



National
Qualifications
2025

X813/75/02

Chemistry
Section 1 — Questions

THURSDAY, 1 MAY

1:00 PM – 3:30 PM

Instructions for the completion of Section 1 are given on *page 02* of your question and answer booklet X813/75/01.

Record your answers on the answer grid on *page 03* of your question and answer booklet.

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

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



* X 8 1 3 7 5 0 2 *

SECTION 1 — 25 marks

Attempt ALL questions

1. Oganesson is a newly discovered element with a predicted electron arrangement of 2,8,18,32,32,18,8

In which group of the periodic table should oganesson be placed?

- A 0
- B 1
- C 2
- D 7

2. Which line in the table shows the correct number of protons and electrons for the atom, $^{56}_{26}\text{Fe}$?

	Protons	Electrons
A	56	56
B	56	26
C	26	26
D	26	56

3. Which of the following molecules contains three atoms?

- A Phosphorus trichloride
- B Magnesium chloride
- C Sodium fluoride
- D Carbon dioxide

4. Which bonding and structure is never found in elements?

- A Covalent molecular
- B Ionic lattice
- C Metallic lattice
- D Covalent network

5. Which of the following compounds would conduct electricity at 600 °C?
You may wish to use the data booklet to help you.
- A Silicon dioxide
 - B Lithium bromide
 - C Ammonia
 - D Barium chloride
6. Which of the following oxides, when shaken with water, would give an alkaline solution?
You may wish to use the data booklet to help you.
- A Calcium oxide
 - B Nitrogen dioxide
 - C Sulfur dioxide
 - D Nickel oxide
7. A student made some statements about the effect of adding water to a solution of hydrochloric acid.
Identify the correct statement.
- A The rate of reaction with magnesium will increase.
 - B The concentration of H^+ ions will increase.
 - C The acid will be neutralised.
 - D The pH will increase.
8. Ammonium phosphate, $(\text{NH}_4)_3\text{PO}_4$, has a gram formula mass of 149.
The percentage by mass of nitrogen in ammonium phosphate is equal to
- A $\frac{14}{149} \times 100$
 - B $\frac{42}{149} \times 100$
 - C $\frac{149}{14} \times 100$
 - D $\frac{149}{42} \times 100$

[Turn over

9. What is the charge on the manganese ion in manganese dichromate, MnCr_2O_7 ?
You may wish to use the data booklet to help you.

- A 2+
- B 1+
- C 2-
- D 1-

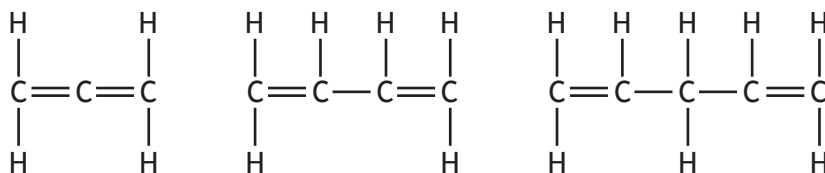
10. Compound X:

- is saturated
- is insoluble in water
- has two hydrogen atoms for every carbon atom.

Which of the following could be compound X?

- A Propane
- B Propan-1-ol
- C Cyclopropane
- D Propene

11. The structures of three members of a homologous series called the dienes are shown.



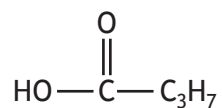
The general formula for the dienes is

- A C_nH_{n+1}
- B C_nH_{n+2}
- C C_nH_{2n}
- D $\text{C}_n\text{H}_{2n-2}$

12. Which of the following formula masses belongs to a hydrocarbon that does **not** belong to the same homologous series as the others?

- A 16
- B 44
- C 58
- D 70

13. The structural formula for a compound is shown.

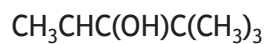


The name of this compound is

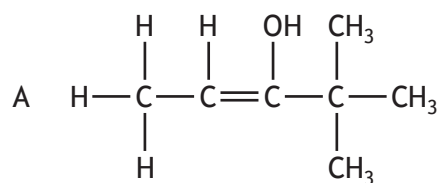
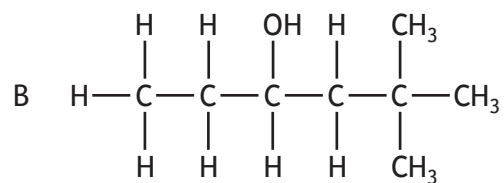
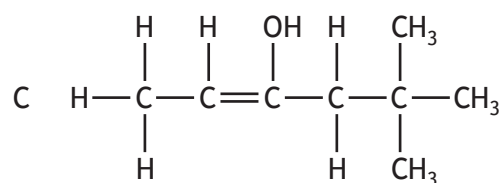
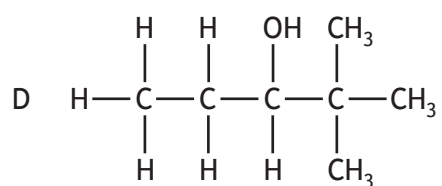
- A propanoic acid
- B propan-1-ol
- C butanoic acid
- D butan-1-ol.

[Turn over

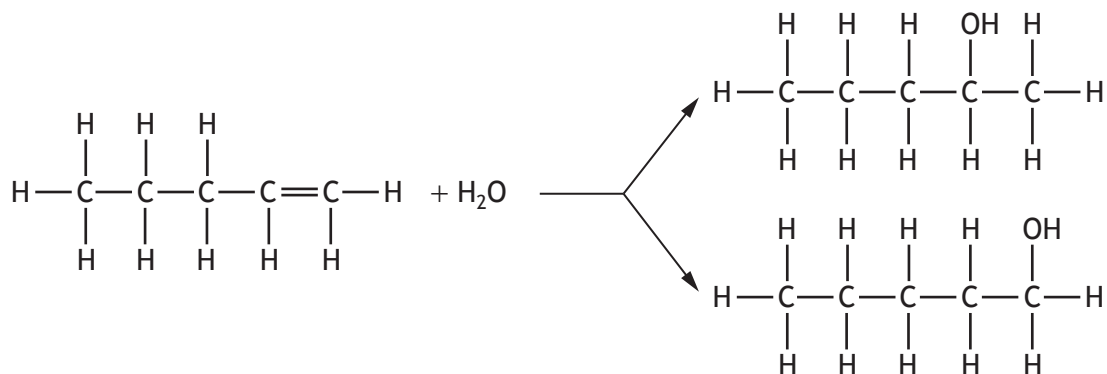
14. The shortened structural formula for a compound is shown.



Which of the following is another way of representing this structure?



15. Pent-1-ene reacts with water to form two products.

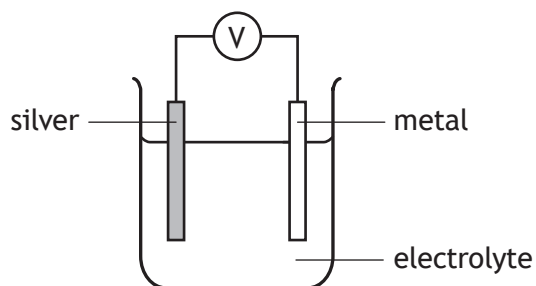


Which of the following alkenes does **not** form two products on reaction with water?

- A But-1-ene
 - B But-2-ene
 - C Hex-1-ene
 - D Hex-2-ene
16. When 5 g of a fuel was burned, 150 kJ of energy was released.
Calculate the energy, in kJ, that would be released if 60 g of the fuel was burned.
- A 30
 - B 150
 - C 1800
 - D 9000
17. Which of the following is **not** involved in metallic bonding?
- A Positive ions
 - B Negative ions
 - C Delocalised electrons
 - D Electrostatic attraction

[Turn over

18. Four different metals were connected to silver in a cell.



The results obtained were recorded in the table.

Metal	Voltage (V)
Iron	0.9
Zinc	1.1
Magnesium	2.7
Metal X	1.5

Which of the following could be metal X?

You may wish to use the data booklet to help you.

- A Aluminium
- B Sodium
- C Nickel
- D Copper

19. Which of the following is **not** a redox reaction?

- A $\text{Zn(s)} + 2\text{H}^+(\text{aq}) \rightarrow \text{Zn}^{2+}(\text{aq}) + \text{H}_2(\text{g})$
- B $\text{Cu(s)} + \text{Cl}_2(\text{g}) \rightarrow \text{Cu}^{2+}(\text{Cl}^-)_2(\text{s})$
- C $\text{Br}_2(\text{aq}) + 2\text{Fe}^{2+}(\text{aq}) \rightarrow 2\text{Fe}^{3+}(\text{aq}) + 2\text{Br}^-(\text{aq})$
- D $\text{Ba}^{2+}(\text{aq}) + \text{SO}_4^{2-}(\text{aq}) \rightarrow \text{Ba}^{2+}\text{SO}_4^{2-}(\text{s})$

20. Which of the following would be recovered unchanged in the Ostwald process?

- A Water
- B Oxygen
- C Ammonia
- D Platinum

21. In nuclear equations a proton is represented as

- A ${}^1_1\text{p}$
- B ${}^1_0\text{p}$
- C ${}^0_1\text{p}$
- D ${}^0_0\text{p}$

22. Which of the following compounds can be prepared by precipitation?
You may wish to use the data booklet to help you.

- A Lithium sulfate
- B Sodium sulfate
- C Barium sulfate
- D Magnesium sulfate

23. A student was reading the volume of liquid in a piece of apparatus.



The correct volume, in cm^3 , that the student should record is

- A 8.8
- B 9.1
- C 9.2
- D 10.8

[Turn over

Questions 24 and 25 refer to the experiment below.

A titration was performed using hydrochloric acid and a 10 cm³ solution of sodium hydroxide. The results are shown in the table.

Titration	Initial reading (cm ³)	Final reading (cm ³)	Titre (cm ³)
1	0.0	11.0	11.0
2	11.0	21.1	10.1
3	22.0	32.6	10.6
4	33.0	43.3	10.3

24. The average of the concordant titre values, in cm³, is

- A 10.8
- B 10.5
- C 10.3
- D 10.2

25. Which piece of apparatus is the most appropriate to measure and transfer the 10 cm³ of sodium hydroxide solution?

- A Burette
- B Pipette
- C Conical flask
- D Measuring cylinder

**[END OF SECTION 1. NOW ATTEMPT THE QUESTIONS IN SECTION 2 OF
YOUR QUESTION AND ANSWER BOOKLET]**

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Mark

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X813/75/01**Chemistry
Section 1 — Answer grid
and Section 2**

THURSDAY, 1 MAY

1:00 PM – 3:30 PM



* X 8 1 3 7 5 0 1 *

Fill in these boxes and read what is printed below.

Full name of centre

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Town

--

Forename(s)

--

Surname

--

Number of seat

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Date of birth

Day

--	--

Month

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Year

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Scottish candidate number

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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.



* X 8 1 3 7 5 0 1 0 1 *

SECTION 1 — 25 marks

The questions for Section 1 are contained in the question paper X813/75/02.

Read these and record your answers on the answer grid on *page 03* opposite.

Use **blue** or **black** ink. Do NOT use gel pens or pencil.

1. The answer to each question is **either** A, B, C or D. Decide what your answer is, then fill in the appropriate bubble (see sample question below).
2. There is **only one correct** answer to each question.
3. Any rough working should be done on the additional space for answers and rough work at the end of this booklet.

Sample question

To show that the ink in a ball-pen consists of a mixture of dyes, the method of separation would be

- A fractional distillation
- B chromatography
- C fractional crystallisation
- D filtration.

The correct answer is **B** — chromatography. The answer **B** bubble has been clearly filled in (see below).

A	B	C	D
☐	☒	☐	☐

Changing an answer

If you decide to change your answer, cancel your first answer by putting a cross through it (see below) and fill in the answer you want. The answer below has been changed to **D**.

A	B	C	D
☐	☒	☐	☒

If you then decide to change back to an answer you have already scored out, put a tick (✓) to the **right** of the answer you want, as shown below:

A	B	C	D
☐	☒ ✓	☐	☒

 or

A	B	C	D
☐	☒ ✓	☐	☐



SECTION 1 — Answer grid



	A	B	C	D
1	☐	☐	☐	☐
2	☐	☐	☐	☐
3	☐	☐	☐	☐
4	☐	☐	☐	☐
5	☐	☐	☐	☐
6	☐	☐	☐	☐
7	☐	☐	☐	☐
8	☐	☐	☐	☐
9	☐	☐	☐	☐
10	☐	☐	☐	☐
11	☐	☐	☐	☐
12	☐	☐	☐	☐
13	☐	☐	☐	☐
14	☐	☐	☐	☐
15	☐	☐	☐	☐
16	☐	☐	☐	☐
17	☐	☐	☐	☐
18	☐	☐	☐	☐
19	☐	☐	☐	☐
20	☐	☐	☐	☐
21	☐	☐	☐	☐
22	☐	☐	☐	☐
23	☐	☐	☐	☐
24	☐	☐	☐	☐
25	☐	☐	☐	☐



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[Turn over for SECTION 2

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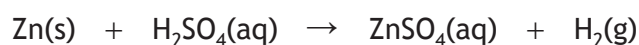


SECTION 2 — 75 marks

Attempt ALL questions

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1. (a) The reaction of zinc with sulfuric acid, $\text{H}_2\text{SO}_4(\text{aq})$, is shown.



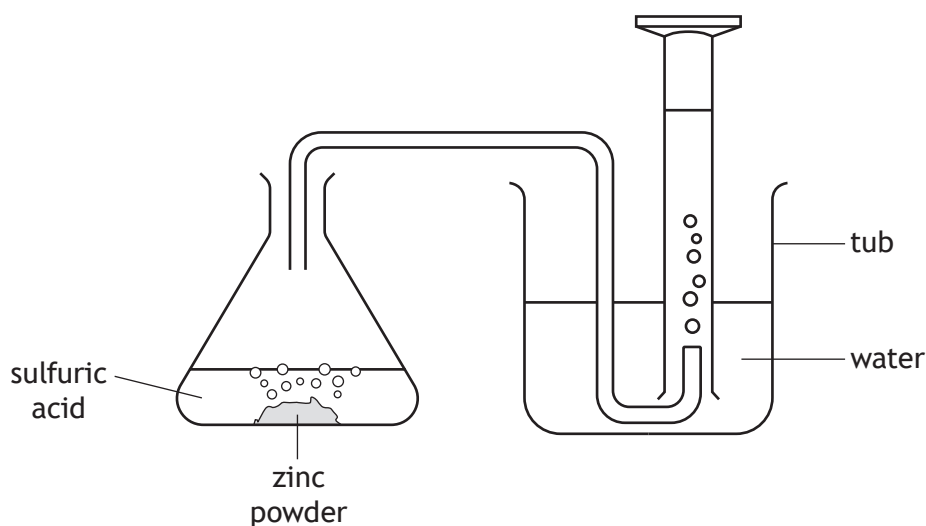
- (i) Hydrogen gas is produced in this reaction.

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, $\text{ZnSO}_4(\text{aq})$, is produced in this reaction.

Name the technique that could be used to obtain a **dry** sample of zinc(II) sulfate, $\text{ZnSO}_4(\text{s})$.

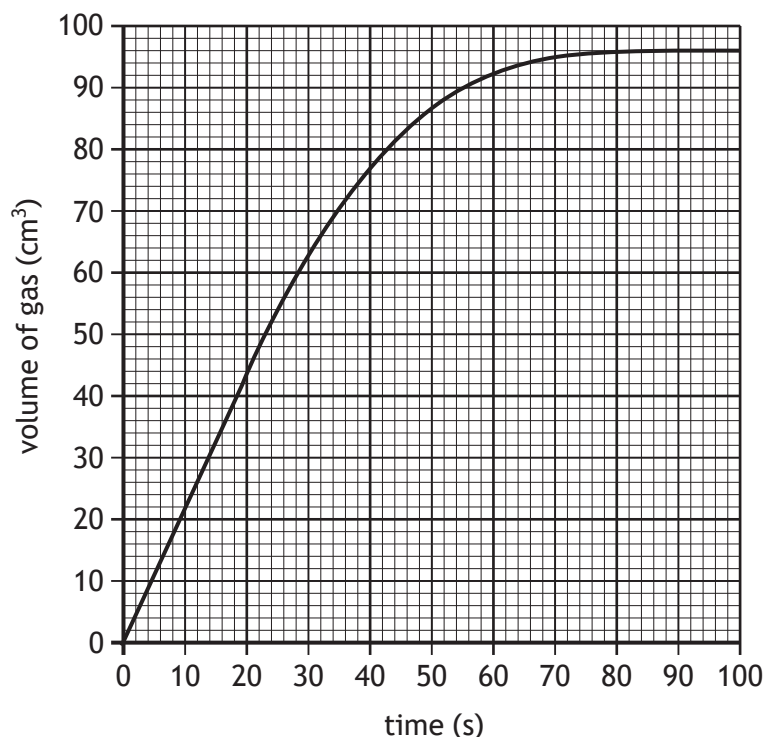
1



1. (continued)

- (b) The volume of hydrogen gas collected over time when zinc powder is added to 100 cm³ of dilute sulfuric acid was recorded.

A graph of the results is shown.



- (i) Calculate the average rate of reaction, in cm³ 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, H₂SO₄(aq).

Predict the volume of gas, in cm³, produced in this reaction. 1



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

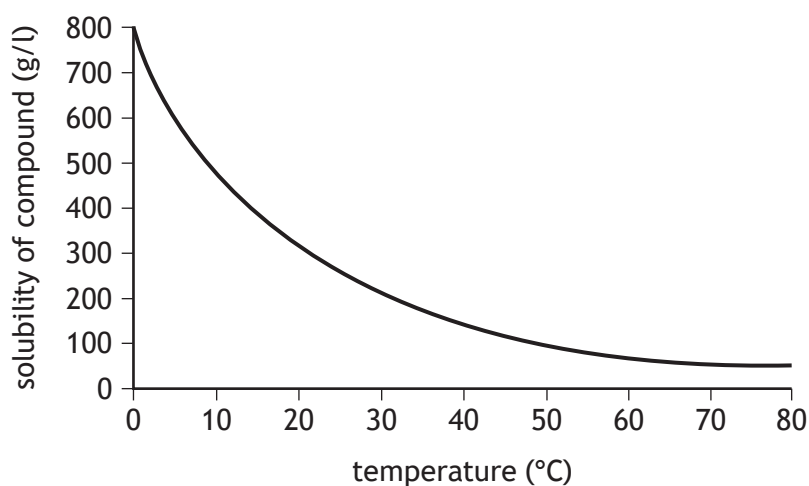
(a) Draw a diagram, showing **all** the outer electrons, to represent a molecule of oxygen, O_2 .

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.

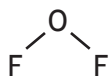
1



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 $\left\{ \begin{array}{l} \text{positive} \\ \text{negative} \\ \text{neutral} \end{array} \right\}$ nuclei are held together
by their common attraction for a shared pair of $\left\{ \begin{array}{l} \text{protons} \\ \text{neutrons} \\ \text{electrons} \end{array} \right\}$.

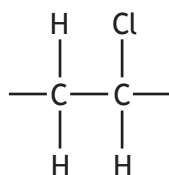
[Turn over



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



3. (continued)

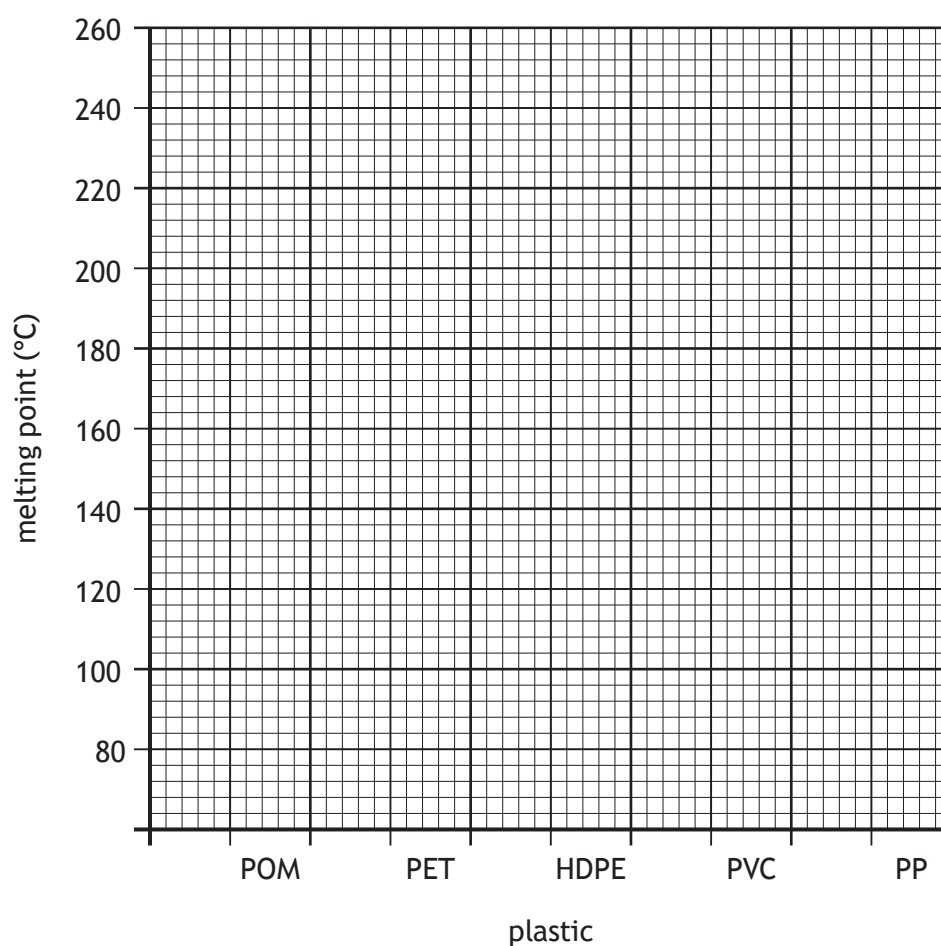
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(b) A table of some thermosoftening plastics and their melting point is shown.

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

2

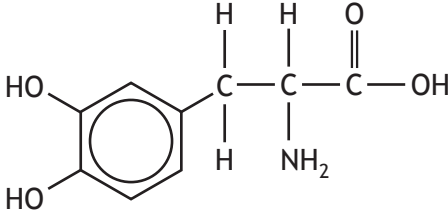
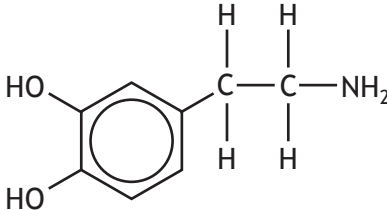
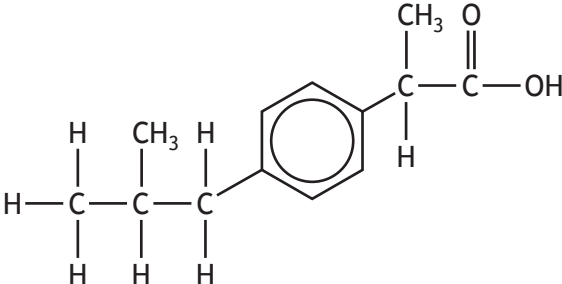


- (ii) Suggest why PVC could **not** be used as a container for boiling water.

1



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

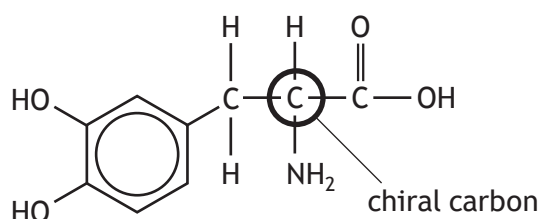


4. (continued)

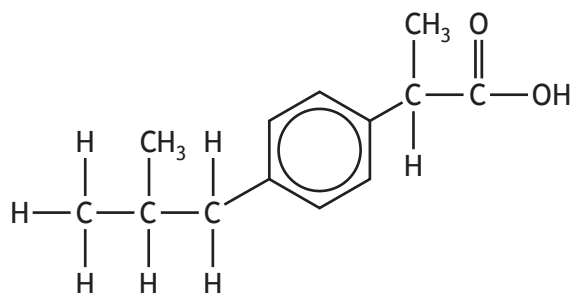
- (c) Many medicine molecules contain a chiral carbon which can affect their ability to work as a medicine.

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



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

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

1

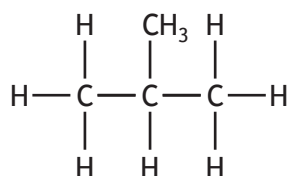
(b) The hydrocarbon iso-octane is added to petrol to improve performance in car engines.

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

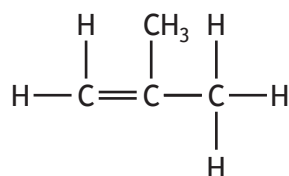
Draw a structure for iso-octane.

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



* X 8 1 3 7 5 0 1 1 4 *

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.

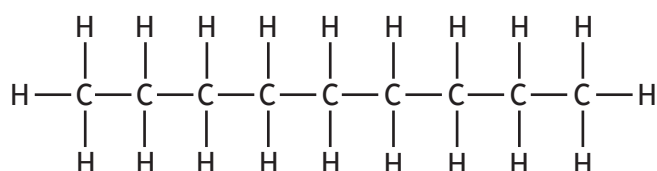
Alkane	Flash point (°C)
Hexane	−22
2,2,4-trimethylpentane	−12
Heptane	−4
2,2-dimethylhexane	−3
2-methylheptane	4
Octane	13

- (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



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



* X 8 1 3 7 5 0 1 1 7 *

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.



Name the element represented by X in the equation.

1



* X 8 1 3 7 5 0 1 1 8 *

7. (c) (continued)

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:

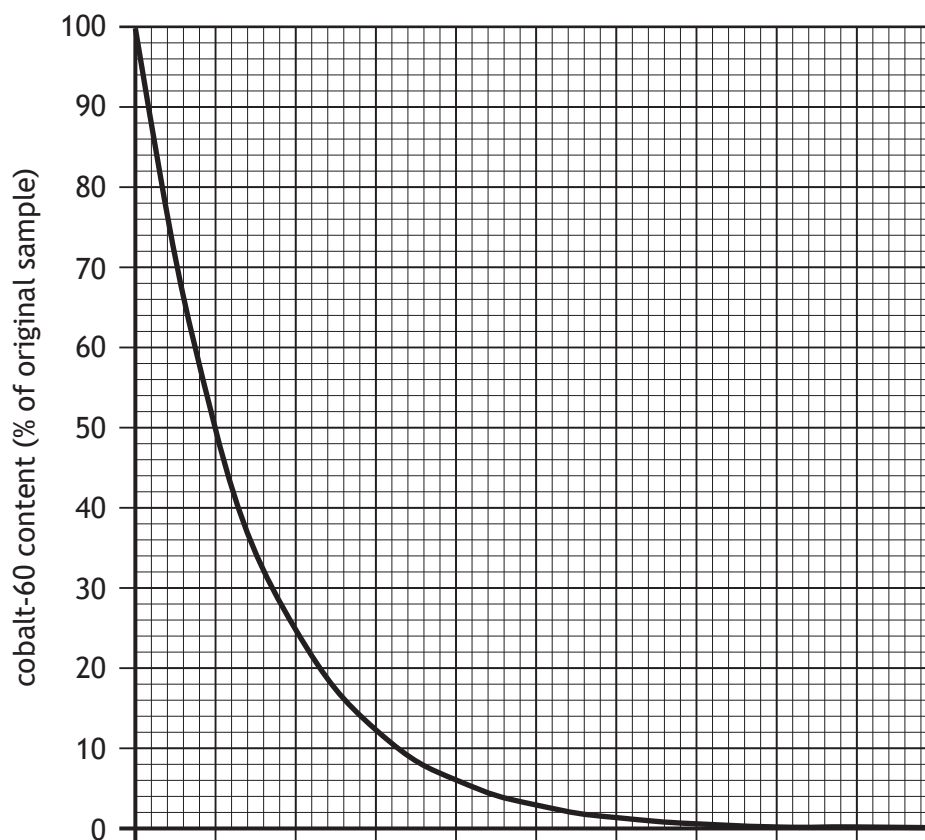
- (i) the scale to the x -axis

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		

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9. Propanol is an alcohol containing three carbon atoms.

(a) Propanol has two possible structures.

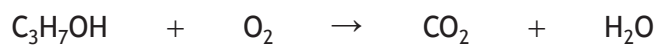
(i) State the term used to describe these two structures of propanol.

1

(ii) Draw **and** name one of the structures of propanol, C₃H₇OH.

2

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



Balance this equation.

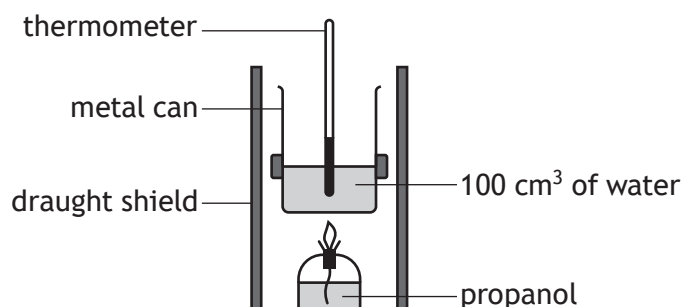
1



9. (continued)

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



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

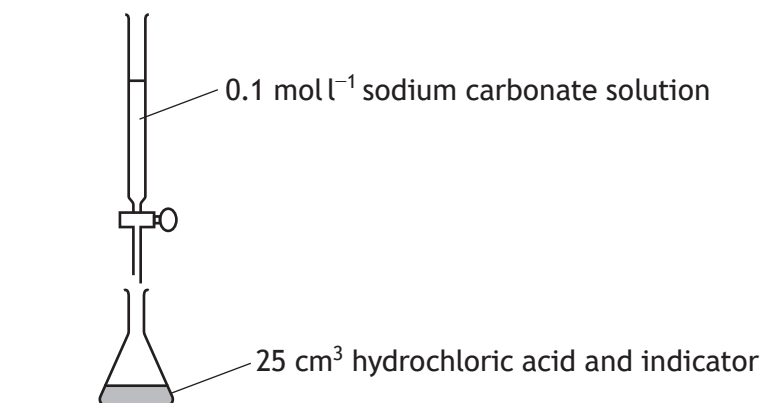


10. (continued)

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- (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, Na₂CO₃, used in the experiment was 19.0 cm³.
Sodium carbonate, Na₂CO₃, reacts with hydrochloric acid, HCl, in the ratio shown.
- $$1 \text{ mol Na}_2\text{CO}_3 : 2 \text{ mol HCl}$$
- Calculate the concentration, in mol l⁻¹, of the hydrochloric acid, HCl, used in the experiment. 3
- Show your working clearly.

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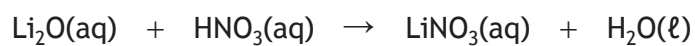


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11. A neutralisation reaction between lithium oxide and nitric acid is shown.



(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.



Name substance X.

1

[Turn over



11. (continued)

(d) Neutralisation reactions release heat energy.

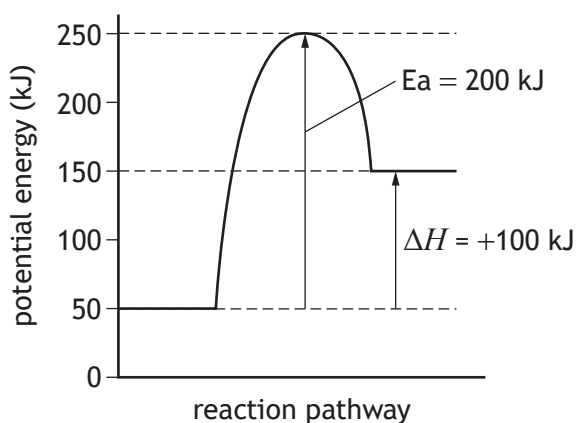
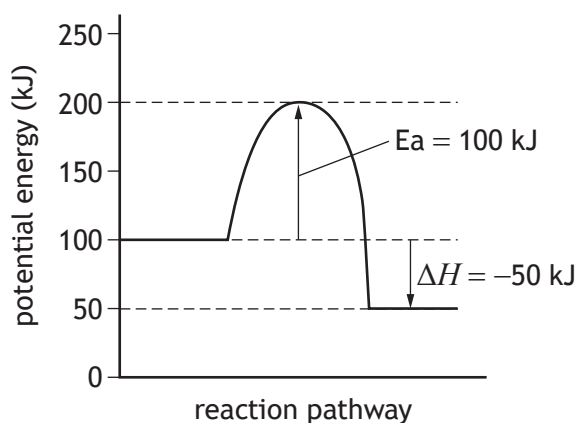
(i) State the term used to describe any reaction that releases heat energy.

1

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

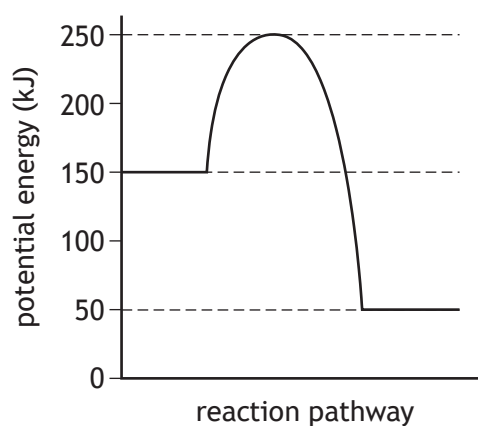
A potential energy diagram can be used to show these values.

(A) Two potential energy diagrams are shown below.



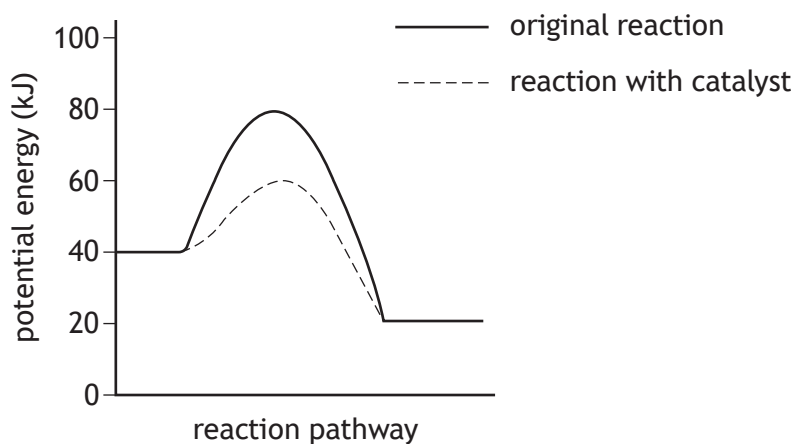
Calculate the enthalpy change, ΔH , in kJ, for the potential energy diagram shown below.

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, E_a , and the enthalpy change, ΔH .

2

Effect of catalyst on activation energy, E_a	<i>increase/decrease/no effect</i>
Effect of catalyst on enthalpy change, ΔH	<i>increase/decrease/no effect</i>

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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

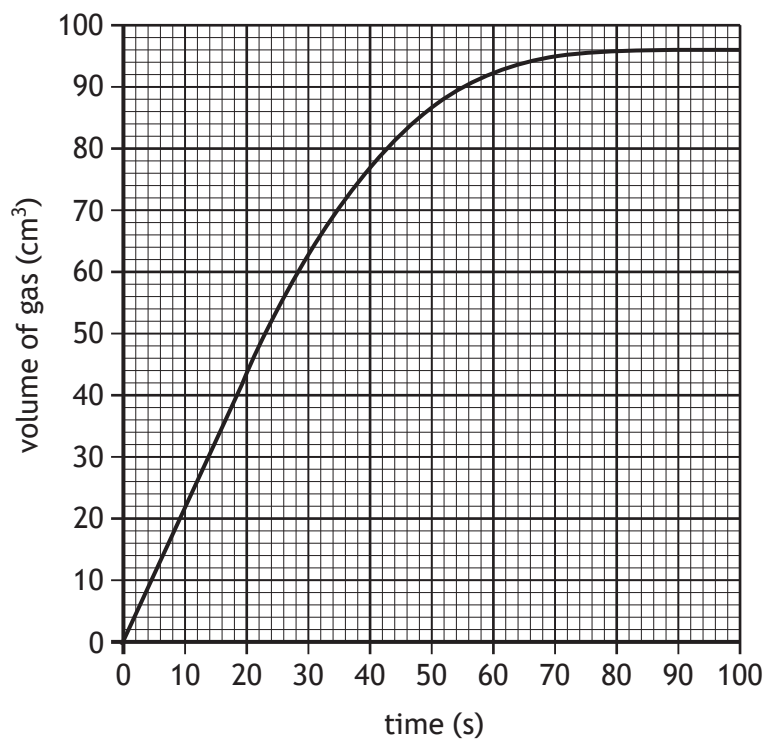
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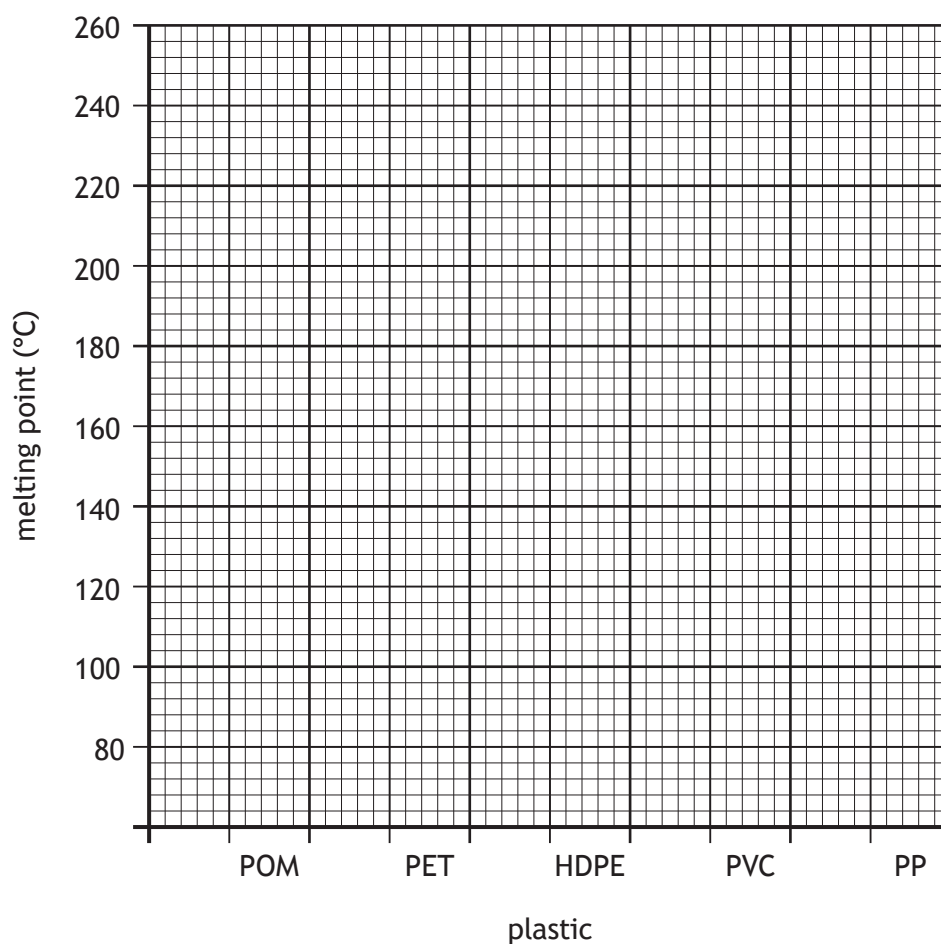
ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK

Additional graph for question 1 (b) (ii)

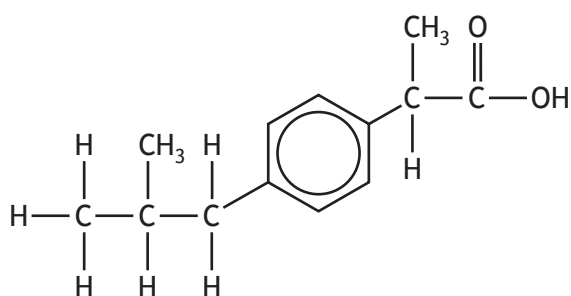


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Additional graph for question 3 (b) (i)

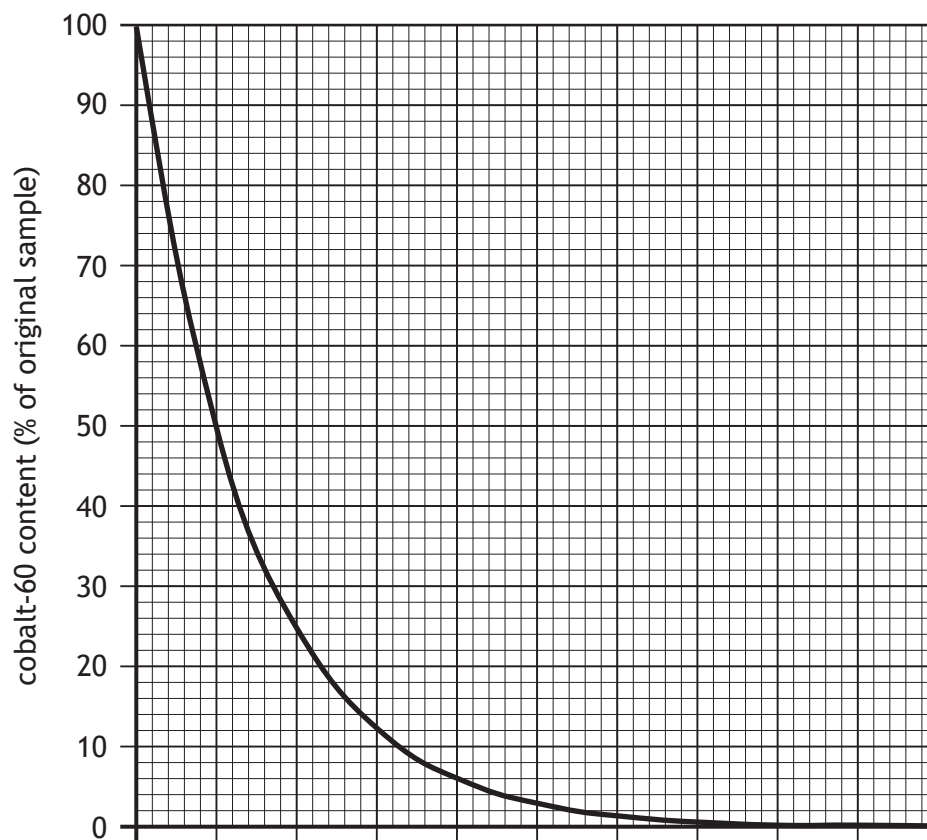


Additional structure for question 4 (c)



ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK

Additional graph for question 7 (d)



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