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

**CHEMISTRY** **9701/01**

Paper 1 Multiple Choice **May/June 2009**

**1 hour**

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

*5448023915*

**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 **15** printed pages and **1** blank page.


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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.*

In leaded petrol there is an additive composed of lead, carbon and hydrogen only. This compound contains 29.7 % carbon and 6.19 % hydrogen by mass.

What is the value of **x** in the empirical formula $PbC_8H_x$?

**A** 5 **B** 6 **C** 16 **D** 20

**2** A household bleach contains sodium chlorate(I), NaC*l*O, as its active ingredient. The concentration of NaC*l*O in the bleach can be determined by reacting a known amount with aqueous hydrogen peroxide, $H_2O_2$.

$$NaClO(aq) + H_2O_2(aq) \rightarrow NaCl(aq) + O_2(g) + H_2O(l)$$

When 25.0 $cm^3$ of bleach is treated with an excess of aqueous $H_2O_2$, 0.0350 mol of oxygen gas is given off.

What is the concentration of NaC*l*O in the bleach?

**A** $8.75 \times 10^{-4}$ mol $dm^{-3}$

**B** 0.700 mol $dm^{-3}$

**C** 0.875 mol $dm^{-3}$

**D** 1.40 mol $dm^{-3}$

**3** The first seven ionisation energies of an element between lithium and neon in the Periodic Table are as follows.

1310 3390 5320 7450 11 000 13 300 71 000 kJ $mol^{-1}$

What is the outer electronic configuration of the element?

**A** $2s^2$ **B** $2s^22p^1$ **C** $2s^22p^4$ **D** $2s^22p^6$

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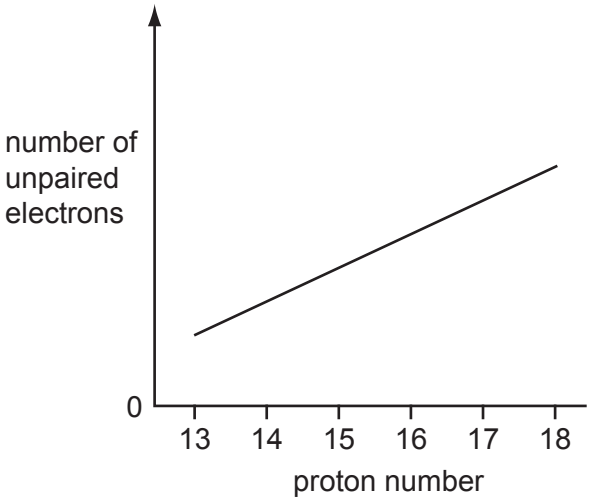
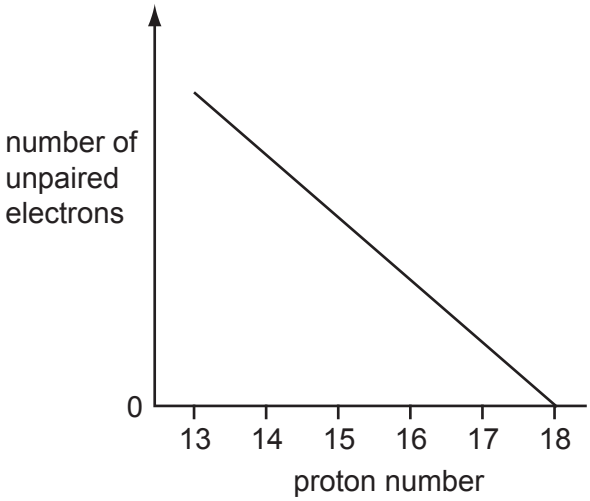
**4** *Use of the Data Booklet is relevant to this question.*

Which graph represents the number of unpaired p orbital electrons for atoms with proton numbers 13 to 18?

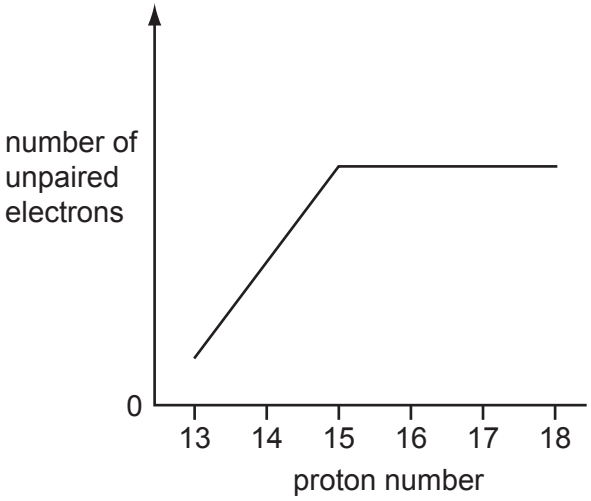
**A**



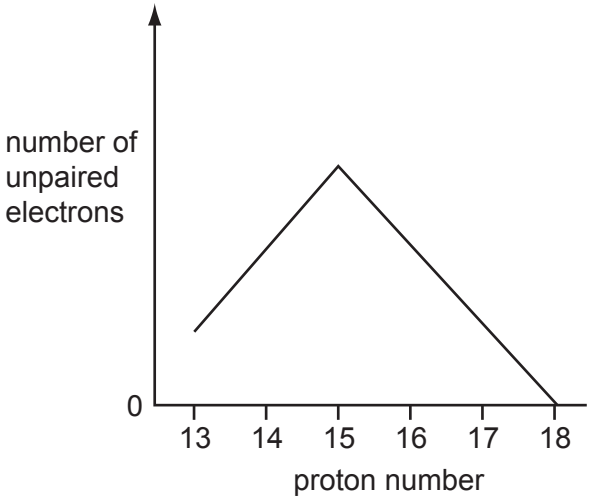

**B**




**C**




**D**




**5** Which statement explains why the boiling point of methane is higher than that of neon?
[$A_r$: H, 1; C, 12; Ne, 20]

**A** A molecule of methane has a greater mass than a molecule of neon.

**B** Molecules of methane form hydrogen bonds, but those of neon do not.

**C** Molecules of methane have stronger intermolecular forces than those of neon.

**D** The molecule of methane is polar, but that of neon is not.

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**6** In which reaction does the carbon-containing product have a smaller bond angle than the organic reactant?

**A** bromoethane refluxed with ethanolic sodium hydroxide

**B** complete combustion of methane in air

**C** methane and an excess of chlorine under ultraviolet light

**D** polymerisation of ethene

**7** A crystal of iodine produces a purple vapour when gently heated.

Which pair of statements correctly describes this process?

| | type of bond broken | formula of purple species |
|---|---|---|
| **A** | covalent | I |
| **B** | covalent | $I_2$ |
| **C** | induced dipole-dipole | $I_2$ |
| **D** | permanent dipole-dipole | $I_2$ |

**8** Hydrogen peroxide slowly decomposes into water and oxygen. The enthalpy change of reaction can be calculated using standard enthalpies of formation.

$\Delta H_f^{\ominus}$(hydrogen peroxide(l)) = –187.8 kJ mol$^{-1}$

$\Delta H_f^{\ominus}$(water(l)) = –285.8 kJ mol$^{-1}$

Using a Hess cycle, what is the enthalpy change of reaction for this decomposition?

$$2H_2O_2(l) \rightarrow 2H_2O(l) + O_2(g)$$

**A** +98 kJ mol$^{-1}$

**B** –98 kJ mol$^{-1}$

**C** –196 kJ mol$^{-1}$

**D** –947.2 kJ mol$^{-1}$

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**9** When copper is extracted from its ores, the metal is not pure enough for electrical uses. The impure copper, which contains small amounts of silver and gold, is purified by electrolysis. During this process a 'sludge' forms beneath the anode which is found to contain silver and traces of gold.

Why is silver found in this sludge?

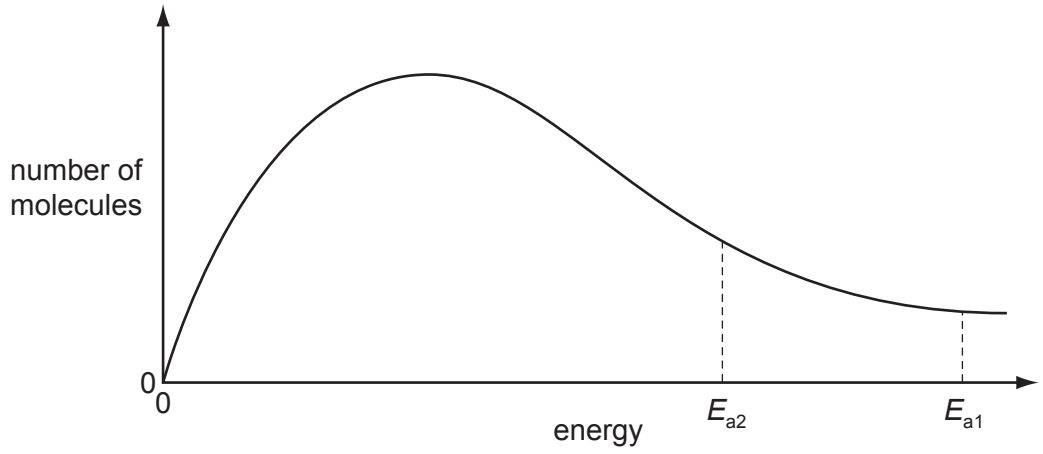
**A** Silver is less electropositive than copper.

**B** Silver is more dense than copper and falls off the cathode.

**C** Silver reacts with the electrolyte to form an insoluble chloride salt.

**D** Silver reacts with the electrolyte to form an insoluble sulfate salt.

**10** The diagram shows the Maxwell-Boltzmann energy distribution curve for molecules of a mixture of two gases at a given temperature. For a reaction to occur the molecules must collide together with sufficient energy.




$E_a$ is the activation energy for the reaction between the gases. Of the two values shown, one is for a catalysed reaction, the other for an uncatalysed one.

Which pair of statements is correct when a catalyst is used?

| | | | | |
|---|---|---|---|---|
| **A** | $E_{a1}$ | catalysed reaction<br>fewer effective collisions | $E_{a2}$ | uncatalysed reaction<br>more effective collisions |
| **B** | $E_{a1}$ | uncatalysed reaction<br>fewer effective collisions | $E_{a2}$ | catalysed reaction<br>more effective collisions |
| **C** | $E_{a1}$ | catalysed reaction<br>more effective collisions | $E_{a2}$ | uncatalysed reaction<br>fewer effective collisions |
| **D** | $E_{a1}$ | uncatalysed reaction<br>more effective collisions | $E_{a2}$ | catalysed reaction<br>fewer effective collisions |

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**11** In some fireworks there is a reaction between powdered aluminium and powdered barium nitrate in which heat is evolved and an unreactive gas is produced.

What is the equation for this reaction?

**A** $2Al + Ba(NO_3)_2 \rightarrow Al_2O_3 + BaO + 2NO$

**B** $4Al + 4Ba(NO_3)_2 \rightarrow 2Al_2O_3 + 4Ba(NO_2)_2 + O_2$

**C** $10Al + 3Ba(NO_3)_2 \rightarrow 5Al_2O_3 + 3BaO + 3N_2$

**D** $10Al + 18Ba(NO_3)_2 \rightarrow 10Al(NO_3)_3 + 18BaO + 3N_2$

**12** Which group of particles is in order of increasing size?

**A** N O F

**B** $N^{3-}$ $O^{2-}$ $F^-$

**C** $Na^+$ $Mg^{2+}$ $Al^{3+}$

**D** $Na^+$ Ne $F^-$

**13** River water in a chalky agricultural area may contain $Ca^{2+}$, $Mg^{2+}$, $CO_3^{2-}$, $HCO_3^-$, $Cl^-$ and $NO_3^-$ ions. In a waterworks, such water is treated by adding a calculated quantity of calcium hydroxide.

What will be precipitated following the addition of calcium hydroxide?

**A** $CaCl_2$

**B** $CaCO_3$

**C** $Ca(NO_{3)\,2}$

**D** $Mg(NO_3)_2$

**14** Over half a million tonnes of bromine are manufactured annually and are mainly used for making other compounds. One important use is for agricultural chemicals.

What is another important use for bromine?

**A** antiseptic agents

**B** bleaches for textiles and the paper industry

**C** flame-retardants and fire extinguishers

**D** water purification

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**15** In black and white photographic film, light converts silver chloride into metallic silver. After the film has been developed, the unreacted silver chloride is removed by reaction with sodium thiosulfate to produce a 'fixed' negative.

$$AgCl + 2Na_2S_2O_3 \rightarrow 4Na^+ + Cl^- + [Ag(S_2O_3)_2]^{3-}$$

What is the function of the thiosulfate ion?

**A** to make the silver ions soluble

**B** to oxidise the silver ions

**C** to oxidise the silver metal

**D** to reduce the silver ions

**16** 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 sulfuric 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 sulfuric acid react to form astatine.

**17** Deposits of ammonium compounds have been discovered in areas of high atmospheric pollution.

They are believed to arise from the following reaction.

$$SO_3 + H_2O + 2NH_3 \rightarrow (NH_4)_2SO_4$$

What does **not** occur in this reaction?

**A** acid / base neutralisation

**B** dative bond formation

**C** ionic bond formation

**D** oxidation / reduction

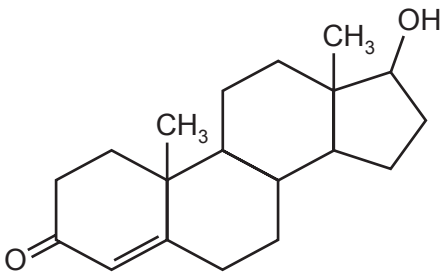
**18** Mohr's salt is a pale green crystalline solid which is soluble in water. It is a 'double sulfate' which contains two cations, one of which is $Fe^{2+}$.

The identity of the second cation was determined by heating solid Mohr's salt with solid sodium hydroxide and a colourless gas was evolved. The gas readily dissolved in water giving an alkaline solution. A grey-green solid residue was also formed which was insoluble in water.

What are the identities of the gas and the solid residue?

| | gas | residue |
|---|---|---|
| **A** | $H_2$ | $FeSO_4$ |
| **B** | $NH_3$ | $Na_2SO_4$ |
| **C** | $NH_3$ | $Fe(OH)_2$ |
| **D** | $SO_2$ | $Fe(OH)_2$ |

**19** In recent years a number of athletes have been banned from sports because of their illegal use of synthetic testosterone, a naturally occurring hormone in the body.




testosterone

How many chiral centres are present in a testosterone molecule?

**A** 1 **B** 2 **C** 3 **D** 6

**20** The compound known as 'gamma-linolenic acid' is found in significant amounts in the seeds of the Evening Primrose plant. There is evidence that the compound may help patients with diabetes.

$$CH_3(CH_2)_4CH{=}CHCH_2CH{=}CHCH_2CH{=}CH(CH_2)_4CO_2H$$

gamma-linolenic acid

How many *cis-trans* isomers does gamma-linolenic acid have?

**A** 3 **B** 6 **C** 8 **D** 12

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**21** What 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** Trichloroethanoic acid, $CCl_3CO_2H$, is used in cosmetic surgery to perform a 'chemical peel' to remove dead skin.

Trichloroethanoic acid can be made by reacting chlorine with ethanoic acid.

What is the mechanism of this reaction?

**A** electrophilic addition

**B** electrophilic substitution

**C** free radical addition

**D** free radical substitution

**23** Polymerisation of chloroethene gives PVC.

How does the carbon-carbon bond in PVC compare with that in chloroethene?

**A** longer and stronger

**B** longer and weaker

**C** shorter and stronger

**D** shorter and weaker

**24** In the hydrolysis of bromoethane by aqueous sodium hydroxide, what is the nature of the attacking group and of the leaving group?

| | attacking group | leaving group |
|---|---|---|
| **A** | electrophile | electrophile |
| **B** | electrophile | nucleophile |
| **C** | nucleophile | electrophile |
| **D** | nucleophile | nucleophile |

**25** Which reaction would **not** give propene as one product?

**A** adding an excess of concentrated sulfuric acid to propan-1-ol

**B** adding warm aqueous sodium hydroxide to 2-bromopropane

**C** adding warm ethanolic sodium hydroxide to 1-bromopropane

**D** passing propan-2-ol vapour over heated aluminium oxide

**26** Glycol, used in anti-freeze, has the formula $HOCH_2CH_2OH$. It can be oxidised to give a number of products.

What is the molecular formula of an oxidation product of glycol that will **not** react with sodium?

**A** $C_2H_2O_2$ **B** $C_2H_2O_3$ **C** $C_2H_2O_4$ **D** $C_2H_4O_2$

**27** Which ester is formed when the alcohol $CH_3CH_2OH$ is reacted with $CH_3CH_2CH_2CO_2H$?

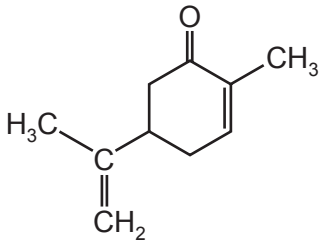
**A** ethyl propanoate

**B** ethyl butanoate

**C** propyl ethanoate

**D** butyl ethanoate

**28** Carvone gives the characteristic flavour to caraway and spearmint.




carvone

Prolonged heating of carvone with hot concentrated acidified potassium manganate(VII) produces carbon dioxide and a compound **X**.

**X** contains nine carbon atoms and reacts with 2,4-dinitrophenylhydrazine reagent.

What is the maximum number of molecules of 2,4-dinitrophenylhydrazine that will react with one molecule of **X**?

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

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**29** 2-Methylbuta-1,3-diene, $CH_2=C(CH_3)–CH=CH_2$, is used as a monomer in the manufacture of synthetic rubbers.

Which compound would **not** produce this monomer on treatment with concentrated sulfuric acid at 170 °C?

**A** $(CH_3)_2C(OH)CH(OH)CH_3$

**B** $HOCH_2CH(CH_3)CH_2CH_2OH$

**C** $HOCH_2CH(CH_3)CH(OH)CH_3$

**D** $HOCH_2C(CH_3)(OH)CH_2CH_3$

**30** A compound **Y** has the following properties.

- It is a liquid at room temperature and atmospheric pressure.
- It does not mix completely with water.
- It does not decolourise acidified potassium manganate(VII).

What could **Y** be?

**A** ethane

**B** ethanoic acid

**C** ethanol

**D** ethyl ethanoate

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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** On a scale in which the mass of a $^{12}C$ atom is 12 the relative molecular mass of a particular sample of chlorine is 72.

Which properties of the atoms in this sample are always the same?

**1** radius

**2** nucleon number

**3** isotopic mass

**32** An ideal gas obeys the gas laws under all conditions of temperature and pressure.

Which of the following are true for an ideal gas?

**1** The molecules have negligible volume.

**2** There are no forces of attraction between molecules.

**3** The molecules have an average kinetic energy which is proportional to its absolute temperature.

**33** For which reactions does the value of $\Delta H^{\ominus}$ represent **both** a standard enthalpy change of combustion **and** a standard enthalpy change of formation?

**1** $C(s) + O_2(g) \rightarrow CO_2(g)$

**2** $2C(s) + O_2(g) \rightarrow 2CO(g)$

**3** $CO(g) + \frac{1}{2} O_2(g) \rightarrow CO_2(g)$

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**34** The following reaction takes place using liquid ammonia as a solvent.

$$Na^+ NH_2^- + NH_4^+Cl^- \rightarrow Na^+Cl^- + 2NH_3$$

Which statements best explain why this reaction should be classified as a Brønsted-Lowry acid-base reaction?

**1** The ammonium ion acts as a proton donor.

**2** $Na^+Cl^-$ is a salt.

**3** Ammonia is always basic.

**35** The rock *dolomite* is a double carbonate of magnesium and calcium, $CaCO_3.MgCO_3$.

When heated strongly, a product called *calcined dolomite* is formed which is used to line some furnaces for the production of metals.

Why is *calcined dolomite* used for this purpose?

**1** It is a refractory material.

**2** It will absorb acidic impurities in metallurgical processes.

**3** It will reduce metallic oxides to metals.

**36** Which properties in the sequence hydrogen chloride, hydrogen bromide and hydrogen iodide steadily increase?

**1** thermal stability

**2** bond length

**3** ease of oxidation

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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.

**37** A fraction of distilled crude oil contains molecules with between 15 and 19 carbon atoms. This fraction is cracked by strong heating.

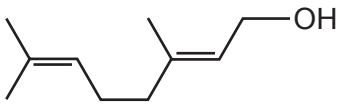
Why is this done?

**1** To produce alkenes.

**2** To produce smaller molecules which are in higher demand.

**3** To insert oxygen atoms into the hydrocarbons.

**38** Geraniol is one of several compounds produced by the scent glands of honey bees to help them mark nectar-bearing flowers and locate the entrances to their hives.




geraniol

Which reactions will geraniol undergo?

**1** reaction with hot concentrated acidic $KMnO_4$ to give propanone

**2** addition of halogens

**3** reaction with aqueous $NaHCO_3$ to give $CO_2$

**39** How can the rate of reaction between ethanal and aqueous hydrogen cyanide be increased?

**1** by irradiation with ultraviolet light

**2** by a rise in temperature

**3** by the addition of a small quantity of aqueous sodium cyanide

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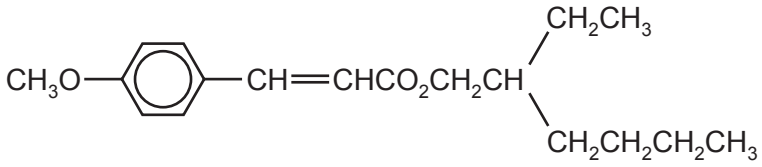
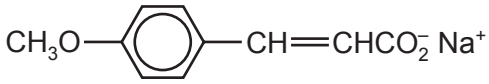
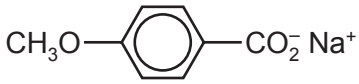
**40** A sun protection cream contains the following ester as its active ingredient.



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** 

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