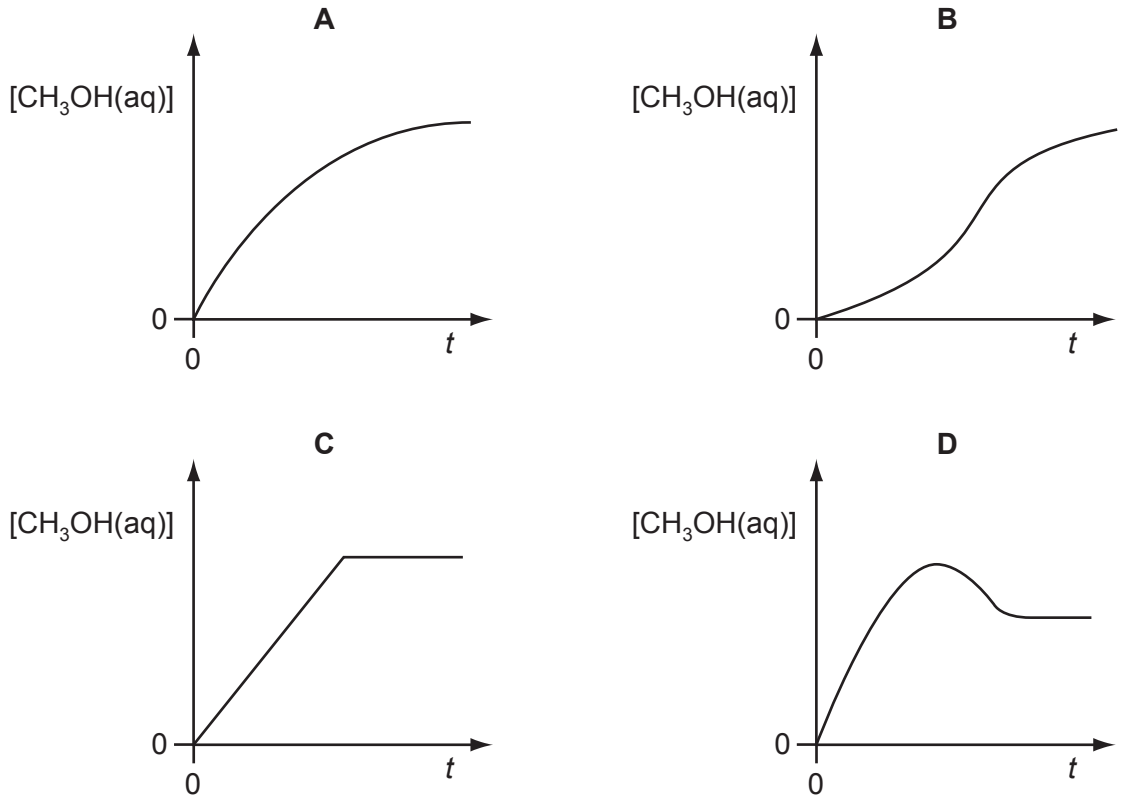
C The volume will stay the same, because any thermal expansion could be exactly counteracted by a shift of equilibrium towards the left.

D The volume will decrease, because a shift of equilibrium towards the left would more than counteract any thermal expansion.

11 The reaction represented by the following equation was carried out.

$$HCO_2CH_3(aq) + NaOH(aq) \rightarrow HCO_2Na(aq) + CH_3OH(aq)$$

Which graph best shows the relationship between $[CH_3OH(aq)]$ and t, the time from mixing of the reactants?



12 The following species contain the same number of electrons.

In which order do their radii increase?

	smallest radius ⟶		largest radius
A	Ar	K^+	Ca^{2+}
B	Ca^{2+}	Ar	K^+
C	Ca^{2+}	K^+	Ar
D	K^+	Ar	Ca^{2+}

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

Which element is likely to have an electronegativity similar to that of aluminium?

A barium

B beryllium

C magnesium

D strontium

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

Which is true for calcium or its compounds compared with the corresponding statements for magnesium?

A Calcium has a smaller atomic radius.

B Calcium oxide reacts less vigorously with water.

C Calcium reacts more vigorously with water.

D The sum of the first two ionisation energies of calcium is greater.

15 Concentrated sulphuric acid is added to separate solid samples of sodium chloride, sodium bromide or sodium iodide.

With which sample(s) does sulphuric acid act as an oxidising agent?

A sodium chloride only

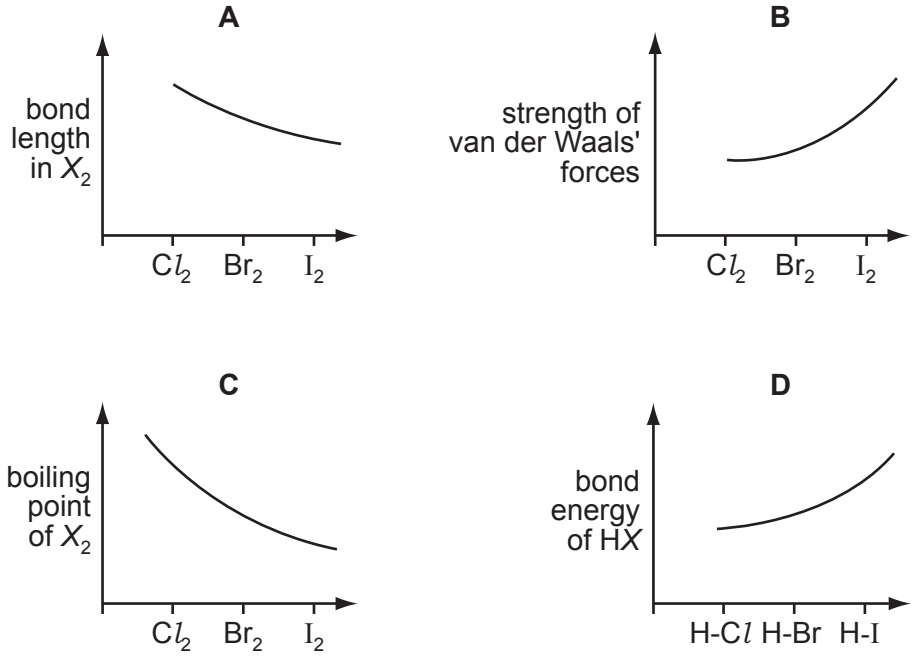
B sodium chloride and sodium bromide

C sodium bromide and sodium iodide

D sodium iodide only

© UCLES 2005

16 Which graph correctly describes a trend found in the halogen group?



17 Limestone, $CaCO_3$, has been used as a building material for thousands of years, and was used on the Pyramids in Egypt. In the past hundred years many limestone buildings have begun to suffer damage.

What is the cause of this damage?

A hydrocarbon emissions from motor vehicles

B increased temperature due to global warming

C increased ultraviolet radiation as the ozone layer is destroyed

D sulphur dioxide from fossil fuels forming 'acid rain'

18 In an historically famous experiment Wöhler heated "inorganic" ammonium cyanate in the absence of air. The only product of the reaction was "organic" urea, $CO(NH_2)_2$. No other products were formed in the reaction.

What is the formula of the cyanate ion present in ammonium cyanate?

A CNO^- **B** CNO^{2-} **C** CO^- **D** NO^-

19 Bromomethane, CH_3Br, is used as a fumigant to destroy insect pests in grain that is to be stored. It can be made by reacting methanol with hydrogen bromide.

$$CH_3OH + HBr \rightarrow CH_3Br + H_2O$$

What type of reaction is this?

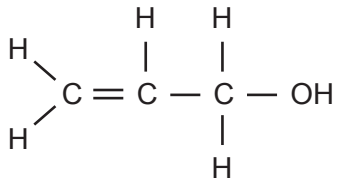
A condensation

B electrophilic substitution

C free radical substitution

D nucleophilic substitution

20 Prop-2-en-1-ol (allyl alcohol) has the following structure.



Which reagent would react with prop-2-en-1-ol to form a product that could exist as optical isomers?

A bromine

B hydrogen and nickel

C phosphorus pentachloride

D sodium

21 Under the Montreal Protocol the use of chlorofluorocarbons is to be phased out. Fluorocarbons are often used to replace them. One chlorofluorocarbon which was widely used as a solvent is CCl_2FCClF_2 and large stocks of it remain. One process to use up these stocks is to convert it into the fluorocarbon CH_2FCF_3 by the following route.

$$CCl_2FCClF_2 \xrightarrow{\text{step 1}} CCl_3CF_3 \xrightarrow{\text{step 2}} CCl_2FCF_3 \xrightarrow{\text{step 3}} CH_2FCF_3$$

What type of reaction is step 1?

A elimination

B free radical substitution

C isomerisation

D nucleophilic substitution

© UCLES 2005

22 When bromine reacts with propene in an organic solvent at room temperature, what is the mechanism by which the bromine attacks the propene?

A electrophilic addition

B electrophilic substitution

C nucleophilic addition

D nucleophilic substitution

23 Dichlorodifluoromethane, CCl_2F_2, has been used in aerosol propellants and as a refrigerant.

Which statement helps to explain why dichlorodifluoromethane is chemically inert?

A The carbon-fluorine bond energy is large.

B The carbon-fluorine bond has a low polarity.

C Fluorine is highly electronegative.

D Fluorine compounds are non-flammable.

24 Under identical conditions, even though it proceeds by the same mechanism, reaction 1 is faster than reaction 2.

reaction 1 $CH_3CHBrCH_3 + NaCN \rightarrow CH_3CH(CN)CH_3 + NaBr$

reaction 2 $CH_3CHBrCH_3 + NaI \rightarrow CH_3CHICH_3 + NaBr$

What factor will explain this result?

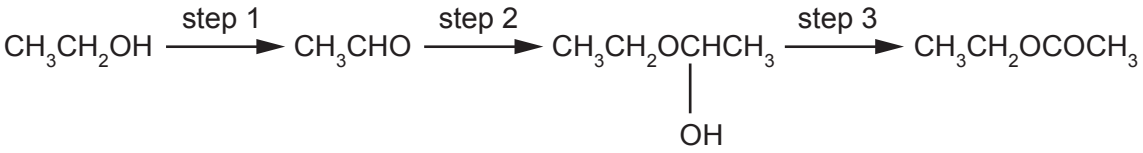
A The C — I bond is a stronger bond than the C — Br bond.

B The C — N bond is a stronger bond than the C — I bond.

C The cyanide ion is a stronger nucleophile than the iodide ion.

D The cyanide ion is a weaker nucleophile than the iodide ion.

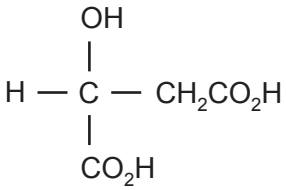
25 Ethyl ethanoate is a very important solvent in industry. Currently, researchers are investigating ways of producing the ester from cheap, low grade ethanol by the following process.



What types of reaction are steps 1 and 3?

	step 1	step 3
A	elimination	esterification
B	elimination	isomerisation
C	oxidation	esterification
D	oxidation	oxidation

26 Malic acid occurs in apples.



malic acid

Which substance will react with all three –OH groups present in the malic acid molecule?

A ethanol in the presence of concentrated sulphuric acid

B potassium hydroxide

C sodium

D sodium carbonate

27 Which compound reacts with its own oxidation product (an oxidation which involves no loss of carbon) to give a sweet-smelling liquid?

A propanal

B propanoic acid

C propanone

D propan–1–ol

© UCLES 2005

28 Which reagent could be used to distinguish between

$CH_3CH(OH)CH_2CHO$ and $CH_3COCH_2CH_2OH$?

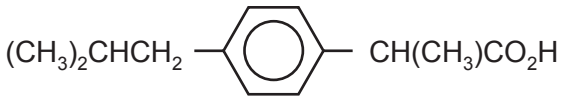
A acidified potassium dichromate(VI)

B dilute sulphuric acid

C 2,4–dinitrophenylhydrazine

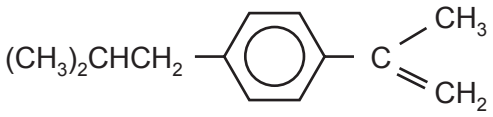
D Fehling's reagent

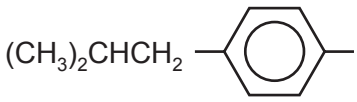
29 Ibuprofen is an anti-inflammatory drug.

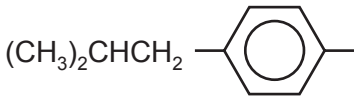


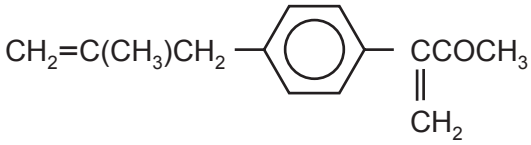
ibuprofen

What reaction would lead to its formation?

A  + hot concentrated $KMnO_4$

B  + warm acidified $K_2Cr_2O_7$

C  + warm $H_2SO_4(aq)$

D  + H_2 / Pt catalyst

30 In many countries plastic waste is collected separately and sorted. Some of this is incinerated to provide heat for power stations.

Why is pvc, polyvinylchloride, removed from any waste that is to be incinerated?

A It can be melted down and re-used.

B Its combustion products are harmful.

C It destroys the ozone layer.

D It does not burn easily.

© UCLES 2005

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.

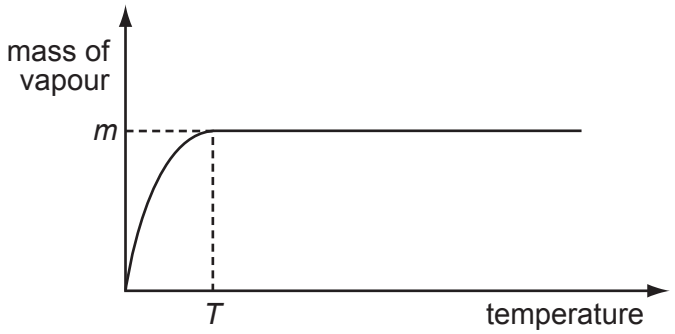
31 Which of the following molecules and ions have a regular trigonal planar shape?

1 $AlCl_3$

2 CH_3^+

3 PH_3

32 A quantity of solid *Y* was placed in a previously evacuated vessel and the apparatus was then held at a series of different temperatures. At each temperature, the mass of *Y* in the vapour state was calculated from pressure measurements. The results are shown below.



What can be deduced from the diagram?

1 The mass of *Y* used in the experiment was *m*.

2 The pressure of the vapour was constant for all temperatures above temperature *T*.

3 Liquid appeared at temperature *T*.

© UCLES 2005

33 Which of the enthalpy changes of the following reactions can **only** be obtained by application of Hess' Law?

1 The hydration of anhydrous copper sulphate to form crystals of $CuSO_4.5H_2O$.

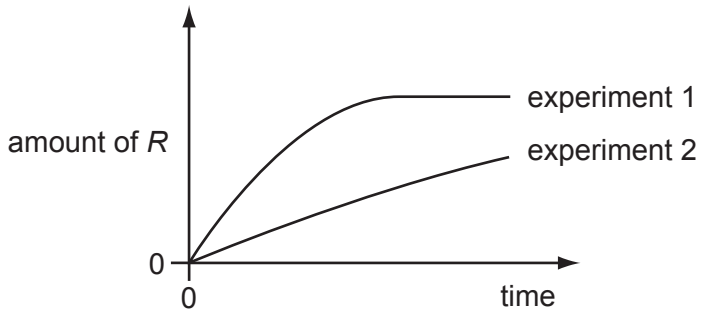
2 The formation of methane from its elements.

3 The combustion of glucose, $C_6H_{12}O_6$.

34 The stoichiometry of a catalysed reaction is shown by the equation below.

$$P(g) + Q(g) \rightleftharpoons R(g) + S(g)$$

Two experiments were carried out in which the production of *R* was measured against time. The results are shown in the diagram below.



Which changes in the conditions from experiment 1 to experiment 2 might explain the results shown?

1 Less of *P* was used.

2 A different catalyst was used.

3 Product *S* was continuously removed from the reaction vessel.

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

Which properties would be expected from radium, $_{88}Ra$, or its compounds?

1 Radium carbonate decomposes only at a very high temperature.

2 Radium hydroxide is very insoluble.

3 Radium does not react with cold water.

© UCLES 2005

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 number of moles of chlorine that react with 1 mol of *X* is twice the number of moles of chlorine that react with 1 mol of *Y*.

Which of these pairs could be *X* and *Y*?

	X	*Y*
1	Mg(s)	Na(s)
2	H_2	KBr(aq)
3	cold NaOH(aq)	hot NaOH(aq)

37 Which statements are true about the Haber process for the manufacture of ammonia?

1 At higher temperatures, the yield goes down but the rate of production of ammonia is faster.

2 At higher pressures, the yield goes down but the rate of production of ammonia is faster.

3 In the presence of a catalyst, the yield goes down but the rate of production of ammonia is faster.

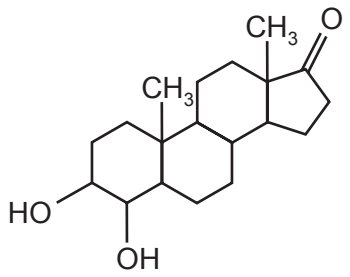
38 Which compounds can be obtained from ethene in a **single** reaction?

1 CH_3CH_3

2 $-(-CH_2CH_2-)-_n$

3 $HOCH_2CH_2OH$

39 The steroid shown is an intermediate compound obtained during the synthesis of *Formestane* which is used in the treatment of breast cancer.



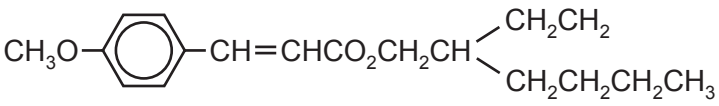
Which statements about this compound are correct?

1 It reacts with hydrogen cyanide in a nucleophilic addition reaction.

2 It can be oxidised by warm acidified potassium dichromate(VI) to a carboxylic acid.

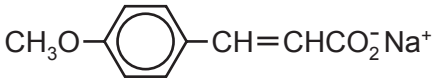
3 It will react with Fehling's solution.

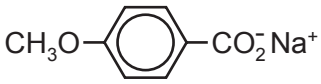
40 A sun protection cream contains the following ester as its active ingredient.



What are the products of its partial or total hydrolysis by aqueous sodium hydroxide?

1 $CH_3CH_2CH_2CH_2CH(CH_2CH_3)CH_2OH$

2 

3 

© UCLES 2005

BLANK PAGE

Every reasonable effort has been made to trace all copyright holders where the publishers (i.e. UCLES) are aware that third-party material has been reproduced. The publishers would be pleased to hear from anyone whose rights they have unwittingly infringed.

University of Cambridge International Examinations is part of the University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.