FOR OFFICIAL USE

N5

National Qualifications 2025

Mark

X813/75/01

Chemistry
Section 1 — Answer grid and Section 2

THURSDAY, 1 MAY
1:00 PM – 3:30 PM

X8137501

Fill in these boxes and read what is printed below.

Full name of centre

Town

Forename(s)

Surname

Number of seat

Date of birth
Day Month Year

Scottish candidate number

Total marks — 100

SECTION 1 — 25 marks
Attempt ALL questions.
Instructions for the completion of Section 1 are given on *page 02*.

SECTION 2 — 75 marks
Attempt ALL questions.

You may refer to the Chemistry Data Booklet for National 5.

Write your answers clearly in the spaces provided in this booklet. Additional space for answers and rough work is provided at the end of this booklet. If you use this space you must clearly identify the question number you are attempting. Any rough work must be written in this booklet. You should score through your rough work when you have written your final copy.

Use **blue** or **black** ink.

Before leaving the examination room you must give this booklet to the Invigilator; if you do not, you may lose all the marks for this paper.

SQA

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MARKS | DO NOT WRITE IN THIS MARGIN

SECTION 2 — 75 marks

Attempt ALL questions

1. (a) The reaction of zinc with sulfuric acid, $H_2SO_4(aq)$, is shown.

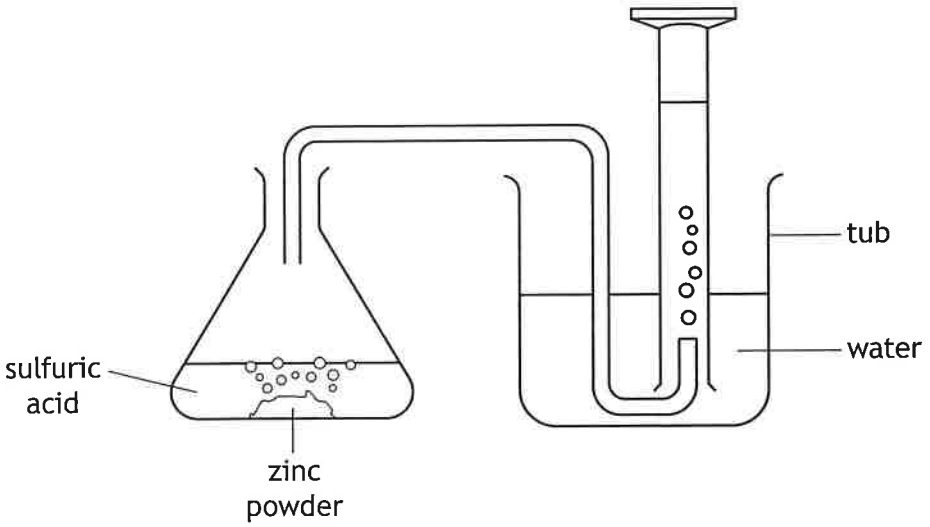
$$Zn(s) + H_2SO_4(aq) \rightarrow ZnSO_4(aq) + H_2(g)$$

(i) Hydrogen gas is produced in this reaction.

State the test, including the result, for hydrogen gas. 1

(ii) A student was asked to draw a diagram of the apparatus used to **collect and measure** the volume of hydrogen gas produced during the reaction.

Their diagram is shown.



Describe **one** way in which the student's diagram is incorrect. 1

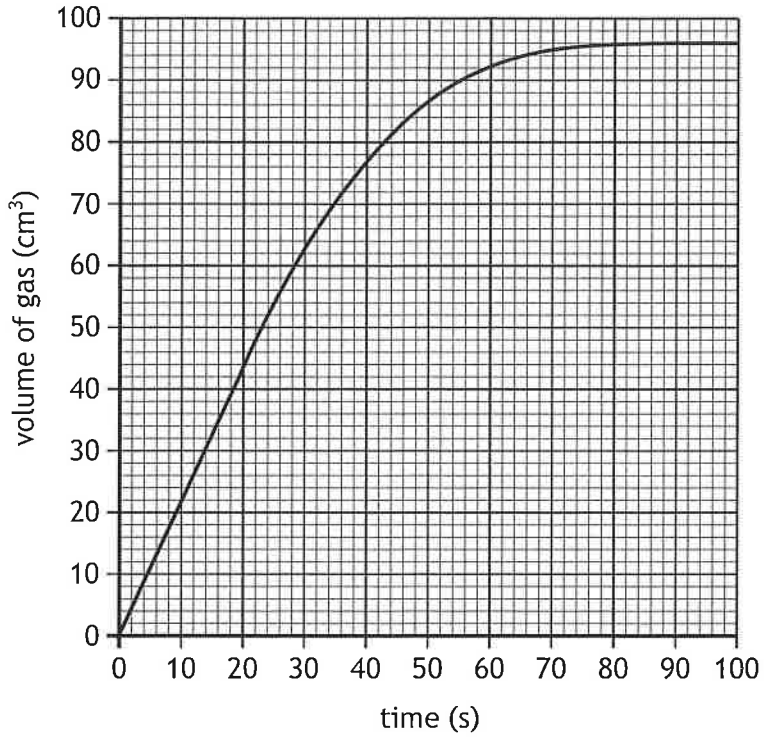
(iii) A solution of zinc(II) sulfate, $ZnSO_4(aq)$, is produced in this reaction.

Name the technique that could be used to obtain a **dry** sample of zinc(II) sulfate, $ZnSO_4(s)$. 1

1. (continued)

(b) The volume of hydrogen gas collected over time when zinc powder is added to 100 cm^3 of dilute sulfuric acid was recorded.

A graph of the results is shown.



(i) Calculate the average rate of reaction, in $cm^3 s^{-1}$, for the first 50 seconds. **2**

Show your working clearly.

(ii) **Add a curve to the graph** to show the results that would be expected if the experiment was repeated using the same mass of zinc lumps. **1**

(An additional graph, if required, can be found on *page 31*.)

(iii) A similar experiment was carried out using the same mass of zinc powder and the same volume and concentration of hydrochloric acid, HCl(aq), in place of sulfuric acid, $H_2SO_4(aq)$.

Predict the volume of gas, in cm^3, produced in this reaction. **1**

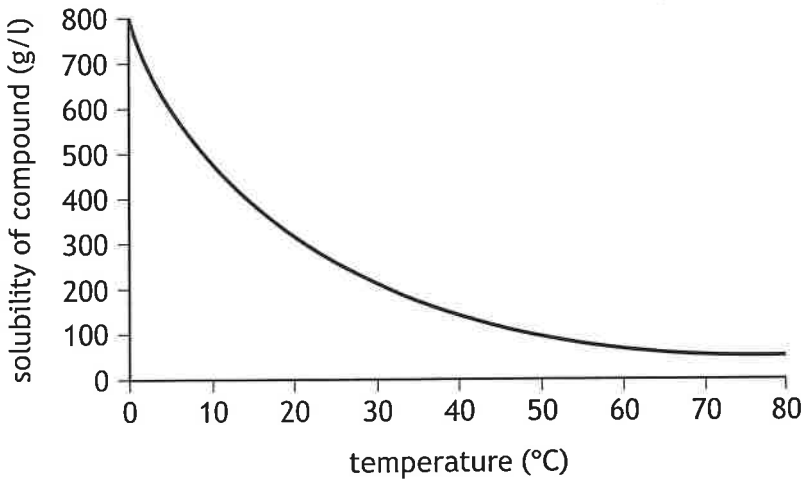
MARKS | DO NOT WRITE IN THIS MARGIN

2. Oxygen is an odourless, colourless gas that is present in the Earth's atmosphere.

(a) Draw a diagram, showing **all** the outer electrons, to represent a molecule of oxygen, O_2. 1

(b) Name an element that has similar chemical properties to oxygen. 1

(c) The graph shows the solubility of a compound containing oxygen at different temperatures.

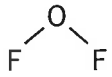


State the relationship between temperature and the solubility of the compound. 1

2. **(continued)**

(d) Oxygen can react with fluorine to form oxygen fluoride molecules, containing covalent bonds.

A molecule of oxygen fluoride is shown.



(i) State the name used to describe the shape of an oxygen fluoride molecule. **1**

(ii) Circle the correct words to complete the sentence. **1**

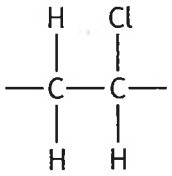
A covalent bond forms when two { positive / negative / neutral } nuclei are held together by their common attraction for a shared pair of { protons / neutrons / electrons }.

[Turn over

3. Plastics which soften when heated are classed as thermosoftening plastics.

(a) Poly(vinyl chloride), PVC, is an example of a thermosoftening plastic and is used in the manufacture of clothing.

The repeating unit of PVC is shown.



(i) Draw the monomer used to make PVC. 1

(ii) When PVC is burned, the gas hydrogen chloride is formed.

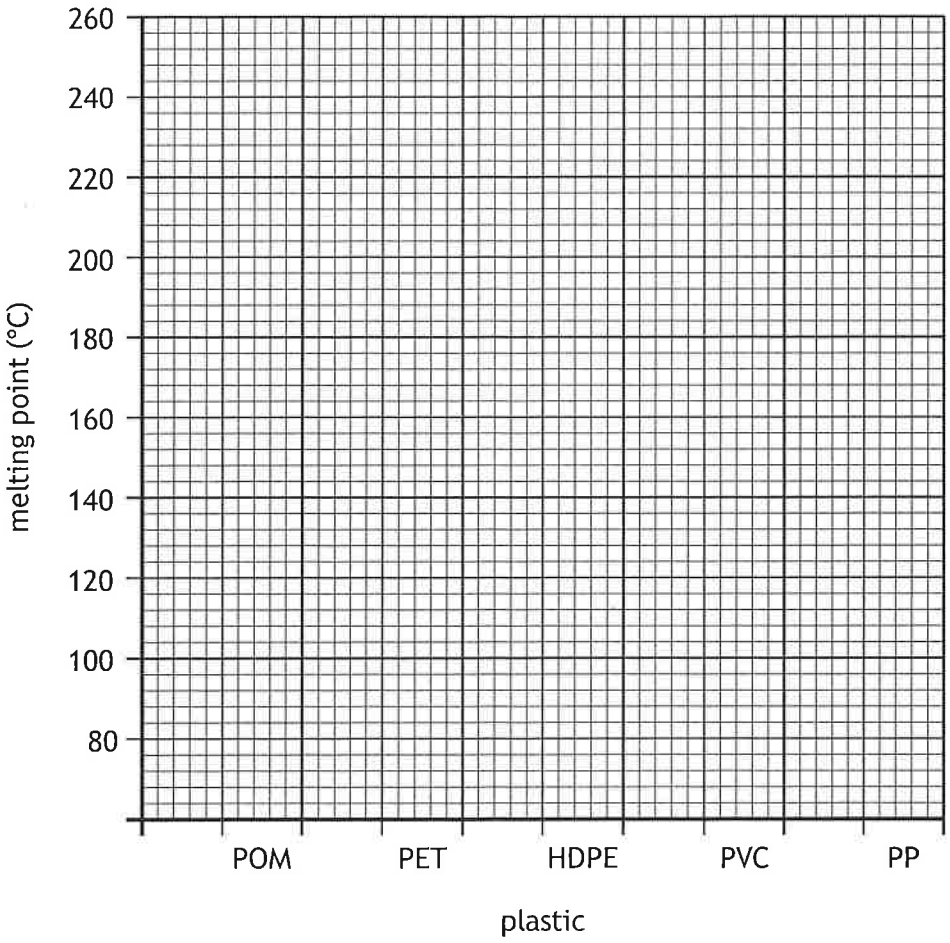
Hydrogen chloride molecules, HCl(g), contain only two atoms.

State the term used to describe a molecule containing only two atoms. 1

(b) A table of some thermosoftening plastics and their melting point is shown.

Plastic	Melting point (°C)
POM	165
PET	260
HDPE	131
PVC	82
PP	130

(i) Complete the graph to show the melting point for each of the plastics. **2**
(An additional graph, if required, can be found on *page 32*.)

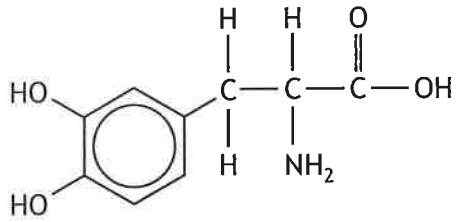
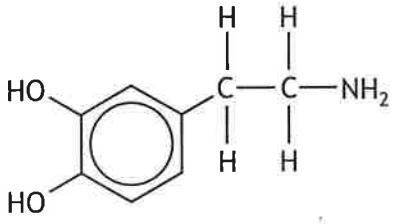
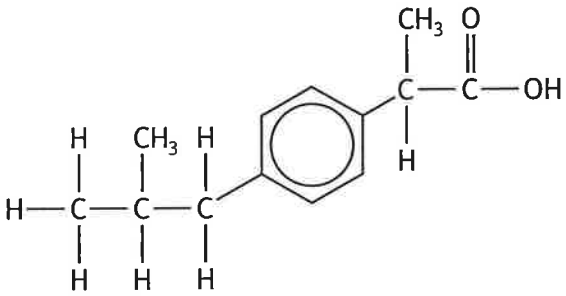


(ii) Suggest why PVC could **not** be used as a container for boiling water. **1**

MARKS | DO NOT WRITE IN THIS MARGIN

4. Many medicines are compounds that contain carbon atoms.

The table shows some examples of these medicines and their use.

Name of medicine	Use of medicine	Structure of molecule
L-DOPA	treatment of Parkinson's disease	
Dopamine	treatment of low blood pressure	
Ibuprofen	treatment of pain and inflammation	

(a) Name the functional group that is present in both L-DOPA and ibuprofen but is **not** present in dopamine. 1

(b) A key step in producing L-DOPA involves an addition reaction with hydrogen molecules. This is carried out using a catalyst.

(i) Name the type of addition reaction that involves the addition of hydrogen. 1

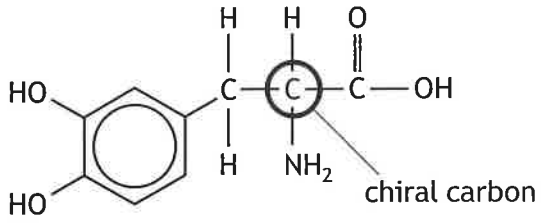
(ii) State what is meant by the term catalyst. 1

4. (continued)

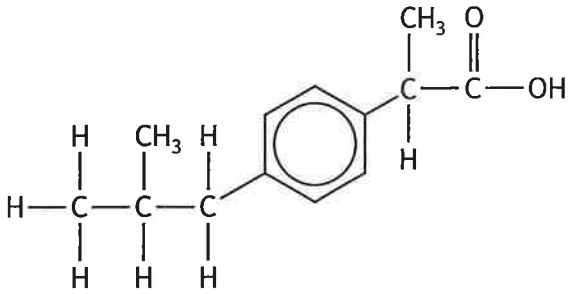
(c) Many medicine molecules contain a chiral carbon which can affect their ability to work as a medicine.

A chiral carbon is any carbon atom that is attached to four different atoms or groups of atoms.

The chiral carbon in the L-DOPA molecule is circled.



Ibuprofen also has a chiral carbon in its molecule.



Circle the chiral carbon in the ibuprofen structure above. 1

(An additional structure, if required, can be found on *page 32*.)

(d) An antagonist is a medicine that works by blocking the body's normal function.

Painkillers are common examples of antagonists which work by blocking the body's response to pain.

Name the medicine, from the table on *page 12*, which would be described as an antagonist. 1

[Turn over

MARKS | DO NOT WRITE IN THIS MARGIN

5. Petrol is a fuel used in some car engines.

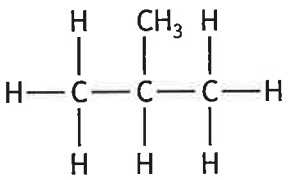
(a) State what is meant by the term fuel. 1

(b) The hydrocarbon iso-octane is added to petrol to improve performance in car engines.

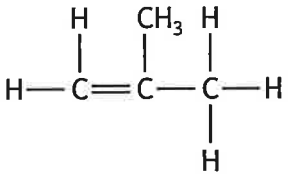
(i) The systematic name for iso-octane is 2,2,4-trimethylpentane.

Draw a structure for iso-octane. 1

(ii) Iso-octane is produced by reacting together iso-butane and iso-butene.



iso-butane



iso-butene

State the test, including the result, that could be used to distinguish between a sample of iso-butane and iso-butene. 1

5. (continued)

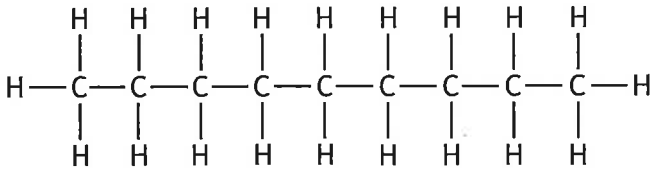
(c) The flash point is the lowest temperature at which a fuel can catch fire.

The table shows the flash point of some alkanes.

Alkane	Flash point (°C)
Hexane	–22
2,2,4-trimethylpentane	–12
Heptane	–4
2,2-dimethylhexane	–3
2-methylheptane	4
Octane	13

(i) State the effect that increasing the number of branches in alkanes, containing the same number of carbon atoms, has on the flash point of the alkane. 1

(ii) Predict the flash point, in °C, of the alkane shown. 1



[Turn over

5. (continued)

(d) Alcohols are commonly added to petrol to help them burn. These compounds are often described as oxygenates.

(i) Suggest why oxygenates help petrol burn. 1

(ii) The alcohols most commonly added to petrol are methanol and ethanol.

The boiling points of methanol and ethanol are shown.

Alcohol	Boiling point (°C)
Methanol	65
Ethanol	78

Explain why ethanol has a higher boiling point than methanol. 2

MARKS | DO NOT WRITE IN THIS MARGIN

6. Fertilisers are substances which restore the elements essential for healthy plant growth to the soil.

Using your knowledge of chemistry, describe the chemistry of fertilisers. 3

[Turn over

7. Radioactive decay occurs when unstable radioisotopes emit radiation to become more stable.

(a) State the part of the atom involved in radioactive decay. 1

(b) Phosphorus-32 is a radioisotope that is fed to mosquitoes to track how far they travel.

mosquito

A solution of sodium hydrogen phosphate, containing phosphorus-32, was fed to mosquitoes.

(i) Name the other elements present in sodium hydrogen phosphate. 1

(ii) State how the half-life of phosphorus-32, present in sodium hydrogen phosphate, compares to the half-life of a pure phosphorus-32 sample. 1

(c) Iodine-131 is a radioisotope which emits beta radiation and is used in medicine.

(i) The equation for the beta decay of iodine-131 is shown.

$$^{131}_{53}I \rightarrow X + {}^{0}_{-1}e$$

Name the element represented by X in the equation. 1

MARKS | DO NOT WRITE IN THIS MARGIN

(ii) A sample of iodine-131 had a mass of 40 g. After being left for 32 days the sample had a mass of 2.5 g.

Calculate the half-life, in days, of iodine-131. 2

(d) Another radioisotope used in medicine is cobalt-60. Cobalt-60 has a half-life of 5 years.

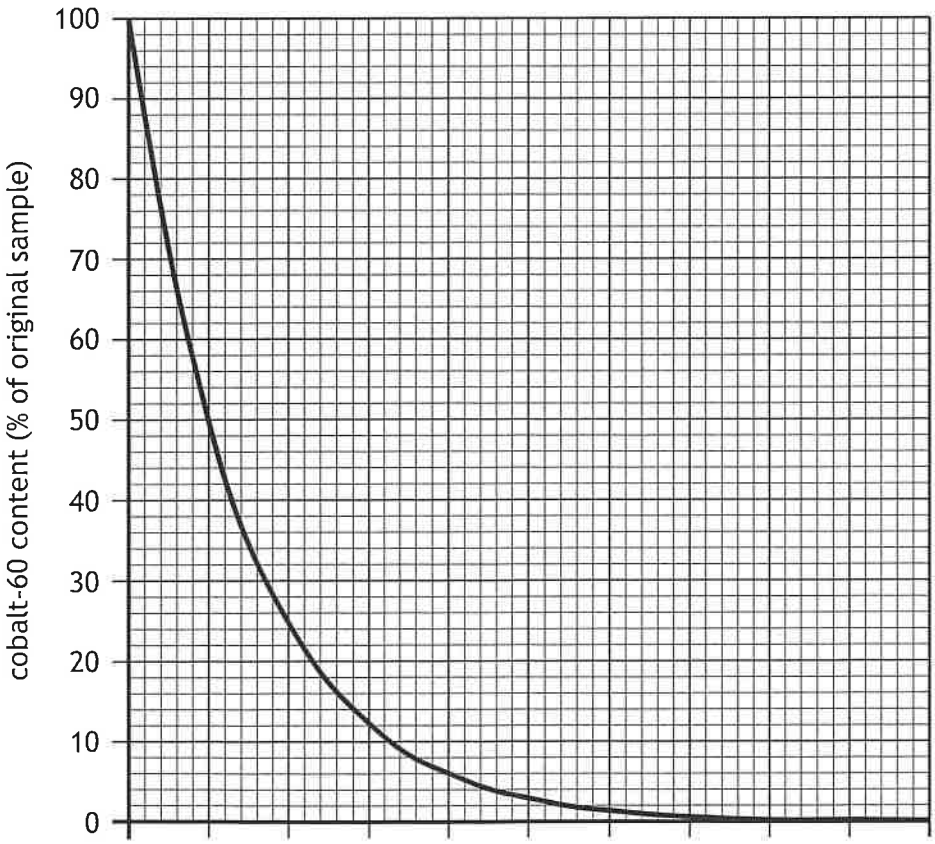
A graph of the percentage of a cobalt-60 sample remaining over time is shown.

Complete the graph by adding:

(i) the scale to the x-axis 1

(ii) the label to the x-axis. 1

(An additional graph, if required, can be found on *page 33*.)



8. Read the passage and answer the questions that follow.

The Mole

Atoms and molecules are so small that even one gram of a substance contains many trillions of atoms.

To simplify this, chemists measure the quantity of a chemical using a unit called the mole. This term was introduced in 1865 by the chemist August Wilhelm von Hofmann to describe the mass of a molecule, because the Latin term for mass is moles.

Another scientist, Amedeo Avogadro, took this one step further by defining one mole as the number of carbon atoms in 12 g of carbon, where each atom contains six protons and six neutrons. This number, known as Avogadro's number, is 6.02×10^{23}.

For example, one mole of water contains 6.02×10^{23} water molecules.

Avogadro's number is represented by the letter L. This can be used to calculate the number of atoms in one mole of molecules as shown in the table.

Molecular formula	Total number of atoms in molecule	Number of atoms in one mole
HCl	2	2L
NH_3	4	4L

(a) State the meaning of the Latin term 'moles'. 1

(b) Write the nuclide notation for the carbon atom used to define Avogadro's number. 1

8. (continued)

(c) Calculate the mass, in grams, of 6.02×10^{23} water molecules, H_2O. 1

(d) Suggest why the number of electrons was not considered when calculating the mass of a carbon atom. 1

(e) Complete the table for methane, CH_4. 1

Molecular formula	Total number of atoms in molecule	Number of atoms in one mole
CH_4		

[Turn over

MARKS | DO NOT WRITE IN THIS MARGIN

9. Propanol is an alcohol containing three carbon atoms.

(a) Propanol has two possible structures.

(i) State the term used to describe these two structures of propanol. 1

(ii) Draw **and** name one of the structures of propanol, C_3H_7OH. 2

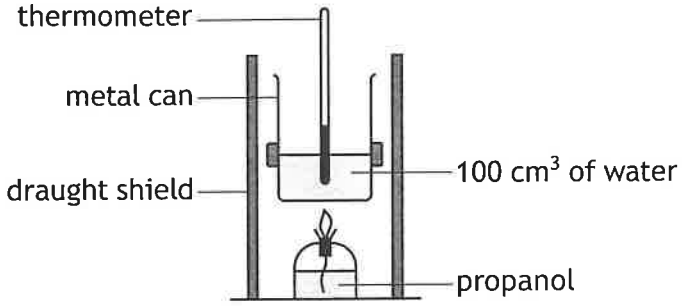
(b) The equation for the combustion of propanol is shown.

$$C_3H_7OH + O_2 \rightarrow CO_2 + H_2O$$

Balance this equation. 1

MARKS | DO NOT WRITE IN THIS MARGIN

(c) A student carried out an investigation to calculate the energy released when burning propanol using the apparatus shown.



(i) Explain why the use of a draught shield improves the accuracy of the student's results. 1

(ii) The student burned propanol three times and recorded the temperature change of the water each time.

Experiment	1	2	3
Temperature change of the water (°C)	23	20	20

(A) Calculate the average temperature change of the water, in °C, for the student's three experiments. 1

(B) Using your answer to part (c) (ii) (A), calculate the average energy, in kJ, absorbed by the water in the student's investigation. 3

MARKS | DO NOT WRITE IN THIS MARGIN

10. Sodium carbonate, Na_2CO_3, is a white, water-soluble compound.

(a) One of the many uses of sodium carbonate is in dishwasher tablets.

Dishwasher tablets must be soluble in water.

(i) State the term used to describe liquids, like water, in which substances dissolve to form solutions. 1

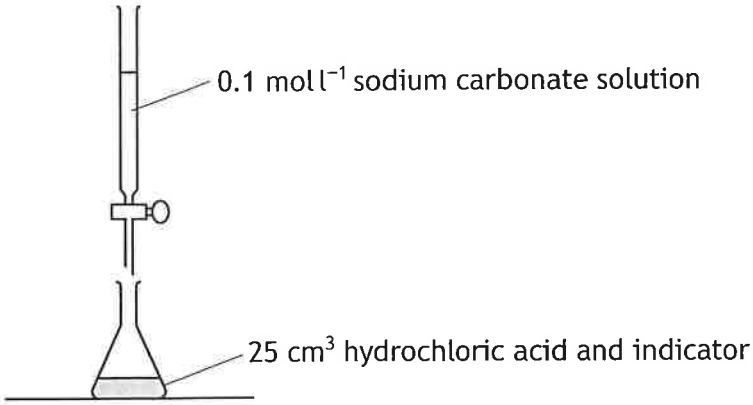
(ii) Dishwasher tablets are often coated in a water-soluble plastic known as poly(ethenol) which is formed by addition polymerisation.

(A) Name the monomer used to make poly(ethenol). 1

(B) Suggest why ethanol could **not** be used as a monomer in an addition polymerisation reaction. 1

MARKS | DO NOT WRITE IN THIS MARGIN

(b) An experiment to determine the concentration of a hydrochloric acid solution using a solution of sodium carbonate is shown.



(i) State the name given to this technique. 1

(ii) Suggest why an indicator is added to the flask. 1

(iii) The average volume of sodium carbonate, Na_2CO_3, used in the experiment was 19.0 cm^3.

Sodium carbonate, Na_2CO_3, reacts with hydrochloric acid, HCl, in the ratio shown.

$$1 \text{ mol } Na_2CO_3 : 2 \text{ mol HCl}$$

Calculate the concentration, in mol l^{-1}, of the hydrochloric acid, HCl, used in the experiment. 3

Show your working clearly.

[Turn over

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MARKS | DO NOT WRITE IN THIS MARGIN

11. A neutralisation reaction between lithium oxide and nitric acid is shown.

$$Li_2O(aq) + HNO_3(aq) \rightarrow LiNO_3(aq) + H_2O(\ell)$$

(a) Name the salt produced in the reaction of lithium oxide and nitric acid. 1

(b) Calculate the mass, in grams, of lithium oxide, Li_2O, required to prepare 250 cm^3 of 0.5 mol l^{-1} solution. 3

Show your working clearly.

(c) Another neutralisation reaction is shown.

$$H_2SO_4 + X \rightarrow CuSO_4 + H_2O + CO_2$$

Name substance X. 1

[Turn over

11. **(continued)**

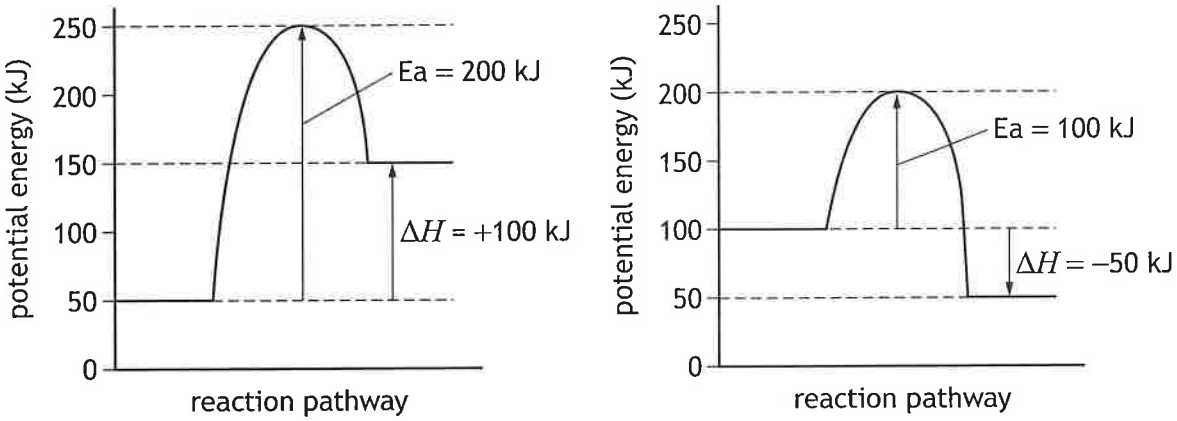
(d) Neutralisation reactions release heat energy.

(i) State the term used to describe any reaction that releases heat energy. 1

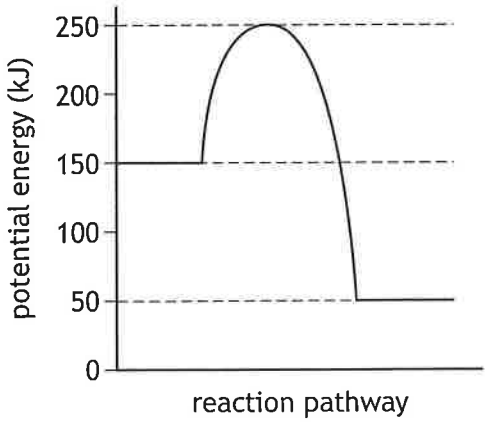
(ii) Activation energy, Ea, and enthalpy change, ΔH, are energy values that are associated with chemical reactions.

A potential energy diagram can be used to show these values.

(A) Two potential energy diagrams are shown below.

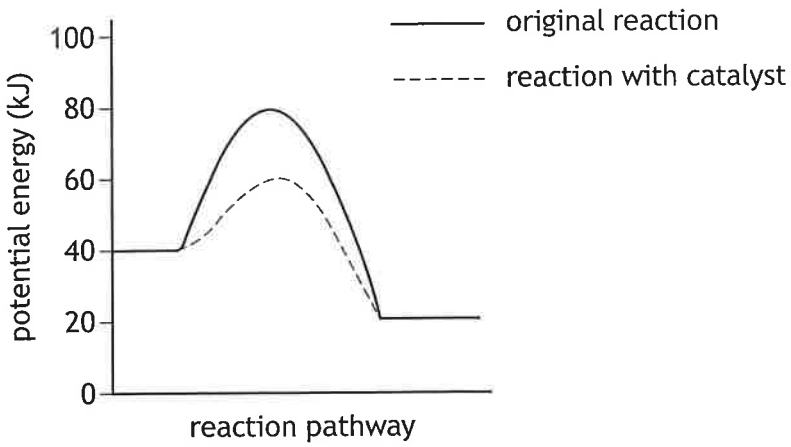


Calculate the enthalpy change, ΔH, in kJ, for the potential energy diagram shown below. 1



11. (d) (ii) (continued)

(B) When a catalyst is added to a reaction, the effect can also be seen on potential energy diagrams.



Circle the correct words to complete the table to show the effect of a catalyst on the activation energy, Ea, and the enthalpy change, ΔH. 2

Effect of catalyst on activation energy, Ea	*increase/decrease/no effect*
Effect of catalyst on enthalpy change, ΔH	*increase/decrease/no effect*

[Turn over

MARKS | DO NOT WRITE IN THIS MARGIN

12. The reactivity series lists metals in order of reactivity.

Using your knowledge of chemistry, suggest experiment(s) that a student could carry out to place calcium, copper, tin and zinc into a reactivity series. 3

[END OF QUESTION PAPER]