

CHEMISTRY

9701/11

Paper 1 Multiple Choice

May/June 2014

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, 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.

DO NOT WRITE IN ANY BARCODES.

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.

Electronic calculators may be used.

This document consists of **14** printed pages and **2** blank pages.

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.*

Atoms of element X have six unpaired electrons.

What could be element X?

- A** carbon
- B** chromium
- C** iron
- D** selenium

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

Iodine is a black, shiny, non-metallic solid and a member of Group VII. It sublimes easily on heating to give a purple vapour.

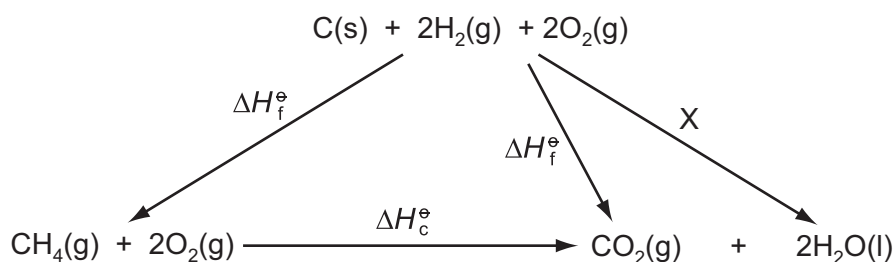
A sample of iodine vapour of mass 6.35 g has a volume of 1.247 dm³ when maintained at constant temperature and a pressure of 1.00×10^5 Pa.

If iodine vapour acts as an ideal gas, what is the temperature of the iodine vapour?

- A** 300 K
- B** 600 K
- C** 300 000 K
- D** 600 000 K

- 3 Enthalpy changes that are difficult to measure directly can often be determined using Hess' Law to construct an enthalpy cycle.

Which enthalpy change is indicated by X in the enthalpy cycle shown?



- A** $-4 \times$ the enthalpy of combustion of hydrogen
- B** $+4 \times$ the enthalpy of combustion of hydrogen
- C** $-2 \times$ the enthalpy of formation of water
- D** $+2 \times$ the enthalpy of formation of water

- 4 The table shows the physical properties of four substances.

Which substance has a giant covalent structure?

	melting point /°C	boiling point /°C	electrical conductivity of solid	electrical conductivity of liquid	electrical conductivity of aqueous solution
A	–119	39	poor	poor	insoluble
B	–115	–85	poor	poor	good
C	993	1695	poor	good	good
D	1610	2230	poor	poor	insoluble

- 5 A student mixed 25.0 cm^3 of 0.350 mol dm^{-3} sodium hydroxide solution with 25.0 cm^3 of 0.350 mol dm^{-3} hydrochloric acid. The temperature rose by 2.50°C . Assume that no heat was lost to the surroundings.

The final mixture had a specific heat capacity of $4.20\text{ J cm}^{-3}\text{ K}^{-1}$.

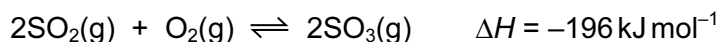
What is the molar enthalpy change for the reaction?

- A** -150 kJ mol^{-1}
B -60.0 kJ mol^{-1}
C -30.0 kJ mol^{-1}
D $-0.150\text{ kJ mol}^{-1}$
- 6 AlCl_3 vapour forms molecules with formula Al_2Cl_6 as it is cooled.

What happens to the bond angles during the change from AlCl_3 to Al_2Cl_6 ?

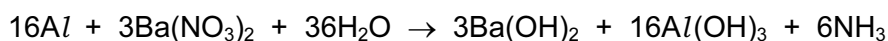
- A** Some decrease, some remain the same.
B Some increase, some remain the same.
C They all decrease.
D They all increase.

- 7 The Contact process is used in the manufacture of sulfuric acid. The equation for the main reaction is shown below.



Which statement about this reaction is **incorrect**?

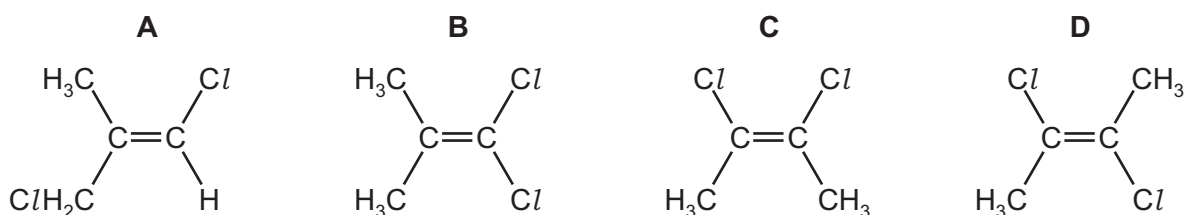
- A** Increased pressure gives a higher yield of SO_3 .
- B** Increased temperature gives a higher yield of SO_3 .
- C** In the forward reaction the oxidation state of sulfur changes from +4 to +6.
- D** Vanadium(V) oxide is used as a catalyst.
- 8 When making sparkler fireworks, a mixture of barium nitrate powder with aluminium powder, water and glue is coated onto wires and allowed to dry. At this stage, the following exothermic reaction may occur.



Which conditions would be best to reduce the rate of this reaction during the drying process, and would also keep the aluminium and barium nitrate unchanged?

	temperature / K	pH
A	298	7
B	298	14
C	398	7
D	398	14

- 9 Which molecular structure will have the **smallest** overall dipole?

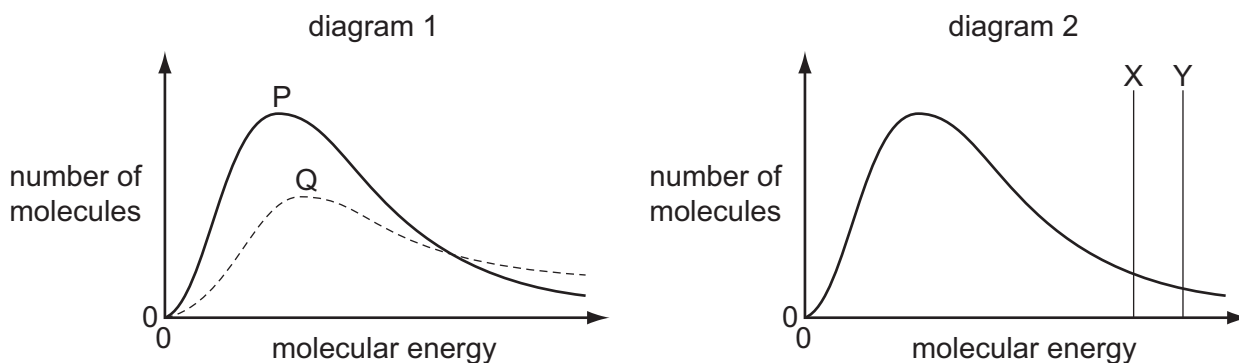


- 10 The equilibrium constant, K_c , for the reaction $\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \rightleftharpoons 2\text{HI}(\text{g})$, is 60 at 450°C .

What is the number of moles of hydrogen iodide in equilibrium with 2 mol of hydrogen and 0.3 mol of iodine at 450°C ?

- A** $\frac{1}{100}$ **B** $\frac{1}{10}$ **C** 6 **D** 36

11 Boltzmann distributions are shown in the diagrams.



In diagram 1, one curve, P or Q, corresponds to a temperature higher than that of the other curve.

In diagram 2, one line, X or Y, corresponds to the activation energy in the presence of a catalyst and the other line corresponds to the activation energy of the same reaction in the absence of a catalyst.

Which combination gives the correct curve and line?

	higher temperature	presence of catalyst
A	P	X
B	P	Y
C	Q	X
D	Q	Y

12 Redox reactions occur very frequently in the chemistry of Group VII.

Which statement is correct?

- A** Chlorine will oxidise bromide ions but not iodide ions.
- B** Fluorine is the weakest oxidising agent out of F_2 , Cl_2 , Br_2 and I_2 .
- C** Iodide ions are the weakest reducing agent out of F^- , Cl^- , Br^- and I^- .
- D** When chlorine reacts with water, chlorine is both oxidised and reduced.

- 13 When equal volumes of saturated solutions of barium hydroxide and calcium hydroxide are mixed, a white precipitate, **Y**, forms. The mixture is filtered and carbon dioxide is bubbled through the filtrate, producing a second white precipitate, **Z**.

What are **Y** and **Z**?

	Y	Z
A	Ba(OH)_2	Ca(OH)_2
B	Ba(OH)_2	CaCO_3
C	Ca(OH)_2	BaCO_3
D	Ca(OH)_2	Ba(OH)_2

- 14 What is the order of increasing melting point of the four chlorides shown?



	lowest melting point	→			highest melting point
A	CCl_4	HCl	PCl_5		MgCl_2
B	HCl	CCl_4	PCl_5		MgCl_2
C	HCl	PCl_5	CCl_4		MgCl_2
D	MgCl_2	PCl_5	CCl_4		HCl

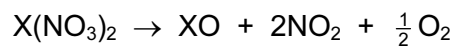
- 15 When calcium is burnt in oxygen, what colour is the flame?

- A** green
B red
C white
D yellow

- 16 Which description of the bonding and acid/base nature of aluminium oxide is correct?

	bonding	acid / base nature
A	covalent	amphoteric
B	covalent	basic
C	ionic	amphoteric
D	ionic	basic

- 17 Group II nitrates undergo thermal decomposition according to the following equation.



Which Group II nitrate requires the highest temperature to bring about its thermal decomposition?

- A barium nitrate
- B calcium nitrate
- C magnesium nitrate
- D strontium nitrate

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

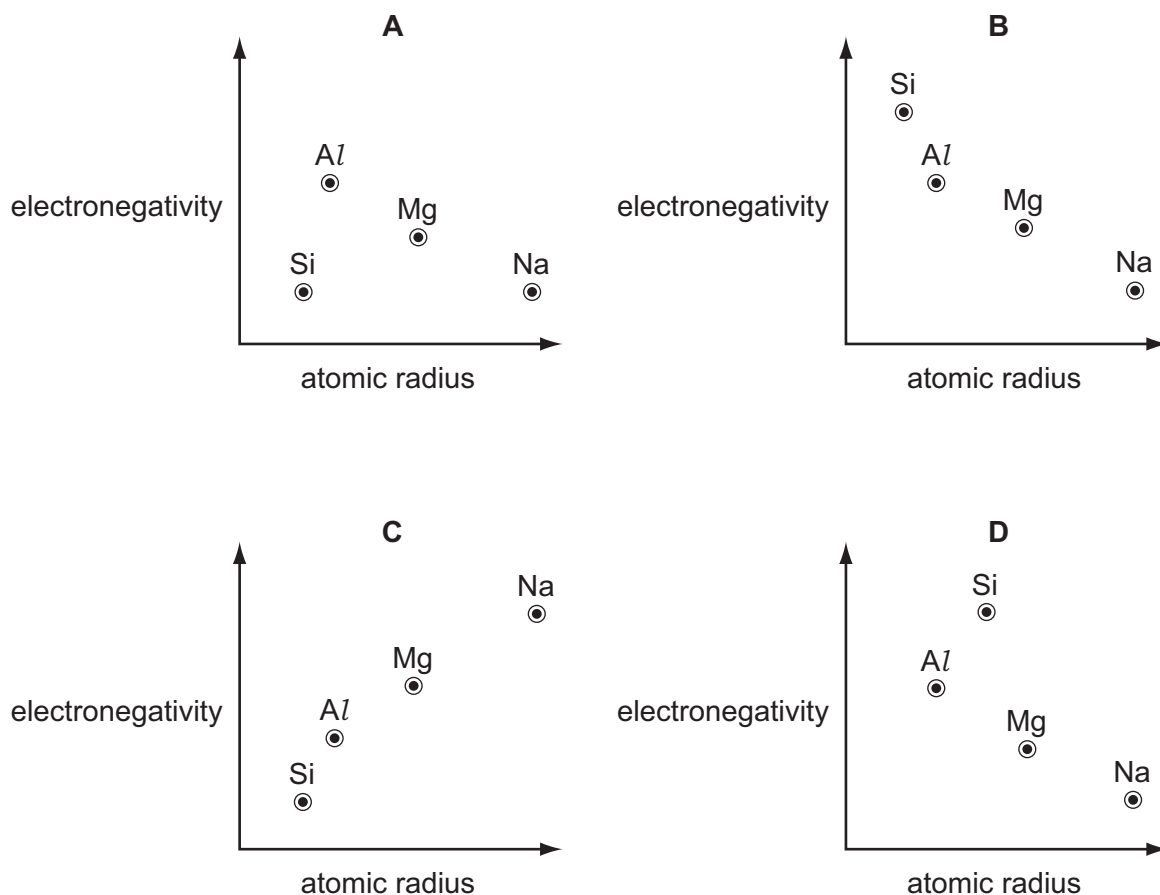
A chemist took 2.00 dm^3 of nitrogen gas, measured under room conditions, and reacted it with a large volume of hydrogen gas, in order to produce ammonia. Only 15.0% of the nitrogen gas reacted to produce ammonia.

What mass of ammonia was formed?

- A 0.213 g B 0.425 g C 1.42 g D 2.83 g

19 Use of the Data Booklet is relevant to this question.

Which graph correctly shows relative electronegativity plotted against relative atomic radius for the elements Na, Mg, Al and Si?



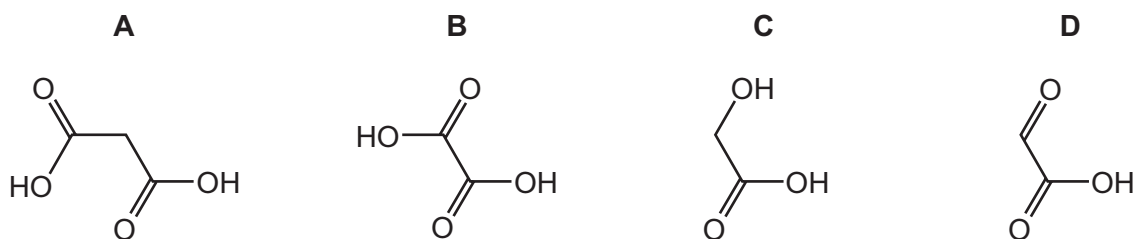
20 Many organic reactions need to be heated before reaction occurs, but some do not require heating.

Which reaction occurs quickly at room temperature?

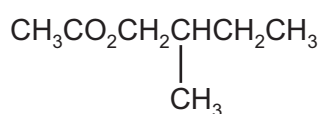
- A $\text{C}_2\text{H}_4 + \text{Br}_2 \rightarrow \text{C}_2\text{H}_4\text{Br}_2$
- B $\text{C}_2\text{H}_4 + \text{H}_2\text{O} \rightarrow \text{CH}_3\text{CH}_2\text{OH}$
- C $\text{CH}_3\text{CH}_2\text{OH} \rightarrow \text{C}_2\text{H}_4 + \text{H}_2\text{O}$
- D $\text{CH}_3\text{CH}_2\text{OH} + \text{HBr} \rightarrow \text{CH}_3\text{CH}_2\text{Br} + \text{H}_2\text{O}$

- 21 Hydroxyethanal, HOCH_2CHO , is heated under reflux with an excess of acidified potassium dichromate(VI) until no further oxidation takes place.

What is the skeletal formula of the organic product?



- 22 An ester with an odour of banana has the following formula.



Which pair of reactants, under suitable conditions, will produce this ester?

- A** $\text{CH}_3\text{CH}_2\underset{\text{CH}_3}{\text{CH}}\text{CH}_2\text{CO}_2\text{H} + \text{CH}_3\text{OH}$
- B** $\text{CH}_3\text{CH}_2\underset{\text{CH}_3}{\text{CH}}\text{CO}_2\text{H} + \text{CH}_3\text{CH}_2\text{OH}$
- C** $\text{CH}_3\text{CO}_2\text{H} + \text{CH}_3\text{CH}_2\underset{\text{CH}_3}{\text{CH}}\text{CH}_2\text{OH}$
- D** $\text{CH}_3\text{CO}_2\text{H} + \text{CH}_3\underset{\text{CH}_3}{\text{CH}}\text{CH}_2\text{CH}_2\text{OH}$

- 23 The hydrolysis of 1-chloropropane to produce propan-1-ol is much slower than the corresponding hydrolysis of 1-iodopropane.

Which statement explains this observation?

- A** Chlorine is more electronegative than iodine.
- B** The bond strength of the $\text{C}-\text{I}$ bond is less than that of the $\text{C}-\text{Cl}$ bond.
- C** The carbon atom in the $\text{C}-\text{Cl}$ bond is more δ^+ than that in the $\text{C}-\text{I}$ bond.
- D** The hydrolysis involves a nucleophilic addition reaction.

- 24 There are three structural isomers with the formula C_5H_{12} .

Which formulae correctly represent these three structural isomers?

- A $CH_3CH_2CH_2CH_2CH_3$ $CH_3CH_2CHCH_3CH_3$ $CH_3CH_3CCH_3CH_3$
 B $CH_3CH_2CH_2CH_2CH_3$ $CH_3CH_2(CH)CH_3CH_3$ $C(CH_3)_4$
 C $CH_3CH_2CH_2CH_2CH_3$ $CH_3CH(CH_3)CH_2CH_3$ $CH_3C(CH_3)_2CH_3$
 D $CH_3CH_2CH_2CH_2CH_3$ $CH_3CH(CH_3)CH_2CH_3$ $CH_3CH_2CH(CH_3)CH_3$
- 25 $CH_3CH_2COCH_2CH_3$ reacts with hydrogen cyanide to form an organic product called a cyanohydrin.

Which feature applies to the cyanohydrin product?

- A It has one chiral centre.
 B It is formed by electrophilic addition.
 C It is formed via an intermediate which contains the C–OH group.
 D Its formation requires the use of cyanide ions as a catalyst.
- 26 How many moles of oxygen molecules are needed for the complete combustion of one mole of 3-methylpent-2-ene?

- A 9 B $9\frac{1}{2}$ C 18 D 19

- 27 The hydrocarbon $C_{17}H_{36}$ can be cracked.

Which compound is the **least** likely to be produced in this reaction?

- A C_3H_8 B C_4H_8 C C_8H_{16} D $C_{16}H_{34}$

- 28 Compound X has the molecular formula $C_4H_{10}O_2$. X has an unbranched carbon chain and contains two OH groups.

On reaction with an excess of hot, acidified, aqueous manganate(VII) ions, X is converted into a compound of molecular formula $C_4H_6O_4$.

To which two carbon atoms in the chain of X are the two OH groups attached?

- A 1st and 2nd
 B 1st and 3rd
 C 1st and 4th
 D 2nd and 3rd

29 How many geometrical (cis-trans) isomers are there of hex-2,4-diene, $\text{CH}_3\text{CH}=\text{CHCH}=\text{CHCH}_3$?

- A none; hex-2,4-diene does not show geometric isomerism
- B 2
- C 3
- D 4

30 Butanoic acid can be produced from 1-bromopropane using reagents X and Y as shown below.



What could be reagents X and Y?

	X	Y
A	KCN in ethanol	HCl(aq)
B	KCN in ethanol	NaOH(aq)
C	NH_3 in ethanol	HCl(aq)
D	NaOH(aq)	$\text{H}^+ / \text{Cr}_2\text{O}_7^{2-}(\text{aq})$

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

When the liquid N_2F_4 is heated, it decomposes into a single product, X.

Which statements are correct?

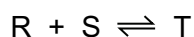
- 1** N–F bonds are broken during this decomposition.
- 2** The enthalpy change when N_2F_4 decomposes into X is approximately $+160 \text{ kJ mol}^{-1}$.
- 3** Molecules of X are non-linear.

32 P and Q are two liquid compounds with similar M_r values. Molecules of P attract each other by hydrogen bonds. Molecules of Q attract each other by van der Waals' forces only.

How do the properties of P and Q differ?

- 1** P has a higher surface tension than Q.
- 2** P is less soluble in water than Q.
- 3** P has a lower melting point than Q.

33 R and S react together.

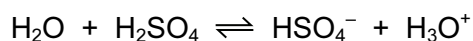
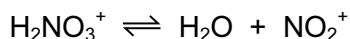
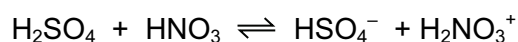


Which factors affect the rate of the forward reaction?

- 1** the activation energy of the reaction
- 2** the enthalpy change of the reaction
- 3** the equilibrium constant of the reaction

- 34 The Brønsted-Lowry theory describes acid and base character.

When concentrated sulfuric acid and concentrated nitric acid are mixed, the following reactions occur.



Which species are bases in these reactions?

- 1 HSO_4^-
- 2 HNO_3
- 3 NO_2^+

- 35 Pollutant oxide **Y**, which contains non-metallic element **X**, is formed in a car engine.

Further oxidation of **Y** to **Z** occurs in the atmosphere. In this further oxidation, 1 mol of **Y** reacts with 0.5 mol of gaseous oxygen molecules.

X could be either nitrogen or sulfur.

Which statements about **X**, **Y** and **Z** can be correct?

- 1 The oxidation number of **X** increases by two from **Y** to **Z**.
- 2 **Y** has an unpaired electron in its molecule.
- 3 **Y** is a polar molecule.

- 36 A test-tube of HI gas and a test-tube of HBr gas are placed together in an environment at temperature, T.

Which combinations of observations are possible depending on the temperature, T?

- 1 A brown vapour appears in one of the test-tubes. No change is apparent in the other test-tube.
- 2 A brown vapour appears in one of the test-tubes. A purple vapour appears in the other test-tube.
- 3 No change is apparent in either test-tube.

- 37 Which pairs of reagents will take part in a redox reaction?

- 1 CH_3COCH_3 + Tollens' reagent
- 2 $\text{CH}_3\text{CH}_2\text{CHO}$ + Fehling's reagent
- 3 $\text{CH}_3\text{CH}=\text{CH}_2$ + Br_2

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.

- 38** The molecule responsible for the pineapple flavour used in sweets is $\text{CH}_3\text{CH}_2\text{CH}_2\text{CO}_2\text{CH}_2\text{CH}_3$.

Which statements about this molecule are correct?

- 1** The name of this compound is ethyl butanoate.
- 2** This compound is a structural isomer of hexanoic acid.
- 3** When this compound is heated with aqueous sodium hydroxide, the products are butan-1-ol and sodium ethanoate.

- 39** The compound pentan-1,4-diol has two OH groups per molecule and can be oxidised.

Which statements about pentan-1,4-diol or its oxidation products are correct?

- 1** When one mole of pentan-1,4-diol reacts with an excess of sodium metal, one mole of hydrogen molecules is produced.
- 2** At least one of the possible oxidation products of pentan-1,4-diol will react with 2,4-dinitrophenylhydrazine reagent.
- 3** Dehydration of pentan-1,4-diol could produce a compound with empirical formula C_5H_8 .

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

In an organic synthesis, a 62% yield of product is achieved.

Which conversions are consistent with this information?

- 1** 74.00 g of butan-2-ol $\rightarrow$ 44.64 g of butanone
- 2** 74.00 g of butan-1-ol $\rightarrow$ 54.56 g of butanoic acid
- 3** 74.00 g of 2-methylpropan-1-ol $\rightarrow$ 54.56 g of 2-methylpropanoic acid

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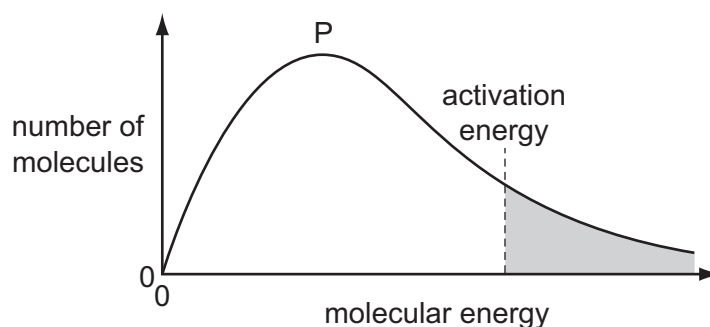
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Section A

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

- 1 The diagram shows a Boltzmann distribution of molecular energies for a gaseous mixture. The distribution has a peak, labelled P on the diagram.



What happens when the temperature of the mixture increases?

- A** The height of the peak, P, decreases and the activation energy moves to the left.
B The height of the peak, P, decreases and the activation energy moves to the right.
C The height of the peak, P, decreases and the activation energy does not change.
D The height of the peak, P, increases and the activation energy moves to the left.
- 2 Substances X, Y and Z are all solids. Some of their physical properties are given in the table.

substance	X	Y	Z
melting point/ $^{\circ}\text{C}$	772	114	1610
boiling point/ $^{\circ}\text{C}$	1407	183	2205
electrical conductivity of the liquid state	conducts	does not conduct	does not conduct

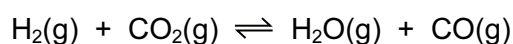
What type of lattice could each substance have?

	X	Y	Z
A	giant molecular	simple molecular	ionic
B	ionic	giant molecular	simple molecular
C	ionic	simple molecular	giant molecular
D	simple molecular	ionic	giant molecular

- 3 The enthalpy change of formation of carbon dioxide is -394 kJ mol^{-1} .
The enthalpy change of formation of water is -286 kJ mol^{-1} .
The enthalpy change of formation of methane is -74 kJ mol^{-1} .

What is the enthalpy change of combustion of methane?

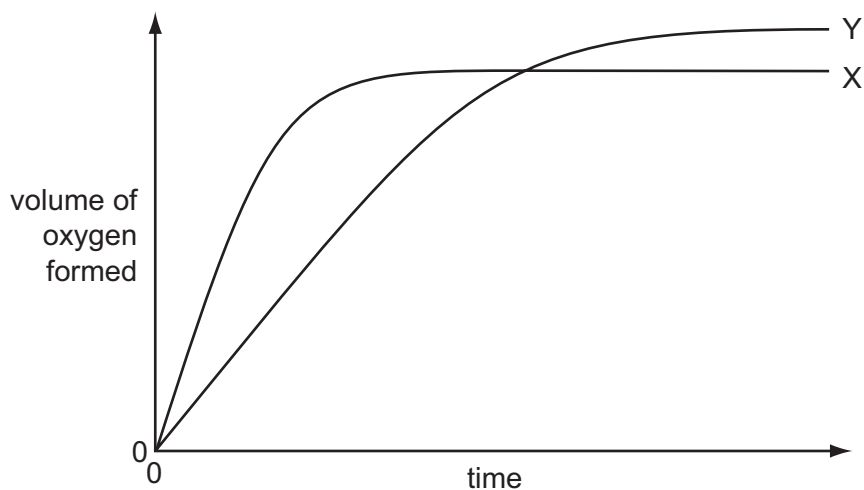
- A -892 kJ mol^{-1}
B -606 kJ mol^{-1}
C $+606 \text{ kJ mol}^{-1}$
D $+892 \text{ kJ mol}^{-1}$
- 4 Hydrogen and carbon dioxide gases are mixed in equal molar amounts at 800 K. A reversible reaction takes place.



At equilibrium, the partial pressures of H_2 and CO_2 are both 10.0 kPa. K_p is 0.288 at 800 K.

What is the partial pressure of CO in the equilibrium mixture?

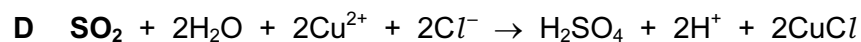
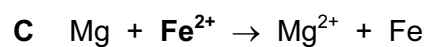
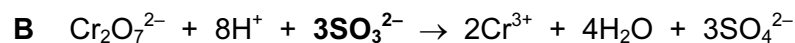
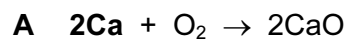
- A 5.37 kPa B 18.6 kPa C 28.8 kPa D 347 kPa
- 5 In the diagram, curve X was obtained by observing the decomposition of 100 cm^3 of 1.0 mol dm^{-3} hydrogen peroxide, catalysed by manganese(IV) oxide.



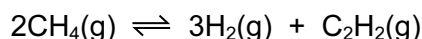
Which alteration to the original experimental conditions would produce curve Y?

- A adding more manganese(IV) oxide
B adding some 0.1 mol dm^{-3} hydrogen peroxide
C adding water
D raising the temperature

6 In which reaction is the species in **bold** acting as an oxidising agent?



7 The formation of hydrogen and ethyne, C_2H_2 , from methane reaches dynamic equilibrium.



What are the units of K_c ?

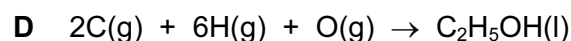
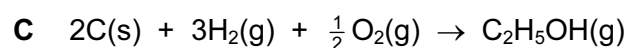
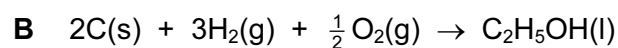
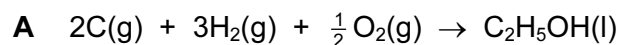
A mol dm^{-3}

B $\text{mol}^2 \text{dm}^{-6}$

C $\text{mol}^3 \text{dm}^{-9}$

D $\text{mol}^4 \text{dm}^{-12}$

8 Which equation represents the standard enthalpy change of formation of ethanol, $\text{C}_2\text{H}_5\text{OH}$?



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

In an experiment, 12.0 dm^3 of oxygen, measured under room conditions, is used to burn completely 0.10 mol of propan-1-ol.

What is the final volume of gas, measured under room conditions?

A 7.20 dm^3

B 8.40 dm^3

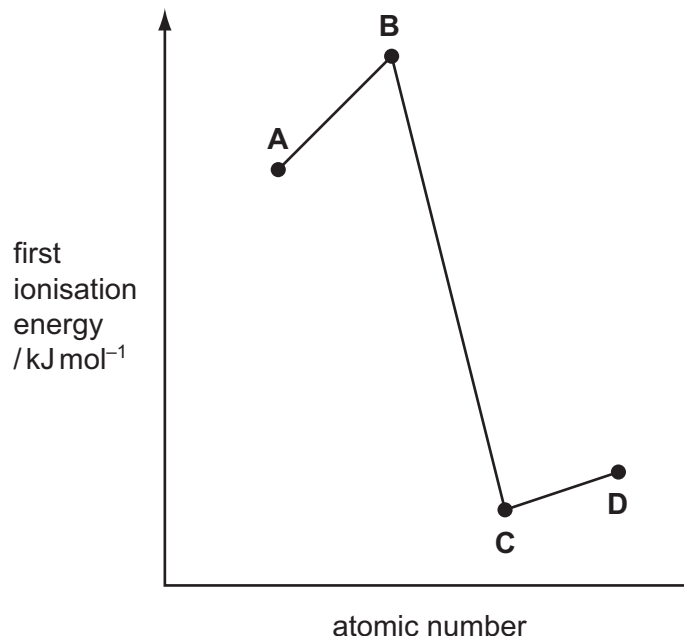
C 16.8 dm^3

D 18.00 dm^3

- 10 Shown on the graph are the relative values of the first ionisation energies of four elements that have consecutive atomic numbers.

One of the elements reacts with hydrogen to form a covalent compound with formula HX.

Which element could be X?



- 11 The diagram shows the skeletal formula of cyclopropane.



The enthalpy change of formation of cyclopropane is $+53.3 \text{ kJ mol}^{-1}$ and the enthalpy change of atomisation of graphite is $+717 \text{ kJ mol}^{-1}$.

The bond enthalpy of H–H is 436 kJ mol^{-1} and of C–H is 410 kJ mol^{-1} .

What value for the average bond enthalpy of the C–C bond in cyclopropane can be calculated from this data?

- A 187 kJ mol^{-1} B 315 kJ mol^{-1} C 351 kJ mol^{-1} D 946 kJ mol^{-1}
- 12 When barium is burnt in oxygen, what colour is the flame?

- A green
B orange
C red
D white

- 13 X and Y are oxides of different Period 3 elements.

If one mole of Y is added to water, the solution formed is neutralised by exactly one mole of X.

What could be the identities of X and Y?

	X	Y
A	Al_2O_3	P_4O_{10}
B	Al_2O_3	SO_3
C	Na_2O	P_4O_{10}
D	Na_2O	SO_3

- 14 Ammonium sulfate in the soil is slowly oxidised by air, producing sulfuric acid, nitric acid and water as the only products.

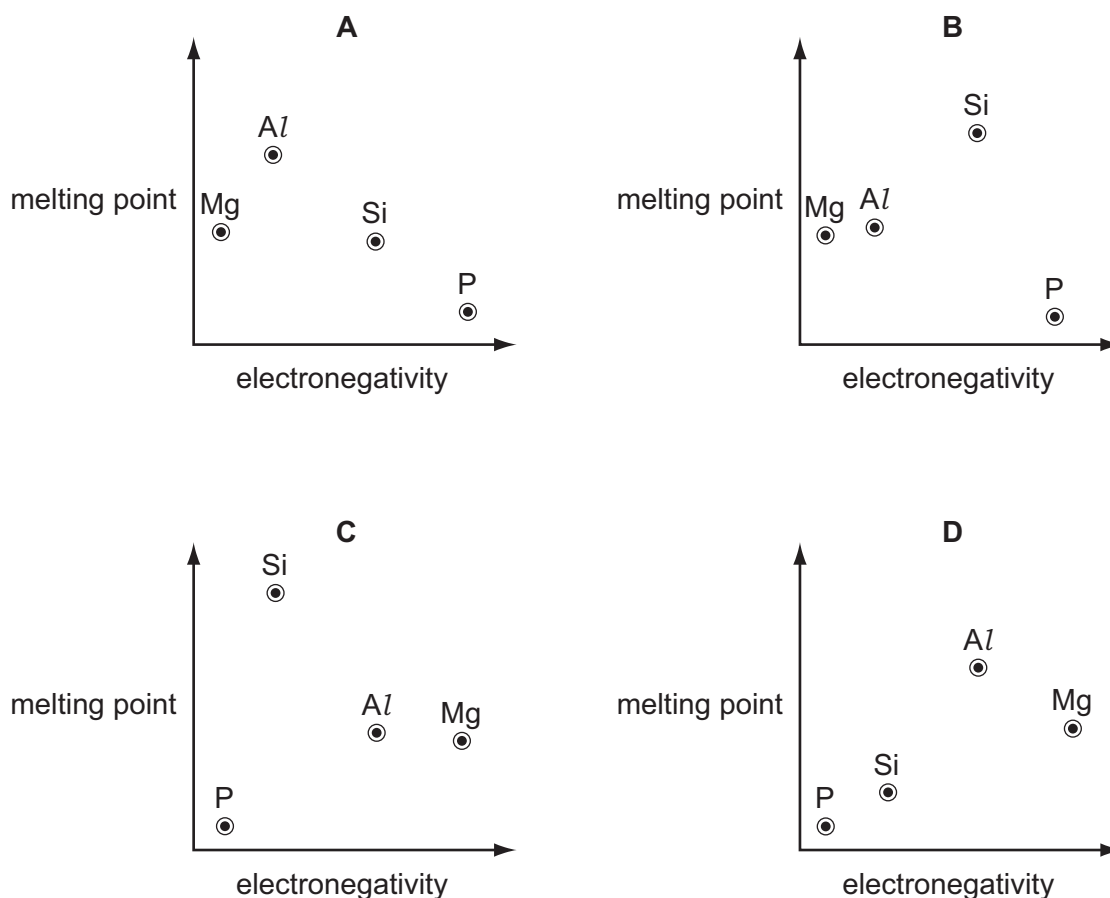
How many moles of oxygen gas are needed for the complete oxidation of one mole of ammonium sulfate?

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

- 15 Which statement about the oxides and hydroxides of the Group II elements Mg, Ca, Sr and Ba is correct?

- A** Each of the oxides reacts readily with water to form a solution of pH 12 or above.
- B** Magnesium oxide is used as a furnace lining because it has a giant molecular structure and hence a high melting point.
- C** The hydroxides are produced directly by the thermal decomposition of the corresponding nitrates.
- D** The solubility of the hydroxides increases from $Mg(OH)_2$ to $Ba(OH)_2$.

- 16 Which graph correctly shows the relative melting points of the elements Mg, Al, Si and P plotted against their relative electronegativities?



- 17 When solid sodium iodide reacts with concentrated sulfuric acid, the products include NaHSO_4 , H_2S , SO_2 and S.

In the formation of which product has the oxidation state of sulfur changed by a value of 8?

- A** H_2S **B** NaHSO_4 **C** S **D** SO_2

- 18 A test-tube of HBr(g) and a test-tube of HI(g) are heated to the same temperature.

Which combination of observations is possible?

	tube of HBr(g)	tube of HI(g)
A	a brown vapour appears	no change is apparent
B	a purple vapour appears	no change is apparent
C	no change is apparent	a brown vapour appears
D	no change is apparent	a purple vapour appears

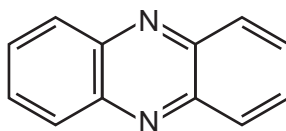
19 Use of the Data Booklet is relevant to this question.

In an experiment, 0.125 mol of chlorine gas, Cl_2 , is reacted with an excess of cold aqueous sodium hydroxide. One of the products is a compound of sodium, oxygen, and chlorine.

Which mass of this product is formed?

- A 9.31 g B 13.3 g C 18.6 g D 26.6 g

20 The diagram shows the skeletal formula of phenazine.



phenazine

What is the empirical formula of phenazine?

- A $\text{C}_6\text{H}_4\text{N}$ B $\text{C}_6\text{H}_6\text{N}$ C $\text{C}_{12}\text{H}_8\text{N}_2$ D $\text{C}_{12}\text{H}_{12}\text{N}_2$

21 Halogenoalkanes undergo a range of nucleophilic substitution reactions.

Which reaction proceeds **only** by an $\text{S}_{\text{N}}1$ mechanism?

- A $\text{CH}_3\text{CH}_2\text{Br} + \text{NH}_3$
B $\text{CH}_3\text{CH}_2\text{CH}_2\text{I} + \text{OH}^-$
C $\text{CH}_3\text{CHBrCH}_3 + \text{NH}_3$
D $(\text{CH}_3)_3\text{CI} + \text{OH}^-$

22 Which alcohol has a chiral centre **and** can be oxidised to a ketone?

- A pentan-2-ol
B pentan-3-ol
C 3-methylhexan-1-ol
D 3-methylhexan-3-ol

- 23 An ester of structural formula $\text{CH}_3\text{CO}_2\text{CH}_3$ is heated with an aqueous solution of sodium hydroxide.

What are the two organic products of this reaction?

- A ethanoic acid and methanol
 - B methanoic acid and ethanol
 - C sodium ethanoate and methanol
 - D sodium methanoate and ethanol
- 24 Ethene reacts with aqueous bromine to give two products, $\text{CH}_2\text{BrCH}_2\text{Br}$ and $\text{CH}_2\text{BrCH}_2\text{OH}$.

Which statement about these products is correct?

- 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 organic compound.
 - D Both products can form hydrogen bonds with water.
- 25 Which statement does **not** correctly describe a problem related to the disposal of PVC?
- A PVC is slowly degraded in the environment by bacteria and fungi.
 - B PVC is slowly degraded in the environment by sunlight.
 - C When PVC is burnt, a significant amount of ethene gas is present in the products.
 - D When PVC is burnt, a significant amount of HCl gas is present in the products.

- 26 Compound X, $\text{C}_4\text{H}_8\text{O}$, produces an orange precipitate when it is reacted with 2,4-dinitrophenylhydrazine reagent. Compound X produces a carboxylic acid when heated under reflux with an acidified solution of potassium dichromate(VI).

What could be compound X?

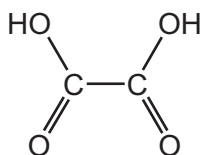
- A butanal
- B butanone
- C 2-methylbutanal
- D 4-hydroxybut-1-ene

- 27 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 All fluorine compounds are non-flammable.
- B Fluorine is highly electronegative.
- C The carbon-fluorine bond energy is large.
- D The carbon-fluorine bond has a low polarity.

- 28 The diagram shows the structure of ethanedioic acid.



Ethanedioic acid reacts with ethanol in the presence of a few drops of concentrated sulfuric acid to form a diester. The molecular formula of the diester is $\text{C}_6\text{H}_{10}\text{O}_4$.

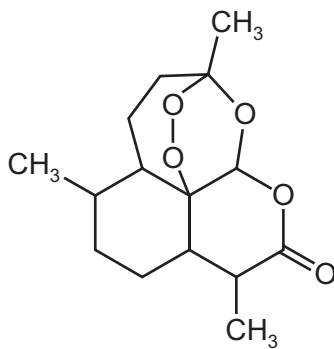
What is the structural formula of the diester?

- A $\text{CH}_3\text{CH}_2\text{CO}_2\text{CO}_2\text{CH}_2\text{CH}_3$
 - B $\text{CH}_3\text{CH}_2\text{OCOCO}_2\text{CH}_2\text{CH}_3$
 - C $\text{CH}_3\text{CH}_2\text{O}_2\text{CO}_2\text{CCH}_2\text{CH}_3$
 - D $\text{CH}_3\text{CO}_2\text{CH}_2\text{CH}_2\text{OCOCH}_3$
- 29 When heated with KOH dissolved in ethanol, halogenoalkanes can undergo an elimination reaction to form alkenes.

What are the possible elimination products when 2-bromobutane is heated with KOH dissolved in ethanol?

- A $\text{CH}_3\text{CH}=\text{CHCH}_3$ only
- B $\text{CH}_3\text{CH}_2\text{CH}=\text{CH}_2$ only
- C $\text{CH}_3\text{CH}=\text{CHCH}_3$ and $\text{CH}_3\text{CH}_2\text{CH}=\text{CH}_2$
- D $\text{CH}_3\text{CH}=\text{CHCH}_3$ and $\text{CH}_2=\text{CHCH}=\text{CH}_2$

30 Artemisinin is a powerful anti-malarial drug.



artemisinin

How many chiral centres are there in each molecule of artemisinin?

A 4

B 6

C 7

D 8

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.

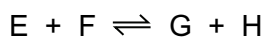
- 31** P and Q are two compounds with similar M_r values. Molecules of P attract each other by hydrogen bonds. Molecules of Q attract each other by van der Waals' forces only.

A sample of liquid P is compared to a sample of liquid Q.

How will their properties differ?

- 1** P is more soluble in water than Q.
- 2** P has a higher melting point than Q.
- 3** P is more viscous than Q.

- 32** The reaction



is catalysed by platinum.

Which statements about the properties of the catalyst are correct?

- 1** The catalyst has no effect on the enthalpy change of the reaction.
- 2** The catalyst increases the rate of the reverse reaction.
- 3** The catalyst increases the average kinetic energy of the reacting particles.

- 33** Which elements have atoms which can form π bonds with atoms of other elements?

- 1** oxygen
- 2** nitrogen
- 3** fluorine

34 Sulfuric acid is a Brønsted-Lowry acid.

In which reactions is sulfuric acid behaving as an acid?

- 1 $\text{H}_2\text{SO}_4 + \text{HNO}_3 \rightarrow \text{H}_2\text{NO}_3^+ + \text{HSO}_4^-$
- 2 $\text{H}_2\text{SO}_4 + \text{CO}_3^{2-} \rightarrow \text{CO}_2 + \text{H}_2\text{O} + \text{SO}_4^{2-}$
- 3 $\text{H}_2\text{SO}_4 + \text{MgO} \rightarrow \text{MgSO}_4 + \text{H}_2\text{O}$

35 Silver chloride dissolves in aqueous ammonia.

What happens in this process?

- 1 Ammonia forms a complex with the Ag^+ ion.
 - 2 Ammonia acts as a Brønsted-Lowry base.
 - 3 A redox reaction occurs.
- 36 A car has a catalytic converter fitted to its exhaust. On analysis its exhaust gases are shown to contain small quantities of nitrogen oxides.

Which modifications would result in lower exhaust concentrations of nitrogen oxides?

- 1 an increase in the surface area of the catalyst in the converter
- 2 an increase in the rate of flow of the exhaust gases through the converter
- 3 a much higher temperature of combustion in the engine

37 Which alcohols **cannot** be dehydrated to form alkenes?

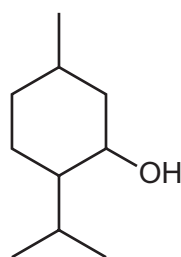
- 1 CH_3OH
- 2 $(\text{CH}_3)_3\text{COH}$
- 3 $\text{CH}_3\text{CH}_2\text{OH}$

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.

38 Menthol is a naturally-occurring alcohol found in peppermint oil.



menthol

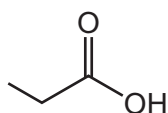
Which reagents will react with menthol?

- 1** aqueous bromine
- 2** sodium metal
- 3** aqueous acidified manganate(VII)

39 Which pairs of reagents will take part in a redox reaction under suitable conditions?

- 1** $\text{CH}_3(\text{CH}_2)_4\text{CHO}$ + Tollens' reagent
- 2** $\text{CH}_3(\text{CH}_2)_4\text{CH}_3$ + Br_2
- 3** $\text{CH}_3\text{CO}(\text{CH}_2)_4\text{CH}_3$ + Fehling's reagent

40 Propanoic acid occurs naturally as a result of the bacterial fermentation of milk, and is partly responsible for the flavour of Swiss cheese.



propanoic acid

Which starting materials could be used to synthesise propanoic acid?

- 1** $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$
- 2** $\text{CH}_3\text{CH}_2\text{CHO}$
- 3** $\text{CH}_3\text{CH}_2\text{CN}$

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CHEMISTRY

9701/13

Paper 1 Multiple Choice

May/June 2014

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, 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.

DO NOT WRITE IN ANY BARCODES.

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.

Electronic calculators may be used.

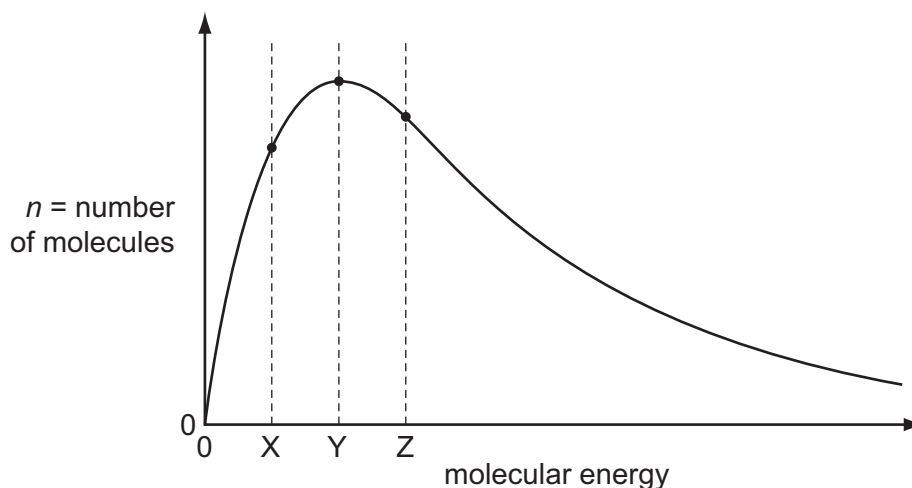
This document consists of **15** printed pages and **1** blank page.



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 Boltzmann distribution for a gas at constant temperature is shown below.

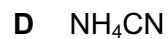
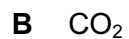
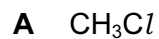


If the temperature of the gas is **reduced** by 10°C the graph changes shape.

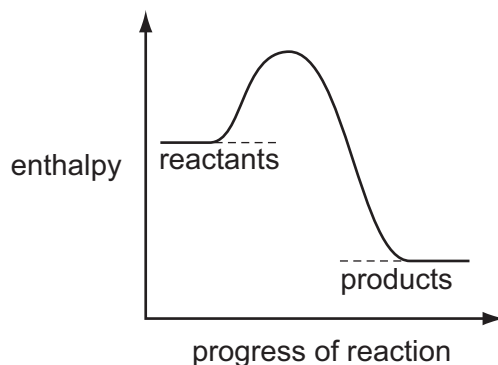
What happens to the values of n for the molecular energies X, Y and Z?

	X	Y	Z
A	higher	lower	higher
B	higher	lower	lower
C	lower	higher	lower
D	lower	lower	lower

- 2 Which compound has the greatest total number of lone pairs of electrons in the valence shells of all of its atoms?



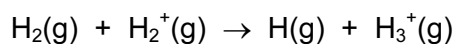
- 3 A reaction pathway diagram is shown.



Which enthalpy change could the diagram **not** apply to?

- A enthalpy of atomisation
 - B enthalpy of combustion
 - C enthalpy of formation
 - D enthalpy of neutralisation
- 4 Use of the Data Booklet is relevant to this question.

The most common ion-molecule reaction in gas clouds of the Universe is as shown.



What could be the composition of an H_3^+ ion?

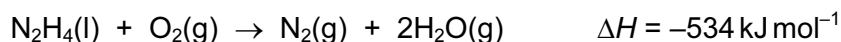
	protons	neutrons	electrons
A	2	1	1
B	2	1	2
C	3	0	1
D	3	0	2

- 5 The electrolysis of brine using the diaphragm cell is an important industrial process.

What happens at the anode?

- A Chloride ions are oxidised.
- B Hydrogen gas is produced.
- C Hydroxide ions are formed.
- D The electrode reaction is $2\text{Cl}^-(\text{aq}) + 2\text{e}^- \rightarrow \text{Cl}_2(\text{g})$.

- 6 Hydrazine, N_2H_4 , is used as a rocket fuel because it reacts with oxygen as shown, producing 'environmentally friendly' gases.



Despite its use as a rocket fuel, hydrazine does not burn spontaneously in oxygen.

Which statement explains why hydrazine does **not** burn spontaneously?

- A** Hydrazine is a liquid.
B The activation energy is too high.
C The $\text{N} \equiv \text{N}$ bond is very strong.
D The reaction is exothermic.
- 7 A 10.0 cm^3 bubble of an ideal gas is formed on the sea bed where it is at a pressure of 2020 kPa.

Just below the sea surface the pressure is 101 kPa and the temperature is the same as the sea bed.

What is the volume of the bubble when it rises to just below the sea surface?

- A** 10.0 cm^3 **B** 20.2 cm^3 **C** 200 cm^3 **D** $2\,020\,000 \text{ cm}^3$
- 8 Four substances have the physical properties shown.

Which substance is an ionic solid?

	melting point / $^{\circ}\text{C}$	boiling point / $^{\circ}\text{C}$	electrical conductivity of solid	electrical conductivity of molten substance	electrical conductivity of aqueous solution
A	-115	-85	poor	poor	good
B	660	2470	good	good	insoluble
C	993	1695	poor	good	good
D	1610	2230	poor	poor	insoluble

- 9 The enthalpy change of formation of $\text{Mn}(\text{NO}_3)_2(\text{s})$ is -696 kJ mol^{-1} .
 The enthalpy change of formation of $\text{MnO}_2(\text{s})$ is -520 kJ mol^{-1} .
 The enthalpy change of formation of $\text{NO}_2(\text{g})$ is $+33 \text{ kJ mol}^{-1}$.

On heating, $\text{Mn}(\text{NO}_3)_2$ decomposes into MnO_2 and NO_2 .



What is the value of the standard enthalpy change of this reaction?

- A -242 kJ mol^{-1}
 B -209 kJ mol^{-1}
 C $+209 \text{ kJ mol}^{-1}$
 D $+242 \text{ kJ mol}^{-1}$
- 10 X is an element in Period 2.
 In which fluoride is the $\text{F}-\text{X}-\text{F}$ angle the largest?
 A BF_3 B CF_4 C NF_3 D OF_2
- 11 Which reaction has an enthalpy change equal to the standard enthalpy change of formation of propane?
 A $3\text{C}(\text{g}) + 4\text{H}_2(\text{g}) \rightarrow \text{C}_3\text{H}_8(\text{g})$
 B $3\text{C}(\text{g}) + 8\text{H}(\text{g}) \rightarrow \text{C}_3\text{H}_8(\text{g})$
 C $3\text{C}(\text{s}) + 4\text{H}_2(\text{g}) \rightarrow \text{C}_3\text{H}_8(\text{g})$
 D $3\text{C}(\text{s}) + 4\text{H}_2(\text{g}) \rightarrow \text{C}_3\text{H}_8(\text{l})$
- 12 A student investigated the chloride of a Period 3 element. This is what he wrote down as his record of what he did and what he saw.

The compound was a white crystalline solid. It dissolved easily in water to give a solution of pH 12. When placed in a test-tube and heated in a roaring Bunsen flame, the compound melted after several minutes heating.

What can be deduced from this record?

- A At least one of the recorded observations is incorrect.
 B The compound was magnesium chloride, MgCl_2 .
 C The compound was phosphorus pentachloride, PCl_5 .
 D The compound was sodium chloride, NaCl .

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

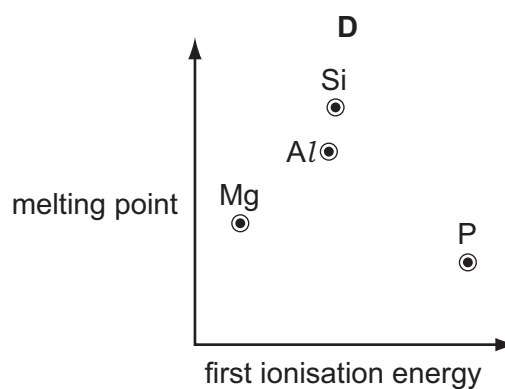
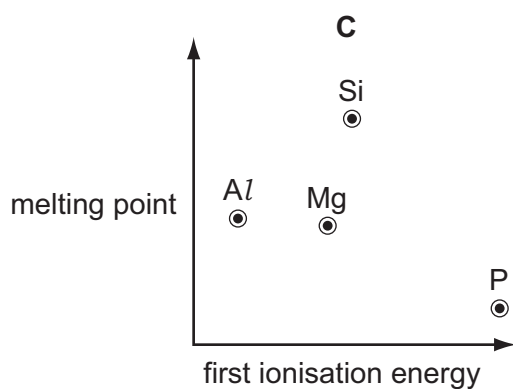
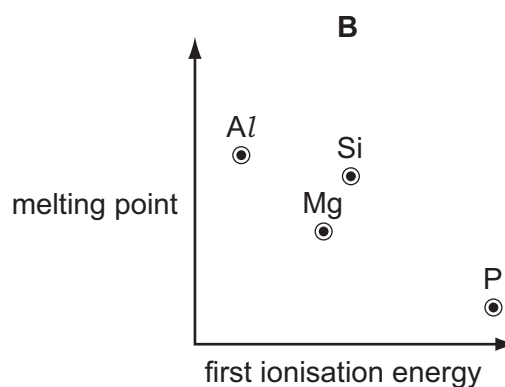
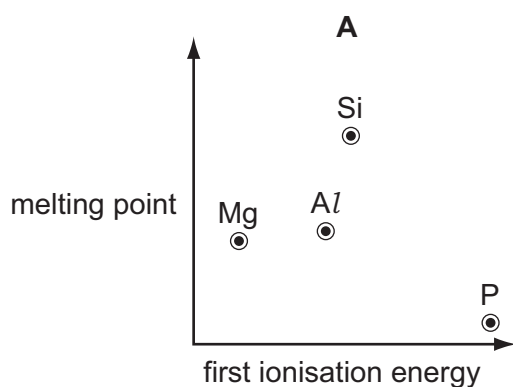
X is an s-block element. **X** forms an insoluble carbonate with the formula XCO_3 . **X** forms a hydroxide that is more soluble than strontium hydroxide.

What could be the identity of **X**?

- A barium
- B calcium
- C cobalt
- D rubidium

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

Which graph correctly shows the melting points of the elements Mg, Al, Si and P plotted against their first ionisation energies?



15 Which substance will **not** be a product of the thermal decomposition of hydrated magnesium nitrate?

- A dinitrogen monoxide
- B magnesium oxide
- C oxygen
- D steam

16 The species Ne, Na^+ and Mg^{2+} are isoelectronic. This means that they have the same number of electrons.

In which order do their radii increase?

	smallest	→	largest
A	Ne	Na^+	Mg^{2+}
B	Ne	Mg^{2+}	Na^+
C	Mg^{2+}	Ne	Na^+
D	Mg^{2+}	Na^+	Ne

17 Use of the Data Booklet is relevant to this question.

In an experiment, 0.6 mol of chlorine gas, Cl_2 , is reacted with an excess of hot aqueous sodium hydroxide. One of the products is a compound of sodium, oxygen and chlorine.

Which mass of this product is formed?

- A 21.3g B 44.7g C 63.9g D 128g

18 Which properties do compounds of aluminium and silicon have in common?

- A Aqueous solutions of their chlorides contain aluminium or silicon cations.
- B Their chlorides have co-ordinate bonding.
- C Their oxides are amphoteric.
- D Their oxides are insoluble in water.

19 When strontium is burnt in oxygen, what colour is the flame?

- A green
- B red
- C white
- D yellow

- 20 Diesters can be made from diacids such as propane-1,3-dioic acid, $\text{HO}_2\text{CCH}_2\text{CO}_2\text{H}$.

Which combination of reactants would form the diester $\text{CH}_3\text{CH}_2\text{OCOCH}_2\text{CH}_2\text{CO}_2\text{CH}_2\text{CH}_3$?

- A butane-1,4-dioic acid and ethanol
 - B ethanedioic acid and propan-1-ol
 - C ethanedioic acid, ethanol and butan-1-ol
 - D propane-1,3-dioic acid, ethanol and propan-1-ol
- 21 In the presence of ultraviolet light, ethane and chlorine react to give a mixture of products.

Which compound could be present in the mixture of products?

- A CH_3Cl
 - B $\text{CH}_3\text{CH}_2\text{CH}_2\text{Cl}$
 - C $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$
 - D $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3$
- 22 Compound **X** produces a carboxylic acid when heated under reflux with acidified potassium dichromate(VI). Compound **X** has no reaction with sodium metal.

What could be the identity of compound **X**?

- A propanal
 - B propanone
 - C propan-1-ol
 - D propan-2-ol
- 23 Which molecule could **not** be obtained from the cracking of a molecule of nonane, $\text{CH}_3(\text{CH}_2)_7\text{CH}_3$?
- A $\text{CH}_2=\text{CHCH}=\text{CH}_2$
 - B $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3$
 - C $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}=\text{CH}_2$
 - D $(\text{CH}_3\text{CH}_2\text{CH}_2)_3\text{CH}$

- 24 A student investigates four different fuels. Each fuel is used separately to raise the temperature of 1 dm^3 of water from 20°C to 100°C . Each fuel undergoes complete combustion. All other conditions are the same in each experiment.

Which fuel would produce the **smallest** amount of carbon dioxide in these experiments?

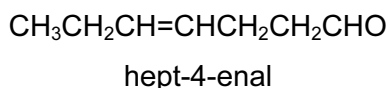
	fuel	energy released per mole of fuel
A	ethanol	1367 kJ mol^{-1}
B	methane	890 kJ mol^{-1}
C	methanol	715 kJ mol^{-1}
D	propane	2220 kJ mol^{-1}

- 25 Most alcohols can be dehydrated to give alkenes.

Which alcohol can be dehydrated to give three different isomeric alkenes?

- A** $\text{CH}_3(\text{CH}_2)_3\text{CH}_2\text{OH}$
B $\text{CH}_3(\text{CH}_2)_2\text{CH}(\text{OH})\text{CH}_3$
C $\text{CH}_3\text{CH}_2\text{CH}(\text{OH})\text{CH}_2\text{CH}_3$
D $\text{CH}_3\text{C}(\text{CH}_3)_2\text{CH}_2\text{OH}$

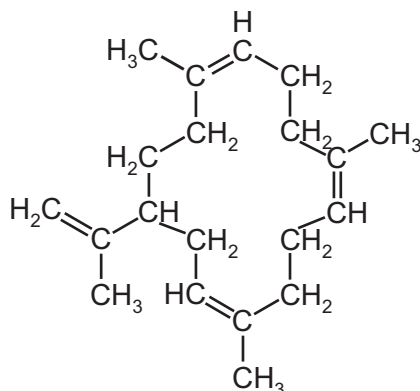
- 26 Hept-4-enal is present in cow's milk.



Which row correctly shows the product formed when hept-4-enal is treated with the given reducing agent?

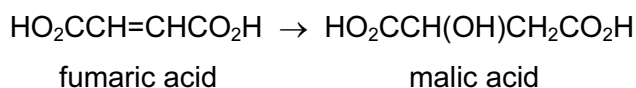
	reducing agent	product
A	$\text{H}_2 + \text{Ni}$	$\text{CH}_3(\text{CH}_2)_5\text{CH}_2\text{OH}$
B	$\text{H}_2 + \text{Ni}$	$\text{CH}_3(\text{CH}_2)_5\text{CH}_3$
C	NaBH_4	$\text{CH}_3(\text{CH}_2)_5\text{CH}_2\text{OH}$
D	NaBH_4	$\text{CH}_3(\text{CH}_2)_5\text{CHO}$

- 27 The naturally-occurring molecule shown below can be made by the addition of four identical monomer molecules.



What could be the structural formula of the monomer?

- A $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}=\text{CH}_2$
 B $\text{CH}_3\text{CH}=\text{CHCH}=\text{CH}_2$
 C $\text{CH}_2=\text{C}(\text{CH}_3)\text{CH}_2\text{CH}_3$
 D $\text{CH}_2=\text{C}(\text{CH}_3)\text{CH}=\text{CH}_2$
- 28 The compound cetyl palmitate, $\text{C}_{15}\text{H}_{31}\text{CO}_2\text{C}_{16}\text{H}_{33}$, is a waxy solid.
- When cetyl palmitate is heated under reflux with an excess of aqueous sodium hydroxide, which products will be formed?
- A $\text{C}_{15}\text{H}_{31}\text{ONa}$ and $\text{C}_{16}\text{H}_{33}\text{CO}_2\text{Na}$
 B $\text{C}_{15}\text{H}_{31}\text{CO}_2\text{Na}$ and $\text{C}_{16}\text{H}_{33}\text{ONa}$
 C $\text{C}_{15}\text{H}_{31}\text{OH}$ and $\text{C}_{16}\text{H}_{33}\text{CO}_2\text{Na}$
 D $\text{C}_{15}\text{H}_{31}\text{CO}_2\text{Na}$ and $\text{C}_{16}\text{H}_{33}\text{OH}$
- 29 One reaction in the Krebs cycle, in which energy is released to the human body, is the conversion of fumaric acid into malic acid.



Which reagent(s) could achieve this conversion in the laboratory?

- A acidified $\text{KMnO}_4(\text{aq})$
 B $\text{Br}_2(\text{aq})$ followed by hot $\text{NaOH}(\text{aq})$
 C $\text{H}_2\text{O}(\text{l})$ with Pt catalyst
 D $\text{H}_2\text{O}(\text{g})$ with H_2SO_4

- 30 The free radical substitution reaction between methane and chlorine involves initiation, propagation and termination stages.

Which row is correct?

	involved in initiation stage	radical produced in a propagation stage
A	heterolytic fission	$\text{H}\bullet$
B	heterolytic fission	$\text{CH}_3\bullet$
C	homolytic fission	$\text{H}\bullet$
D	homolytic fission	$\text{CH}_3\bullet$

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** In 2011 an international group of scientists agreed to add two new elements to the Periodic Table. Both elements had been made artificially and were called ununquadium (Uuq) and ununhexium (Uuh).

	Uuq	Uuh
proton number	114	116
nucleon number	289	292

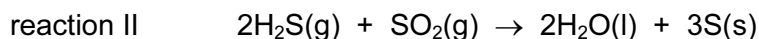
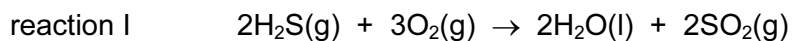
Which statements about these elements are correct?

- 1** One atom of Uuh has one more neutron than one atom of Uuq.
 - 2** One Uuq^{2-} ion has the same number of electrons as one atom of Uuh.
 - 3** One Uuh^+ ion has the same number of electrons as one Uuq^- ion.
- 32** P and Q are two liquid compounds with similar M_r values. Molecules of P attract each other by hydrogen bonds. Molecules of Q attract each other by van der Waals' forces only.

How do the properties of P and Q differ?

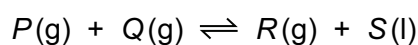
- 1** P has higher surface tension than Q.
- 2** P has a higher boiling point than Q.
- 3** P is less viscous than Q.

- 33 Many crude oils contain H_2S . During refining, by the Claus process, the H_2S is converted into solid sulfur, which is then removed.

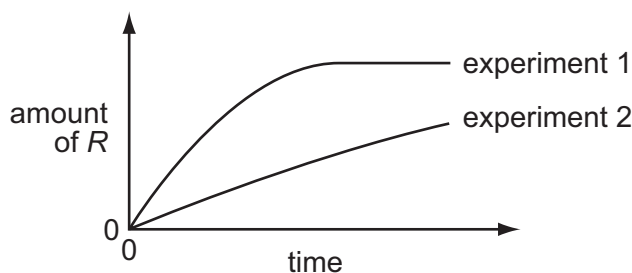


Which statements about the Claus process are correct?

- 1 H_2S is oxidised in reaction I.
 - 2 SO_2 oxidises H_2S in reaction II.
 - 3 Hydrogen is oxidised in reaction II.
- 34 The stoichiometry of a catalysed reaction is shown by the equation below.



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



Which changes in the conditions might explain the results shown?

- 1 A lower pressure was used in experiment 2.
 - 2 A different catalyst was used in experiment 2.
 - 3 Product S was continuously removed from the reaction vessel in experiment 2.
- 35 Which statements explain why sulfur dioxide is used as a food preservative?
- 1 It is a reducing agent and therefore an anti-oxidant.
 - 2 It prevents alcohols in foods forming sour-tasting acids.
 - 3 It does not smell and therefore can be used in large quantities.

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 intermolecular forces between iodine molecules are instantaneous dipole-induced dipole forces.

Which statements explain why iodine has these intermolecular forces?

- 1** An iodine molecule is polar and experiences an attraction from a lone pair of electrons on an adjacent molecule.
- 2** An iodine molecule has a fluctuating dipole because the electrons in a molecule are more mobile than the nuclei.
- 3** The electron charge cloud within an I₂ molecule may become unsymmetrical and may then attract other I₂ molecules.

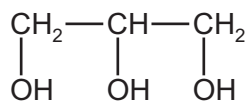
- 37** Which reactions must be warmed to form a solid product?

- 1** CH₃CH₂CHO + 2,4-dinitrophenylhydrazine reagent
- 2** CH₃CH₂CHO + Fehling's reagent
- 3** CH₃CH₂CHO + Tollens' reagent

- 38** When hydrolysed with dilute sulfuric acid, which compounds produce propanoic acid?

- 1** CH₃CH₂CO₂CH₃
- 2** CH₃CH₂CH₂CN
- 3** CH₃CH₂CH₂Cl

39 Propane-1,2,3-triol is the raw material for many important industrial chemical processes.

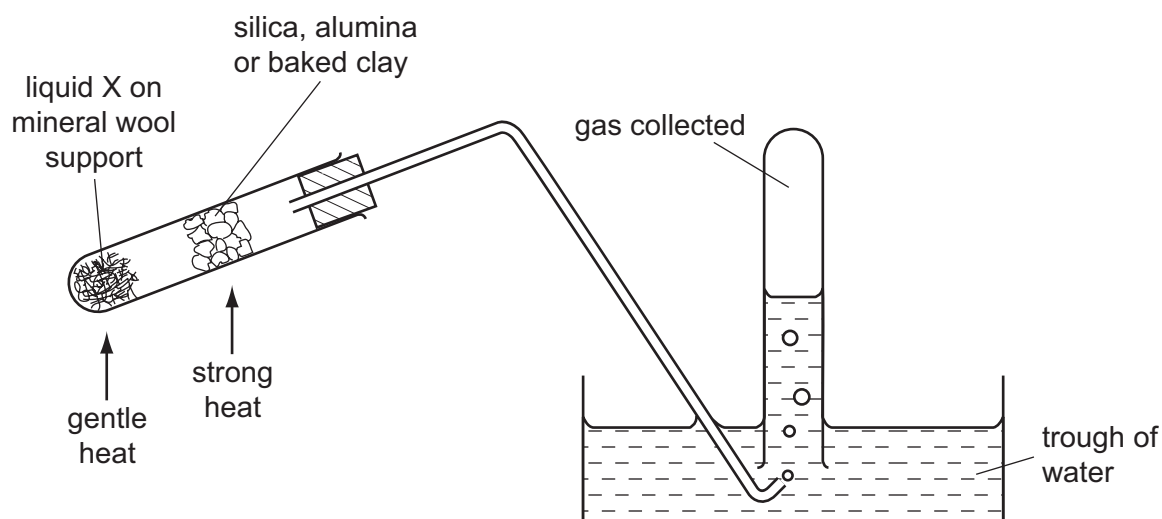


propane-1,2,3-triol

Which statements about propane-1,2,3-triol are correct?

- 1 It reacts with carboxylic acids to form compounds containing up to three ester groups.
- 2 It can be oxidised to form compounds with aldehyde and ketone functional groups.
- 3 It can be oxidised to form compounds with up to three carboxylic acid groups.

40 The diagram shows an experimental set-up which can be used in several different experiments.



Which processes could be demonstrated by using the above apparatus?

- 1 oxidation of ethanol (liquid X)
- 2 dehydration of ethanol (liquid X)
- 3 cracking of paraffin (liquid X)

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