

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Ordinary Level

CHEMISTRY

5070/01

Paper 1 Multiple Choice

October/November 2004

1 hour

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

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.

A copy of the Periodic Table is printed on page 16.

You may use a calculator.

This document consists of **16** printed pages.

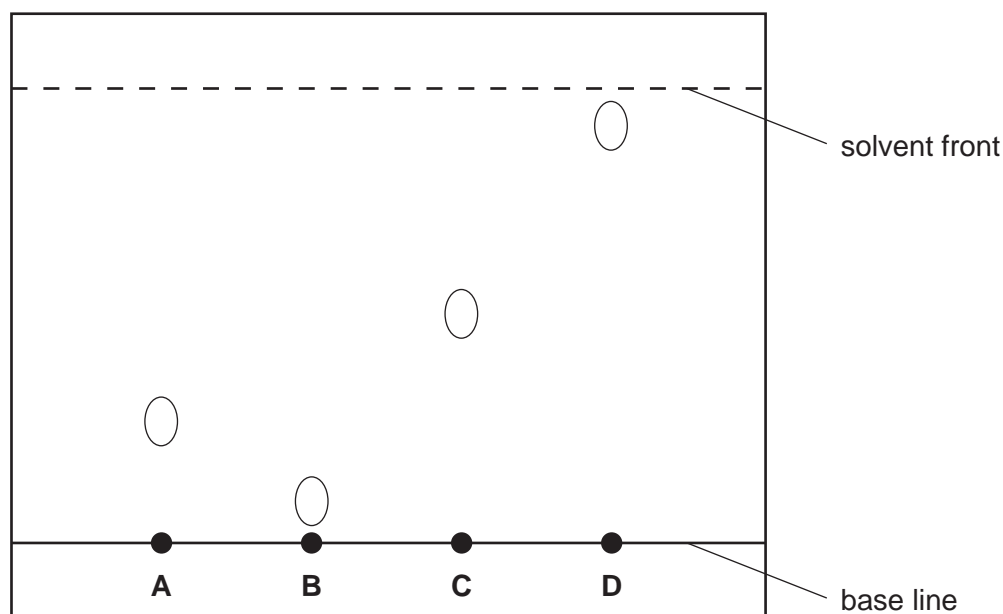


- 1 A pale green solution **X** gives a green precipitate with excess aqueous sodium hydroxide.
An alkaline gas is only given off when the mixture is warmed with powdered aluminium.

Which ions does **X** contain?

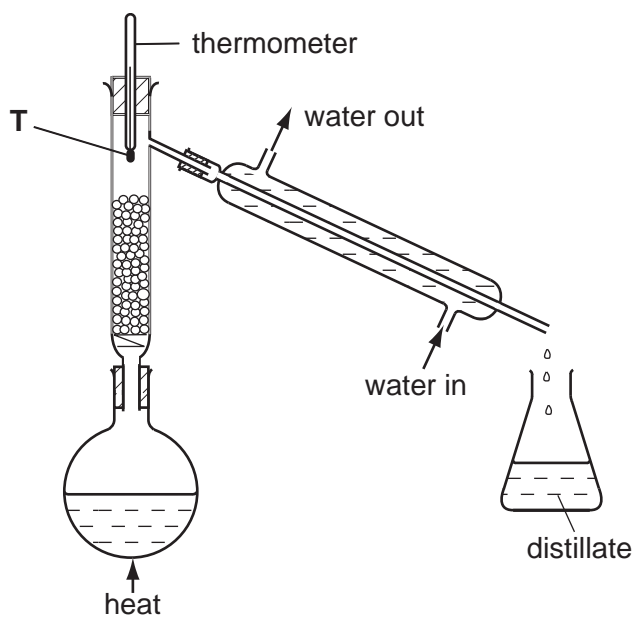
- A** ammonium and copper(II)
B ammonium and iron(III)
C copper(II) and nitrate
D iron(II) and nitrate
- 2 The diagram shows the chromatogram of four different sugars using the same solvent.
Glucose has an R_f value of 0.5.

Which sugar is glucose?

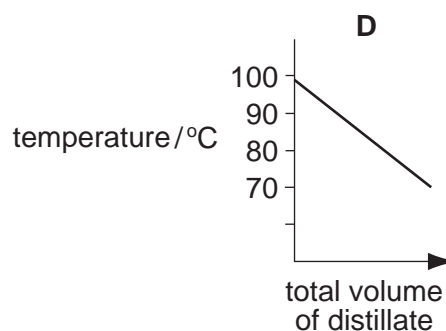
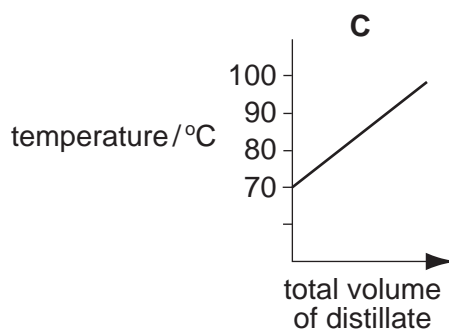
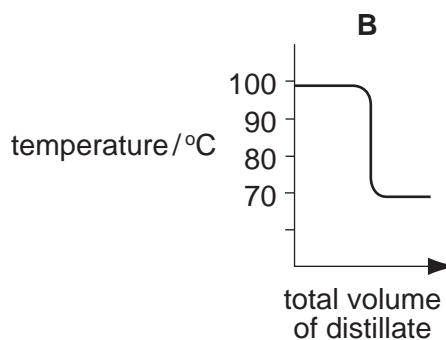
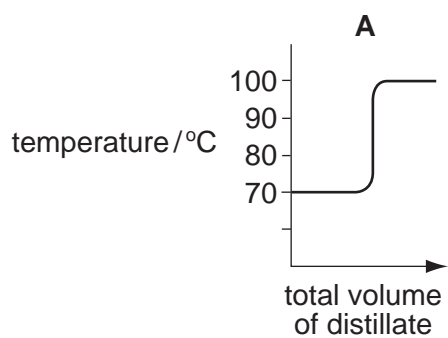


- 3 A liquid boils at a temperature of 100°C .
Which other property of the liquid proves that it is pure water?
- A** It does not leave a residue when boiled.
B It freezes at 0°C .
C It is neither acidic nor alkaline.
D It turns white anhydrous copper(II) sulphate blue.

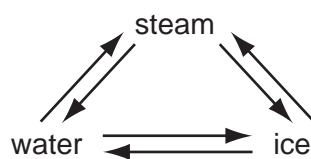
- 4 The diagram shows apparatus used to separate hexane (boiling point, 70°C) and heptane (boiling point, 98°C).



Which graph would be obtained if the temperature at point T was plotted against the total volume of distillate collected?



5 In which conversion do H₂O molecules lose speed?



- A ice → water
- B ice → steam
- C steam → ice
- D water → steam

6 Two particles **X** and **Y** have the composition shown in the table.

particle	number of electrons	number of neutrons	number of protons
X	10	8	8
Y	18	18	17

The particles **X** and **Y** are

- A metal atoms.
- B non-metal atoms.
- C negative ions.
- D positive ions.

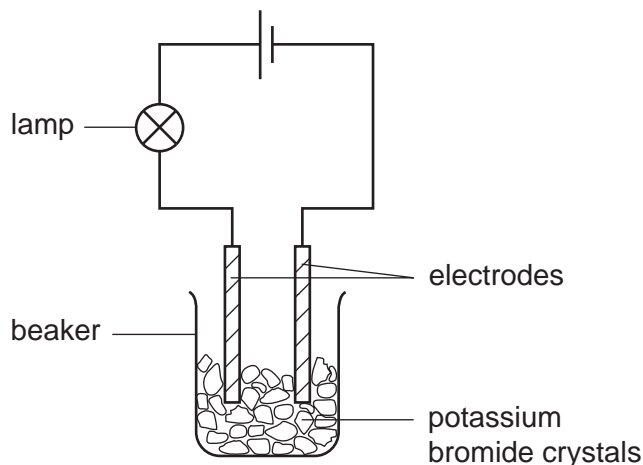
7 What is the nucleon number of the isotope of uranium, ${}_{92}^{235}\text{U}$?

- A 92
- B 143
- C 235
- D 327

8 Which of the following is a compound?

- A air
- B carbon
- C oxygen
- D steam

- 9 The experiment shown is used to test potassium bromide crystals.



The lamp does not light.

Distilled water is then added to the beaker and the lamp lights.

Which statement explains these results?

- A Electrons are free to move in the solution when potassium bromide dissolves.
 - B Metal ions are free to move when potassium bromide melts.
 - C Metal ions are free to move when potassium reacts with water.
 - D Oppositely charged ions are free to move in the solution when potassium bromide dissolves.
- 10 Which compound has both ionic and covalent bonds?
- A ammonium chloride
 - B carbon dioxide
 - C ethyl ethanoate
 - D sodium chloride
- 11 'Cracking' of hydrocarbons breaks them into smaller molecules.

Which example of 'cracking' would produce the largest volume of products from one mole of hydrocarbon? Assume that all measurements are made at the same temperature and pressure.

- A $\text{C}_6\text{H}_{14}(\text{g}) \rightarrow 3\text{C}_2\text{H}_4(\text{g}) + \text{H}_2(\text{g})$
- B $\text{C}_8\text{H}_{18}(\text{g}) \rightarrow 2\text{C}_3\text{H}_8(\text{g}) + \text{C}_2\text{H}_2(\text{g})$
- C $\text{C}_{10}\text{H}_{22}(\text{g}) \rightarrow \text{C}_8\text{H}_{18}(\text{g}) + \text{C}_2\text{H}_4(\text{g})$
- D $\text{C}_{12}\text{H}_{26}(\text{g}) \rightarrow \text{C}_8\text{H}_{18}(\text{g}) + 2\text{C}_2\text{H}_4(\text{g})$

- 12 When 20 cm³ of a gaseous alkene burns in an excess of oxygen, 60 cm³ of carbon dioxide are formed. Both volumes are measured at r.t.p.

What is the formula of the alkene?

- A C₃H₆
- B C₃H₈
- C C₆H₁₂
- D C₆H₁₄

- 13 'Meta-fuel', C₈H₁₆O₄, is a fuel used in camping stoves.

What is the equation for its complete combustion?

- A C₈H₁₆O₄ + 2O₂ → 8C + 8H₂O
- B C₈H₁₆O₄ + 5O₂ → 8CO + 8H₂O
- C C₈H₁₆O₄ + 10O₂ → 8CO₂ + 8H₂O
- D C₈H₁₆O₄ + 8O₂ → 4CO₂ + 4CO + 8H₂O

- 14 Dilute sulphuric acid is electrolysed using inert electrodes.

Which equation represents the reaction at the anode (+ve)?

- A O₂²⁻ → O₂ + 2e⁻
- B 2H⁺ + 2e⁻ → H₂
- C 4OH⁻ → O₂ + 2H₂O + 4e⁻
- D SO₄²⁻ → O₂ + SO₂ + 2e⁻

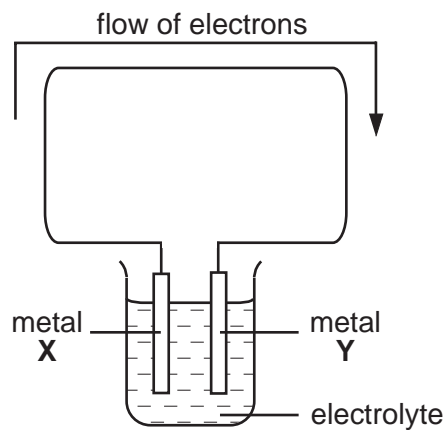
- 15 What are the products when concentrated aqueous lithium chloride is electrolysed?

	at the anode (positive)	at the cathode (negative)
A	chlorine	hydrogen
B	chlorine	lithium
C	oxygen	hydrogen
D	oxygen	lithium

- 16 A solid deposit of element **R** is formed at the cathode(-ve) when an aqueous solution containing ions of **R** is electrolysed.

Which statement about element **R** must be correct?

- A** **R** forms negative ions.
B **R** ions gain electrons at the cathode.
C **R** ions lose electrons at the cathode.
D **R** is above hydrogen in the reactivity series.
- 17 Apparatus was set up as shown.



For which pair of metals would electrons flow in the direction shown?

	metal X	metal Y
A	copper	zinc
B	iron	aluminium
C	iron	magnesium
D	zinc	silver

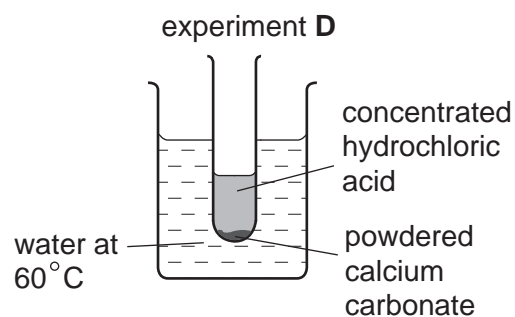
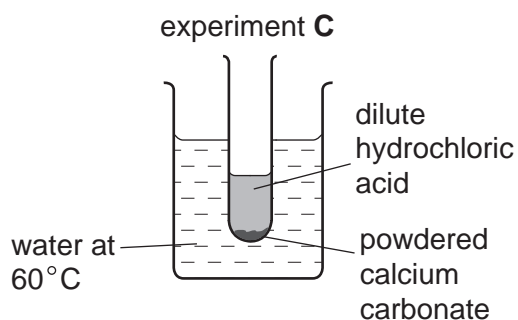
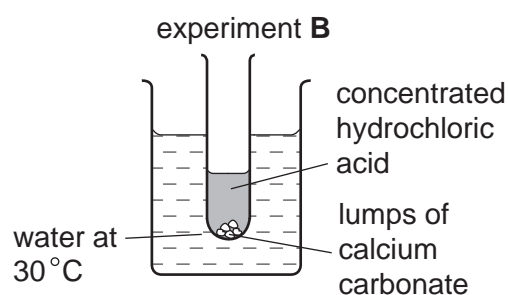
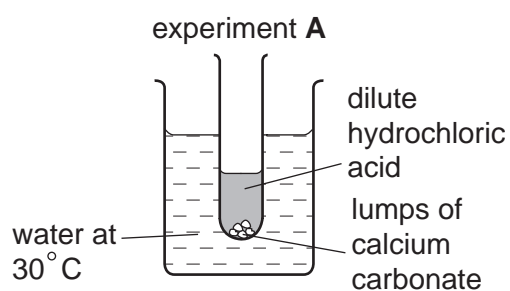
- 18 The table shows the energy released by the complete combustion of some compounds used as fuels.

compound	formula	M_r	ΔH in kJ/mol
methane	CH_4	16	-880
ethanol	$\text{C}_2\text{H}_5\text{OH}$	46	-1380
propane	C_3H_8	44	-2200
heptane	C_7H_{16}	100	-4800

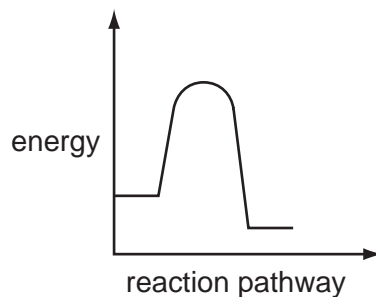
Which fuel produces the most energy when 1 g of the compound is completely burned?

- A ethanol
- B heptane
- C methane
- D propane

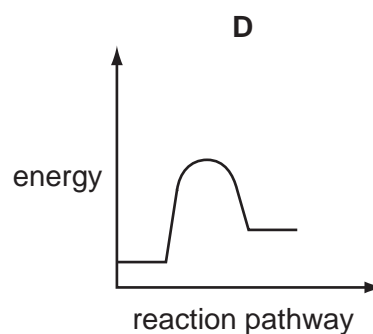
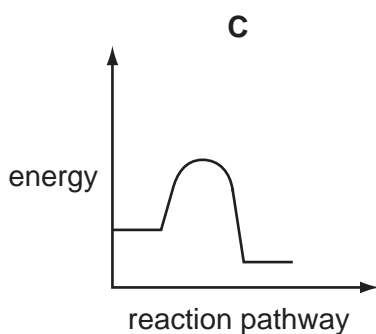
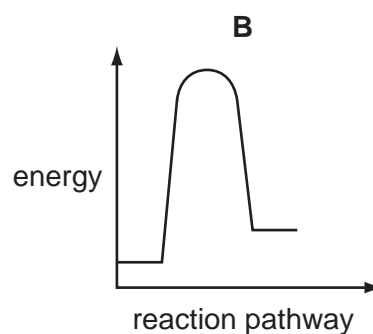
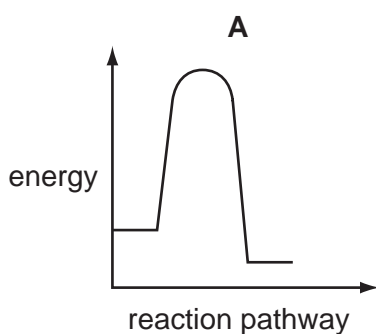
- 19 Which reaction is the fastest?



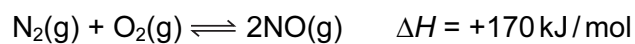
20 The diagram shows the reaction pathway for a reaction without a catalyst.



Which diagram shows the pathway resulting from the addition of a catalyst to the reaction?



21 Nitrogen reacts with oxygen.



At equilibrium, which statement is true?

- A** The concentration of nitrogen present will change with time.
- B** The forward and backward reaction are taking place at the same rate.
- C** The forward reaction releases heat energy.
- D** There are more molecules on the left hand side of the equation than on the right.

22 Which series of changes includes both oxidation and reduction?

- A $C \rightarrow CO \rightarrow CO_2$
- B $PbO_2 \rightarrow PbO \rightarrow Pb$
- C $N_2 \rightarrow NH_3 \rightarrow NO$
- D $C_2H_2 \rightarrow C_2H_4 \rightarrow C_2H_6$

23 The table gives information about three indicators.

indicator	colour at pH 1	pH at which colour changes	colour at pH 12
thymol blue	red	3	yellow
congo red	blue	5	red
phenolphthalein	colourless	10	red

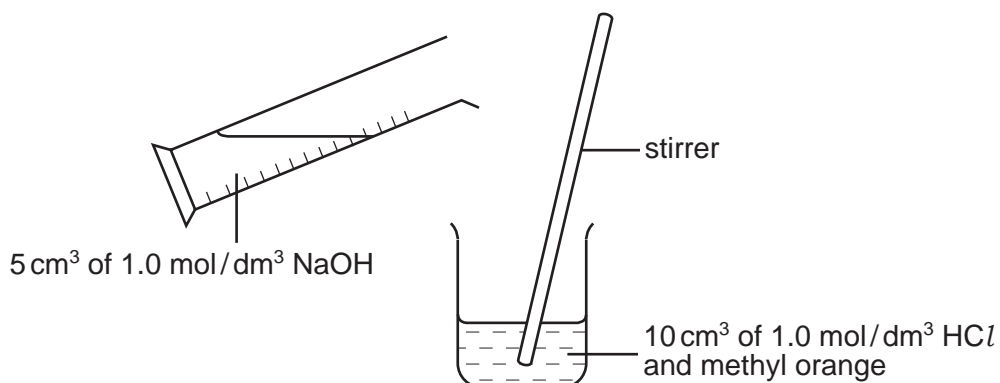
Which colours would be obtained when each indicator was added separately to pure water?

	thymol blue	congo red	phenolphthalein
A	red	blue	red
B	yellow	blue	colourless
C	yellow	blue	red
D	yellow	red	colourless

24 Which reactants could be used safely to prepare potassium chloride?

- A aqueous potassium hydroxide and dilute hydrochloric acid
- B aqueous potassium sulphate and aqueous sodium chloride
- C potassium and aqueous sodium chloride
- D potassium and dilute hydrochloric acid

- 25 In an experiment 5 cm^3 of 1.0 mol/dm^3 sodium hydroxide are gradually added to 10 cm^3 of 1.0 mol/dm^3 hydrochloric acid containing methyl orange.



Which change occurs in the mixture?

- A** The concentration of the H^+ ions increases.
B The methyl orange changes colour.
C More water molecules are formed.
D A precipitate is formed.
- 26 X and Y are diatomic elements. X is less reactive than Y.

What are elements X and Y?

	X	Y
A	bromine	iodine
B	iodine	bromine
C	potassium	sodium
D	sodium	potassium

- 27 Element Z has the following properties.

- It has a high melting point.
- Its presence can lower the activation energy for a reaction.

What type of element is Z?

- A** a halogen
B an alkali metal
C a noble gas
D a transition metal

28 All ammonium salts on heating with sodium hydroxide produce ammonia gas. From which ammonium salt can the greatest mass of ammonia be obtained?

- A 0.5 mol $(\text{NH}_4)_3\text{PO}_4$
- B 0.5 mol $(\text{NH}_4)_2\text{SO}_4$
- C 1.0 mol NH_4Cl
- D 1.0 mol NH_4NO_3

29 The position of metal **M** in the reactivity series is shown.

K, Na, **M**, Al, Zn, Fe, Pb, Cu, Ag

Which method will be used to extract **M** from its ore?

- A electrolysis of its molten oxide
- B electrolysis of its aqueous sulphate
- C reduction of its oxide by heating with hydrogen
- D reduction of its oxide by heating with coke

30 Two elements are in the same group of the Periodic Table.

Which property will be the same for both elements?

- A the charge on their ions
- B their electronic structure
- C their melting point
- D their reactivity with water or acids

31 How does the mass of a sample of copper(II) oxide change when it is heated in hydrogen and in oxygen?

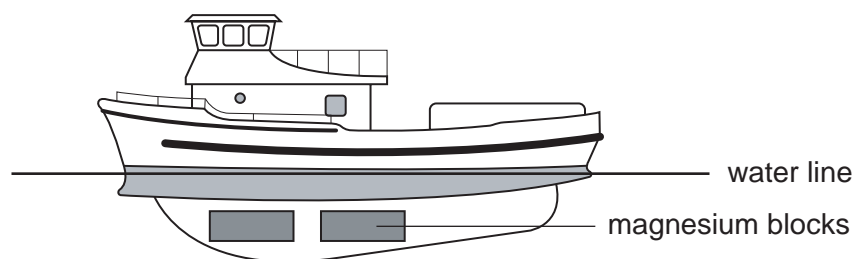
	mass after heating in hydrogen	mass after heating in oxygen
A	decreases	decreases
B	decreases	unchanged
C	unchanged	decreases
D	unchanged	unchanged

32 From which reaction is a gas produced?

- A adding calcium to water
- B adding dilute hydrochloric acid to silver
- C adding dilute sulphuric acid to copper
- D electrolysing aqueous copper(II) sulphate, using copper electrodes

33 The diagram shows a boat made from iron.

Some magnesium blocks are attached to the iron below the water line.



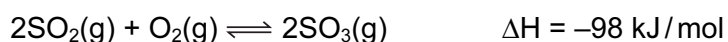
Why does the magnesium stop the iron from rusting?

- A Magnesium reacts in preference to the iron.
 - B Magnesium reacts to form a protective coating of magnesium oxide on the iron.
 - C The magnesium forms an alloy with the iron.
 - D The magnesium stops oxygen in the water from getting to the iron.
- 34 A catalytic converter in a car exhaust system changes pollutants into less harmful products.

Which change does **not** occur in a catalytic converter?

- A carbon dioxide → carbon
- B carbon monoxide → carbon dioxide
- C nitrogen oxides → nitrogen
- D unburned hydrocarbons → carbon dioxide and water

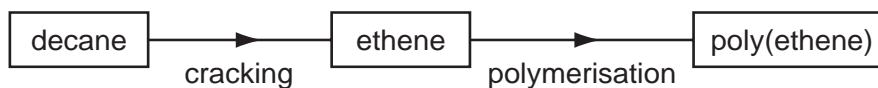
35 The equation shows a reaction in the Contact process.



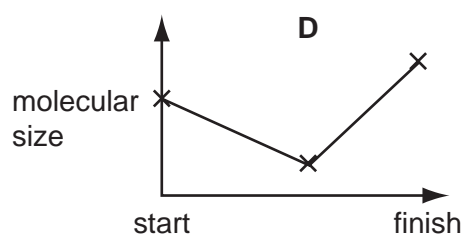
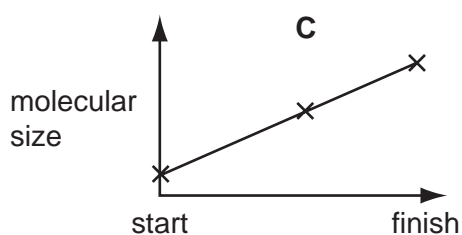
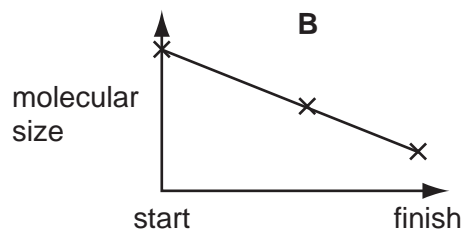
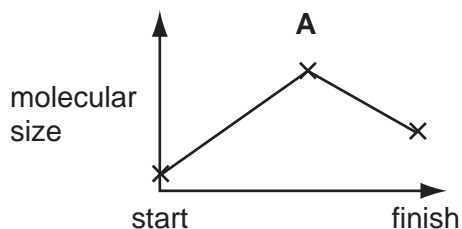
Which change would move the position of equilibrium to the left?

- A adding more O_2
- B increasing the pressure
- C increasing the temperature
- D removing SO_3 from the reacting mixture

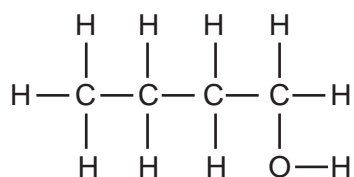
36 Poly(ethene) can be manufactured by the process below.



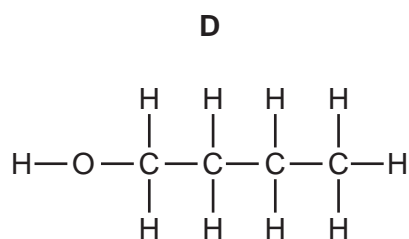
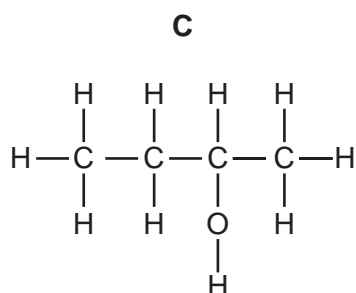
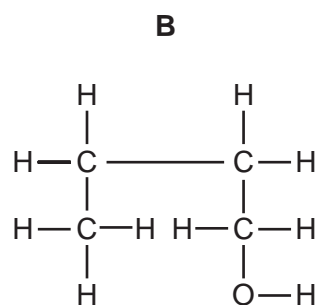
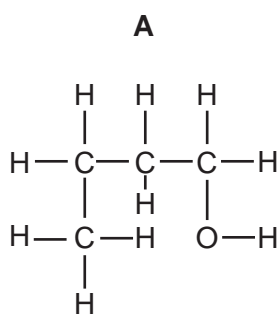
Which diagram shows the change in molecular size during this process?



37 Compound **Q** has the structure shown.



Which structure is an isomer of **Q**?



38 Compound **X** has the molecular formula C_2H_6O .

- **X** can be made by a fermentation process.
- **X** can be oxidised to **Y**.
- **X** can react with **Y** to form **Z** and water.

To which homologous series do **X**, **Y** and **Z** belong?

	X	Y	Z
A	alcohols	carboxylic acids	esters
B	alcohols	esters	carboxylic acids
C	carboxylic acids	alcohols	esters
D	carboxylic acids	esters	alcohols

39 The list shows reactions in which ethanol is either a reactant or a product.

1	combustion of ethanol
2	conversion of ethene to ethanol
3	fermentation of glucose
4	oxidation of ethanol to ethanoic acid

In which reactions is water also either a reactant or a product?

- A** 1, 3 and 4 only
B 2, 3 and 4 only
C 1, 2 and 4 only
D 3 only

40 A vegetable oil is polyunsaturated.

Which statement about this vegetable oil is correct?

- A** It has double bonds between carbon and hydrogen atoms.
B It reacts with hydrogen to form a solid compound.
C It reacts with steam to form margarine.
D It turns aqueous bromine from colourless to brown.

DATA SHEET
The Periodic Table of the Elements

		Group																																			
		I	II	III	IV	V	VI	VII	VIII	IX	X																										
7	3	Li Lithium 4	Be Beryllium 9	<table border="1" style="width: 100%; border-collapse: collapse; text-align: center;"> <tr> <td style="width: 5%;"></td> <td style="width: 5%;"></td> <td style="width: 10%;">1</td> <td style="width: 10%;">2</td> <td style="width: 10%;">3</td> <td style="width: 10%;">4</td> <td style="width: 10%;">5</td> <td style="width: 10%;">6</td> <td style="width: 10%;">7</td> <td style="width: 10%;">8</td> <td style="width: 10%;">9</td> <td style="width: 10%;">10</td> </tr> <tr> <td></td> <td></td> <td>H Hydrogen 1</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> </table>												1	2	3	4	5	6	7	8	9	10			H Hydrogen 1									
		1	2											3	4	5	6	7	8	9	10																
		H Hydrogen 1																																			
23	11	Na Sodium 11	Mg Magnesium 24	B Boron 5	C Carbon 6	N Nitrogen 7	O Oxygen 8	F Fluorine 9	Ne Neon 10	Al Aluminium 13	Si Silicon 14	P Phosphorus 15	S Sulphur 16	Cl Chlorine 17	Ar Argon 18																						
39	19	K Potassium 19	Ca Calcium 20	Zn Zinc 30	Ga Gallium 31	Ge Germanium 32	As Arsenic 33	Se Selenium 34	Br Bromine 35	Kr Krypton 36	Rb Rubidium 37	Sr Strontium 38	Y Yttrium 39	Zr Zirconium 40	Nb Niobium 41	Mo Molybdenum 42	Tc Technetium 43	Ru Ruthenium 44	Rh Rhodium 45	Pd Palladium 46	Ag Silver 47	Cd Cadmium 48	In Indium 49	Sn Tin 50	Sb Antimony 51	Te Tellurium 52	I Iodine 53	Xe Xenon 54									
85	55	Rb Rubidium 37	Sr Strontium 38	Sc Scandium 21	Ti Titanium 22	V Vanadium 23	Cr Chromium 24	Mn Manganese 25	Fe Iron 26	Co Cobalt 27	Ni Nickel 28	Cu Copper 29	Zn Zinc 30	Ga Gallium 31	Ge Germanium 32	As Arsenic 33	Se Selenium 34	Br Bromine 35	Kr Krypton 36	Rb Rubidium 37	Sr Strontium 38	Y Yttrium 39	Zr Zirconium 40	Nb Niobium 41	Mo Molybdenum 42	Tc Technetium 43	Ru Ruthenium 44	Rh Rhodium 45	Pd Palladium 46	Ag Silver 47	Cd Cadmium 48	In Indium 49	Sn Tin 50	Sb Antimony 51	Te Tellurium 52	I Iodine 53	Xe Xenon 54
133	55	Cs Caesium 55	Ba Barium 56	La Lanthanum 57	Hf Hafnium 72	Ta Tantalum 73	W Tungsten 74	Re Rhenium 75	Os Osmium 76	Ir Iridium 77	Pt Platinum 78	Au Gold 79	Hg Mercury 80	Tl Thallium 81	Pb Lead 82	Bi Bismuth 83	Po Polonium 84	At Astatine 85	Rn Radon 86	Fr Francium 87	Ra Radium 88	Ac Actinium 89	Th Thorium 90	Pa Protactinium 91	U Uranium 92	Np Neptunium 93	Pu Plutonium 94	Am Americium 95	Cm Curium 96	Bk Berkelium 97	Cf Californium 98	Es Einsteinium 99	Fm Fermium 100	Md Mendelevium 101	No Nobelium 102	Lr Lawrencium 103	
226	87	Fr Francium 87	Ra Radium 88	La Lanthanum 57	Hf Hafnium 72	Ta Tantalum 73	W Tungsten 74	Re Rhenium 75	Os Osmium 76	Ir Iridium 77	Pt Platinum 78	Au Gold 79	Hg Mercury 80	Tl Thallium 81	Pb Lead 82	Bi Bismuth 83	Po Polonium 84	At Astatine 85	Rn Radon 86	Fr Francium 87	Ra Radium 88	Ac Actinium 89	Th Thorium 90	Pa Protactinium 91	U Uranium 92	Np Neptunium 93	Pu Plutonium 94	Am Americium 95	Cm Curium 96	Bk Berkelium 97	Cf Californium 98	Es Einsteinium 99	Fm Fermium 100	Md Mendelevium 101	No Nobelium 102	Lr Lawrencium 103	
227	89	Fr Francium 87	Ra Radium 88	La Lanthanum 57	Hf Hafnium 72	Ta Tantalum 73	W Tungsten 74	Re Rhenium 75	Os Osmium 76	Ir Iridium 77	Pt Platinum 78	Au Gold 79	Hg Mercury 80	Tl Thallium 81	Pb Lead 82	Bi Bismuth 83	Po Polonium 84	At Astatine 85	Rn Radon 86	Fr Francium 87	Ra Radium 88	Ac Actinium 89	Th Thorium 90	Pa Protactinium 91	U Uranium 92	Np Neptunium 93	Pu Plutonium 94	Am Americium 95	Cm Curium 96	Bk Berkelium 97	Cf Californium 98	Es Einsteinium 99	Fm Fermium 100	Md Mendelevium 101	No Nobelium 102	Lr Lawrencium 103	
226	88	Fr Francium 87	Ra Radium 88	La Lanthanum 57	Hf Hafnium 72	Ta Tantalum 73	W Tungsten 74	Re Rhenium 75	Os Osmium 76	Ir Iridium 77	Pt Platinum 78	Au Gold 79	Hg Mercury 80	Tl Thallium 81	Pb Lead 82	Bi Bismuth 83	Po Polonium 84	At Astatine 85	Rn Radon 86	Fr Francium 87	Ra Radium 88	Ac Actinium 89	Th Thorium 90	Pa Protactinium 91	U Uranium 92	Np Neptunium 93	Pu Plutonium 94	Am Americium 95	Cm Curium 96	Bk Berkelium 97	Cf Californium 98	Es Einsteinium 99	Fm Fermium 100	Md Mendelevium 101	No Nobelium 102	Lr Lawrencium 103	
226	88	Fr Francium 87	Ra Radium 88	La Lanthanum 57	Hf Hafnium 72	Ta Tantalum 73	W Tungsten 74	Re Rhenium 75	Os Osmium 76	Ir Iridium 77	Pt Platinum 78	Au Gold 79	Hg Mercury 80	Tl Thallium 81	Pb Lead 82	Bi Bismuth 83	Po Polonium 84	At Astatine 85	Rn Radon 86	Fr Francium 87	Ra Radium 88	Ac Actinium 89	Th Thorium 90	Pa Protactinium 91	U Uranium 92	Np Neptunium 93	Pu Plutonium 94	Am Americium 95	Cm Curium 96	Bk Berkelium 97	Cf Californium 98	Es Einsteinium 99	Fm Fermium 100	Md Mendelevium 101	No Nobelium 102	Lr Lawrencium 103	
226	88	Fr Francium 87	Ra Radium 88	La Lanthanum 57	Hf Hafnium 72	Ta Tantalum 73	W Tungsten 74	Re Rhenium 75	Os Osmium 76	Ir Iridium 77	Pt Platinum 78	Au Gold 79	Hg Mercury 80	Tl Thallium 81	Pb Lead 82	Bi Bismuth 83	Po Polonium 84	At Astatine 85	Rn Radon 86	Fr Francium 87	Ra Radium 88	Ac Actinium 89	Th Thorium 90	Pa Protactinium 91	U Uranium 92	Np Neptunium 93	Pu Plutonium 94	Am Americium 95	Cm Curium 96	Bk Berkelium 97	Cf Californium 98	Es Einsteinium 99	Fm Fermium 100	Md Mendelevium 101	No Nobelium 102	Lr Lawrencium 103	
226	88	Fr Francium 87	Ra Radium 88	La Lanthanum 57	Hf Hafnium 72	Ta Tantalum 73	W Tungsten 74	Re Rhenium 75	Os Osmium 76	Ir Iridium 77	Pt Platinum 78	Au Gold 79	Hg Mercury 80	Tl Thallium 81	Pb Lead 82	Bi Bismuth 83	Po Polonium 84	At Astatine 85	Rn Radon 86	Fr Francium 87	Ra Radium 88	Ac Actinium 89	Th Thorium 90	Pa Protactinium 91	U Uranium 92	Np Neptunium 93	Pu Plutonium 94	Am Americium 95	Cm Curium 96	Bk Berkelium 97	Cf Californium 98	Es Einsteinium 99	Fm Fermium 100	Md Mendelevium 101	No Nobelium 102	Lr Lawrencium 103	
226	88	Fr Francium 87	Ra Radium 88	La Lanthanum 57	Hf Hafnium 72	Ta Tantalum 73	W Tungsten 74	Re Rhenium 75	Os Osmium 76	Ir Iridium 77	Pt Platinum 78	Au Gold 79	Hg Mercury 80	Tl Thallium 81	Pb Lead 82	Bi Bismuth 83	Po Polonium 84	At Astatine 85	Rn Radon 86	Fr Francium 87	Ra Radium 88	Ac Actinium 89	Th Thorium 90	Pa Protactinium 91	U Uranium 92	Np Neptunium 93	Pu Plutonium 94	Am Americium 95	Cm Curium 96	Bk Berkelium 97	Cf Californium 98	Es Einsteinium 99	Fm Fermium 100	Md Mendelevium 101	No Nobelium 102	Lr Lawrencium 103	
226	88	Fr Francium 87	Ra Radium 88	La Lanthanum 57	Hf Hafnium 72	Ta Tantalum 73	W Tungsten 74	Re Rhenium 75	Os Osmium 76	Ir Iridium 77	Pt Platinum 78	Au Gold 79	Hg Mercury 80	Tl Thallium 81	Pb Lead 82	Bi Bismuth 83	Po Polonium 84	At Astatine 85	Rn Radon 86	Fr Francium 87	Ra Radium 88	Ac Actinium 89	Th Thorium 90	Pa Protactinium 91	U Uranium 92	Np Neptunium 93	Pu Plutonium 94	Am Americium 95	Cm Curium 96	Bk Berkelium 97	Cf Californium 98	Es Einsteinium 99	Fm Fermium 100	Md Mendelevium 101	No Nobelium 102	Lr Lawrencium 103	
226	88	Fr Francium 87	Ra Radium 88	La Lanthanum 57	Hf Hafnium 72	Ta Tantalum 73	W Tungsten 74	Re Rhenium 75	Os Osmium 76	Ir Iridium 77	Pt Platinum 78	Au Gold 79	Hg Mercury 80	Tl Thallium 81	Pb Lead 82	Bi Bismuth 83	Po Polonium 84	At Astatine 85	Rn Radon 86	Fr Francium 87	Ra Radium 88	Ac Actinium 89	Th Thorium 90	Pa Protactinium 91	U Uranium 92	Np Neptunium 93	Pu Plutonium 94	Am Americium 95	Cm Curium 96	Bk Berkelium 97	Cf Californium 98	Es Einsteinium 99	Fm Fermium 100	Md Mendelevium 101	No Nobelium 102	Lr Lawrencium 103	
226	88	Fr Francium 87	Ra Radium 88	La Lanthanum 57	Hf Hafnium 72	Ta Tantalum 73	W Tungsten 74	Re Rhenium 75	Os Osmium 76	Ir Iridium 77	Pt Platinum 78	Au Gold 79	Hg Mercury 80	Tl Thallium 81	Pb Lead 82	Bi Bismuth 83	Po Polonium 84	At Astatine 85	Rn Radon 86	Fr Francium 87	Ra Radium 88	Ac Actinium 89	Th Thorium 90	Pa Protactinium 91	U Uranium 92	Np Neptunium 93	Pu Plutonium 94	Am Americium 95	Cm Curium 96	Bk Berkelium 97	Cf Californium 98	Es Einsteinium 99	Fm Fermium 100	Md Mendelevium 101	No Nobelium 102	Lr Lawrencium 103	
226	88	Fr Francium 87	Ra Radium 88	La Lanthanum 57	Hf Hafnium 72	Ta Tantalum 73	W Tungsten 74	Re Rhenium 75	Os Osmium 76	Ir Iridium 77	Pt Platinum 78	Au Gold 79	Hg Mercury 80	Tl Thallium 81	Pb Lead 82	Bi Bismuth 83	Po Polonium 84	At Astatine 85	Rn Radon 86	Fr Francium 87	Ra Radium 88	Ac Actinium 89	Th Thorium 90	Pa Protactinium 91	U Uranium 92	Np Neptunium 93	Pu Plutonium 94	Am Americium 95	Cm Curium 96	Bk Berkelium 97	Cf Californium 98	Es Einsteinium 99	Fm Fermium 100	Md Mendelevium 101	No Nobelium 102	Lr Lawrencium 103	
226	88	Fr Francium 87	Ra Radium 88	La Lanthanum 57	Hf Hafnium 72	Ta Tantalum 73	W Tungsten 74	Re Rhenium 75	Os Osmium 76	Ir Iridium 77	Pt Platinum 78	Au Gold 79	Hg Mercury 80	Tl Thallium 81	Pb Lead 82	Bi Bismuth 83	Po Polonium 84	At Astatine 85	Rn Radon 86	Fr Francium 87	Ra Radium 88	Ac Actinium 89	Th Thorium 90	Pa Protactinium 91	U Uranium 92	Np Neptunium 93	Pu Plutonium 94	Am Americium 95	Cm Curium 96	Bk Berkelium 97	Cf Californium 98	Es Einsteinium 99	Fm Fermium 100	Md Mendelevium 101	No Nobelium 102	Lr Lawrencium 103	
226	88	Fr Francium 87																																			