



National
Qualifications
SPECIMEN ONLY

S813/75/02

Chemistry
Section 1 — Questions

Date — Not applicable

Duration — 2 hours 30 minutes

Instructions for completion of Section 1 are given on *page 02* of your question and answer booklet S813/75/01.

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.



* S 8 1 3 7 5 0 2 *

SECTION 1 — 25 marks

Attempt ALL questions

1. Which of the following elements usually exists as diatomic molecules?

- A Helium
- B Nitrogen
- C Silicon
- D Sulfur

2. Which line in the table correctly describes a proton?

	<i>Mass</i> (atomic mass units)	<i>Charge</i>
A	negligible	+1
B	negligible	-1
C	1	+1
D	1	0

3. Ionic compounds conduct electricity when molten because they have

- A ions that are free to move
- B delocalised electrons
- C metal atoms
- D a lattice structure.

4. A molecule of phosphine is shown below.



The shape of a molecule of phosphine is

- A linear
- B angular
- C tetrahedral
- D trigonal pyramidal.

5. The table gives information about some particles.
Identify the particle which is a negative ion.

<i>Particle</i>	<i>Number of</i>		
	<i>protons</i>	<i>neutrons</i>	<i>electrons</i>
A	9	10	10
B	11	12	11
C	15	16	15
D	19	20	18

6. The table shows the colours of some ionic compounds in solution.

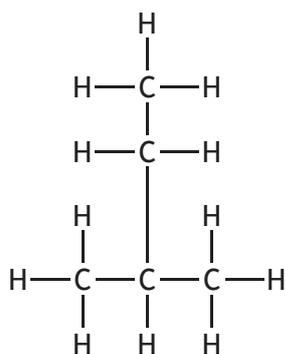
<i>Compound</i>	<i>Colour</i>
copper nitrate	blue
copper chromate	green
strontium nitrate	colourless
strontium chromate	yellow

The colour of the chromate ion is

- A blue
B green
C colourless
D yellow.
7. Which of the following statements correctly describes the concentrations of $\text{H}^+(\text{aq})$ and $\text{OH}^-(\text{aq})$ ions in pure water?
- A The concentrations of $\text{H}^+(\text{aq})$ and $\text{OH}^-(\text{aq})$ ions are equal.
B The concentrations of $\text{H}^+(\text{aq})$ and $\text{OH}^-(\text{aq})$ ions are zero.
C The concentration of $\text{H}^+(\text{aq})$ ions is greater than the concentration of $\text{OH}^-(\text{aq})$ ions.
D The concentration of $\text{H}^+(\text{aq})$ ions is less than the concentration of $\text{OH}^-(\text{aq})$ ions.

[Turn over

8.



The name of the above compound is

- A 2-ethylpropane
- B 1,1-dimethylpropane
- C 2-methylbutane
- D 3-methylbutane.

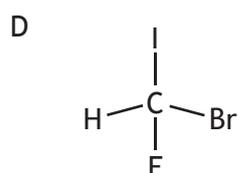
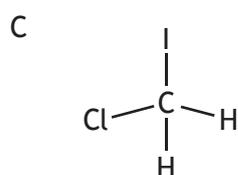
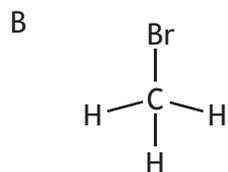
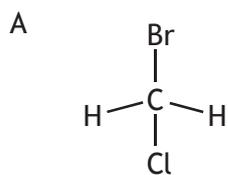
9. Which of the following could be the molecular formula for a cycloalkane?

- A C_6H_8
- B C_6H_{10}
- C C_6H_{12}
- D C_6H_{14}

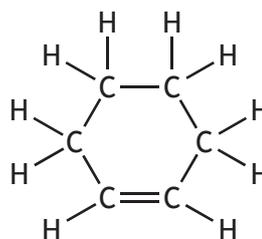
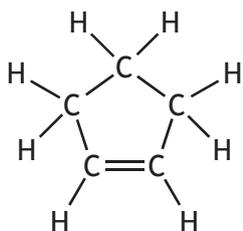
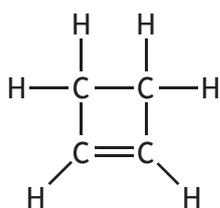
10. In which of the following types of reaction is oxygen a reactant?

- A Combustion
- B Neutralisation
- C Polymerisation
- D Precipitation

11. Molecules in which four different atoms are attached to a carbon atom are said to be chiral. Which of the following molecules is chiral?



12. Three members of the cycloalkene family are



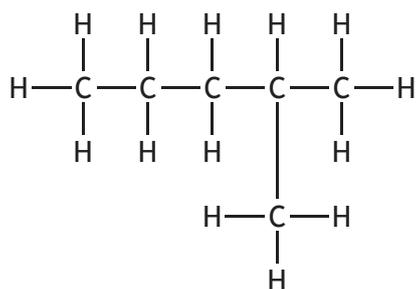
The general formula for the cycloalkene family is

- A $\text{C}_n\text{H}_{2n-2}$
- B $\text{C}_n\text{H}_{2n-4}$
- C C_nH_{2n}
- D $\text{C}_n\text{H}_{2n+2}$

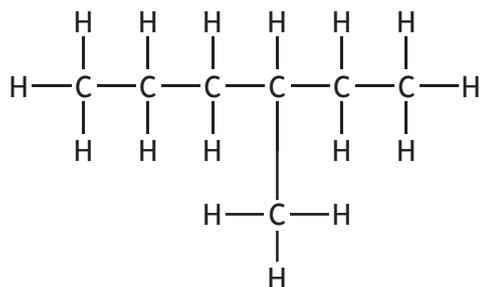
[Turn over

13. Which of the following molecules is an isomer of hept-2-ene?

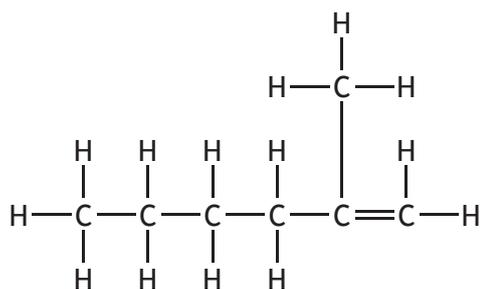
A



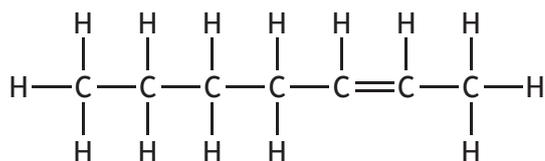
B



C



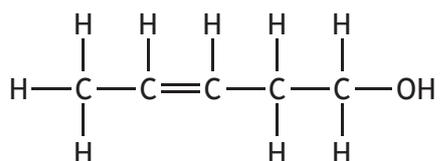
D



14. A student tested some compounds. The results are given in the table.

<i>Compound</i>	<i>pH of aqueous solution</i>	<i>Effect on bromine solution</i>
$ \begin{array}{c} \text{H} \quad \text{H} \\ \quad \\ \text{H}-\text{C}-\text{C}-\text{C} \\ \quad \quad // \\ \text{H} \quad \text{H} \quad \text{O} \\ \quad \quad \quad \backslash \\ \quad \quad \quad \text{OH} \end{array} $	4	no effect
$ \begin{array}{c} \text{H} \quad \quad \text{O} \\ \quad \quad // \\ \text{H}-\text{C}=\text{C}-\text{C} \\ \quad \quad \backslash \\ \text{H} \quad \text{H} \quad \text{OH} \end{array} $	4	decolourised
$ \begin{array}{c} \text{H} \quad \text{H} \quad \text{H} \\ \quad \quad \\ \text{H}-\text{C}-\text{C}-\text{C}-\text{OH} \\ \quad \quad \\ \text{H} \quad \text{H} \quad \text{H} \end{array} $	7	no effect
$ \begin{array}{c} \quad \quad \quad \text{H} \\ \quad \quad \quad \\ \text{H}-\text{C}=\text{C}-\text{C}-\text{OH} \\ \quad \quad \\ \text{H} \quad \text{H} \quad \text{H} \end{array} $	7	decolourised

Which line in the table below shows the correct results for the following compound?

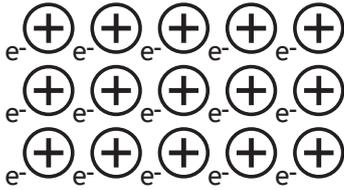


	<i>pH of aqueous solution</i>	<i>Effect on bromine solution</i>
A	4	decolourised
B	7	decolourised
C	4	no effect
D	7	no effect

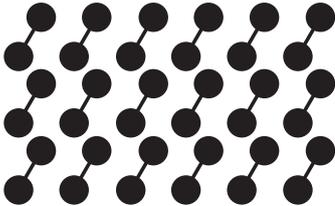
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15. Which of the following diagrams could be used to represent the structure of a metal?

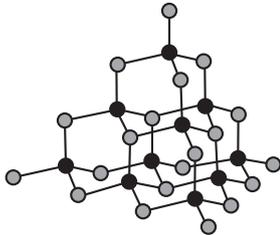
A



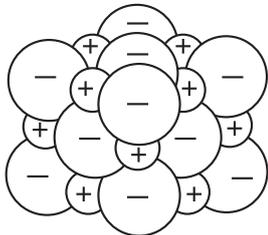
B



C



D



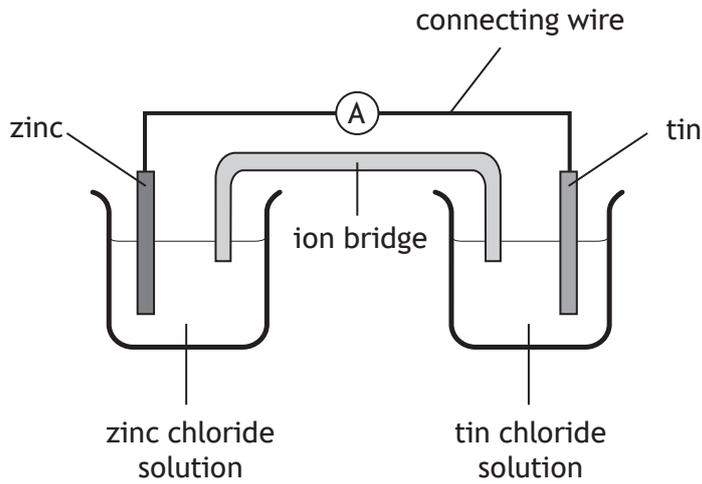
16. Which of the following substances does **not** produce water when it reacts with dilute acid?

- A Sodium hydroxide
- B Magnesium
- C Copper oxide
- D Ammonia solution

17. Which of the following metals can be extracted from its oxide by heat alone?

- A Aluminium
- B Zinc
- C Gold
- D Iron

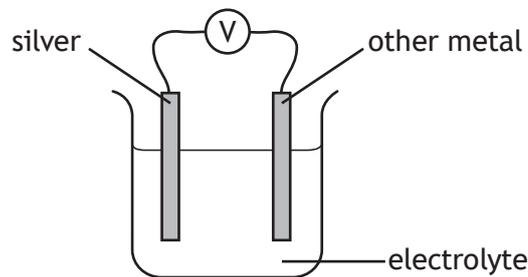
18.



In the cell shown above, electrons flow through

- A the solution from tin to zinc
- B the solution from zinc to tin
- C the connecting wire from tin to zinc
- D the connecting wire from zinc to tin.

19. Four cells were made by joining silver to copper, iron, tin and zinc.



The voltages for the four cells are shown in the table.

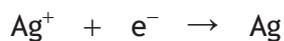
Which cell contained silver joined to copper?

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

Cell	Voltage (V)
A	1.6
B	1.2
C	0.9
D	0.5

[Turn over

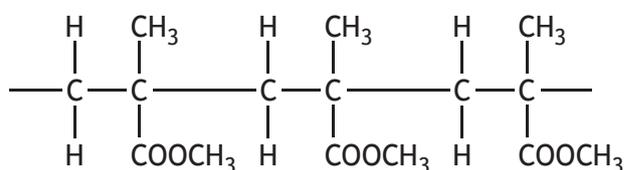
20. The ion-electron equation for the oxidation and reduction steps in the reaction between magnesium and silver(I) ions are:



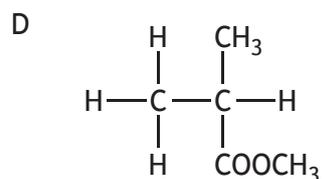
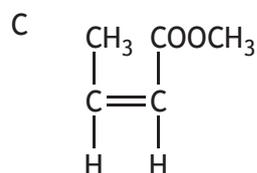
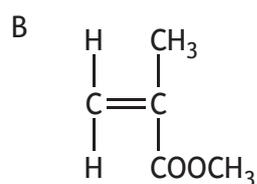
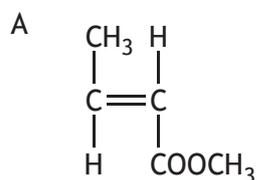
The overall redox equation is

- A $\text{Mg} + 2\text{Ag}^{+} \rightarrow \text{Mg}^{2+} + 2\text{Ag}$
 B $\text{Mg} + \text{Ag}^{+} \rightarrow \text{Mg}^{2+} + \text{Ag}$
 C $\text{Mg} + \text{Ag}^{+} + \text{e}^{-} \rightarrow \text{Mg}^{2+} + \text{Ag} + 2\text{e}^{-}$
 D $\text{Mg} + 2\text{Ag} \rightarrow \text{Mg}^{2+} + 2\text{Ag}^{+}$.

21. The structure below shows a section of an addition polymer.



Which of the following molecules is used to make this polymer?



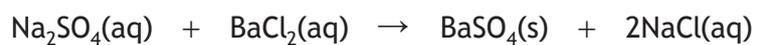
22. Hydrogen gas

- A burns with a pop
- B relights a glowing splint
- C turns damp pH paper red
- D turns limewater cloudy.

23. What is the charge on an iron ion in $\text{Fe}_2(\text{SO}_4)_3$?

- A 3-
- B 3+
- C 2-
- D 2+

24. Sodium sulfate solution reacts with barium chloride solution.



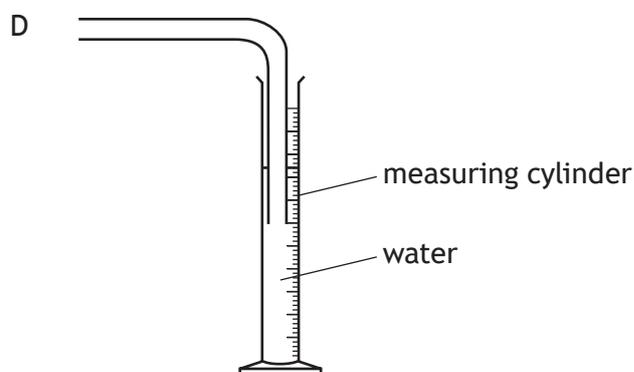
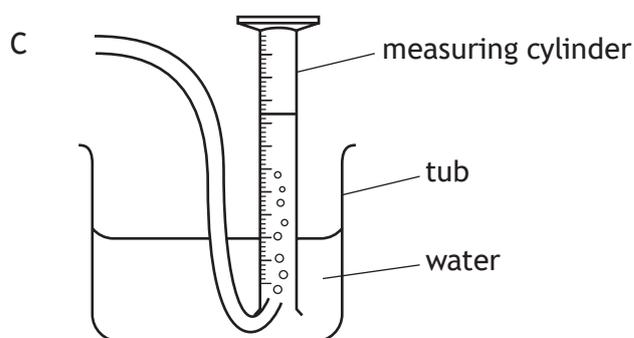
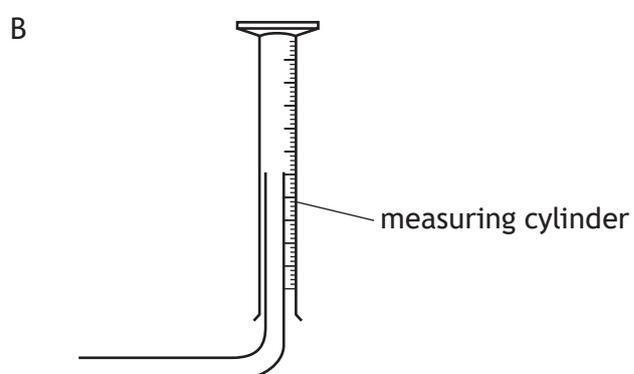
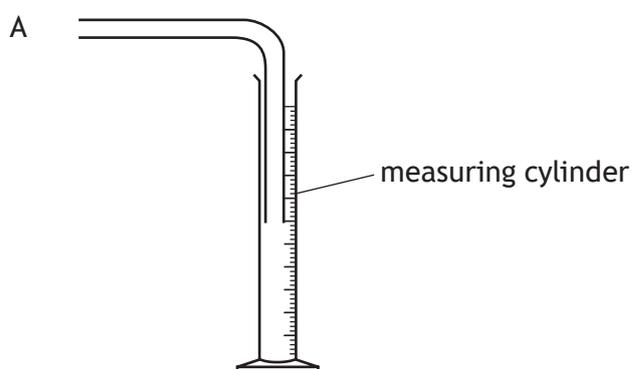
The spectator ions present in this reaction are

- A Ba^{2+} and Cl^-
- B Ba^{2+} and SO_4^{2-}
- C Na^+ and Cl^-
- D Na^+ and SO_4^{2-}

[Turn over

25. But-1-ene is a colourless, insoluble gas which is more dense than air but less dense than water.

Which of the following diagrams shows the most appropriate apparatus for collecting and measuring the volume of but-1-ene?



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

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Mark

S813/75/01

**Chemistry
Section 1 — Answer Grid
And Section 2**

Date — Not applicable

Duration — 2 hours 30 minutes



* S 8 1 3 7 5 0 1 *

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. 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.



* S 8 1 3 7 5 0 1 0 1 *

The questions for Section 1 are contained in the question paper S813/75/02.

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
<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>

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
<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>

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
<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>		<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>



SECTION 1 — Answer Grid



* O B J 2 5 A D 1 *

	A	B	C	D
1	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
5	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
6	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
7	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
8	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
9	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
10	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
11	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
12	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
13	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
14	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
15	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
16	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
17	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
18	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
19	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
20	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
21	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
22	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
23	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
24	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
25	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



* S 8 1 3 7 5 0 1 0 3 *

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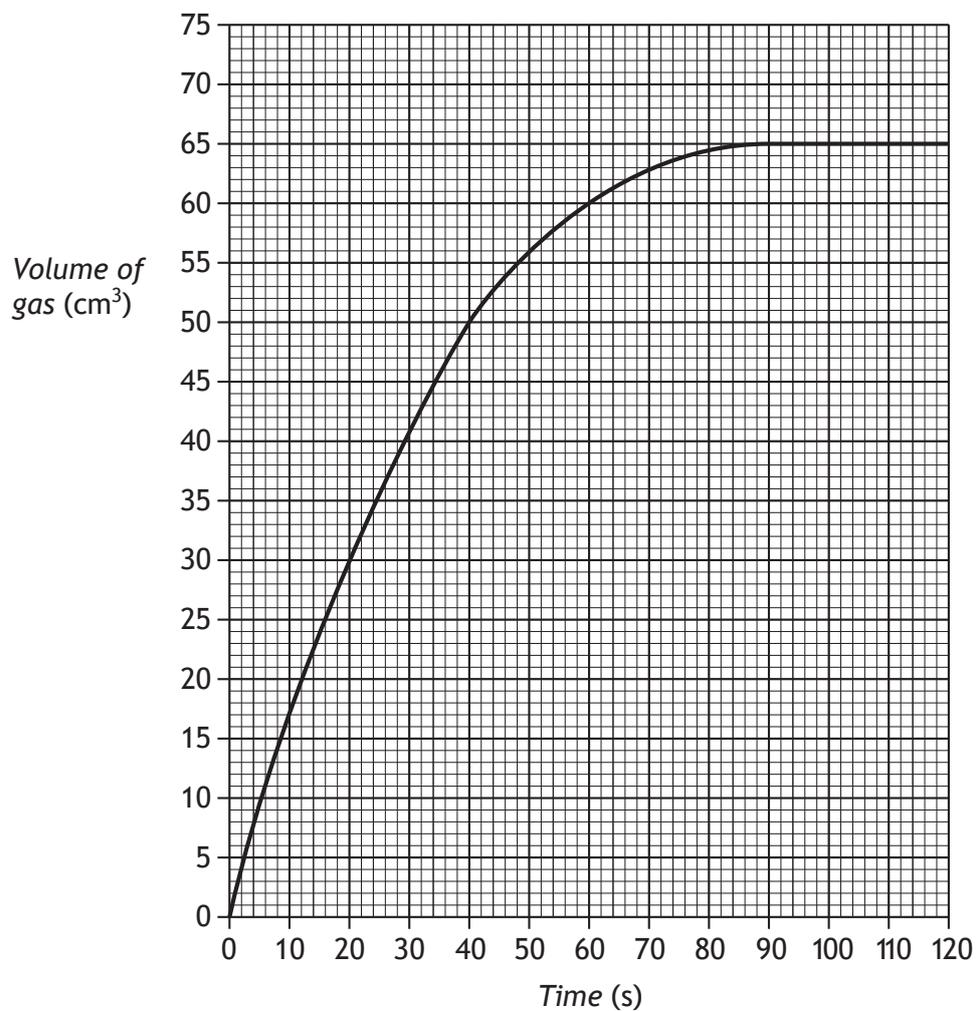
SECTION 2 — 75 marks

Attempt ALL questions

MARKS
DO NOT
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1. Graphs can be used to show the change in the rate of a reaction as the reaction proceeds.

The graph shows the volume of gas produced in an experiment over a period of time.



- (a) State the time, in seconds, at which the reaction stopped.

1

[Turn over



* S 8 1 3 7 5 0 1 0 5 *

1. (continued)

(b) Calculate the average rate of reaction for the first 20 seconds.

3

Your answer must include the appropriate unit.

Show your working clearly.

(c) The graph shows that the rate of reaction decreases as the reaction proceeds.

1

Suggest a reason for this decrease.



2. The group 7 element bromine was discovered by Balard in 1826.
Bromine gets its name from the Greek “bromos” meaning stench.

A sample of bromine consists of a mixture of two isotopes, $^{79}_{35}\text{Br}$ and $^{81}_{35}\text{Br}$.

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

(b) Complete the table for $^{79}_{35}\text{Br}$. 1

<i>Isotope</i>	<i>Number of protons</i>	<i>Number of neutrons</i>
$^{79}_{35}\text{Br}$		

(c) The sample of bromine has an average atomic mass of 80.
Suggest what this indicates about the amount of each isotope in this sample. 1

[Turn over



MARKS

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2. (continued)

- (d) In 1825 bromine had been isolated from sea water by Liebig who mistakenly thought it was a compound of iodine and chlorine.

Using your knowledge of chemistry, comment on why Liebig might have made this mistake.

3



* S 8 1 3 7 5 0 1 0 8 *

3. Antacid tablets are used to treat indigestion which is caused by excess acid in the stomach.

Different brands of tablets contain different active ingredients.

<i>Name of active ingredient</i>	magnesium carbonate	calcium carbonate	magnesium hydroxide	aluminium hydroxide
<i>Reaction with acid</i>	fizzes	fizzes	does not fizz	does not fizz
<i>Cost per gram (pence)</i>	16	11	7.5	22
<i>Mass of solid needed to neutralise 20 cm³ of acid (g)</i>	0.7	1.2	0.6	0.4
<i>Cost of neutralising 20 cm³ of acid (pence)</i>		13.2	4.5	8.8

- (a) Write the formula, showing the charge on each ion, for aluminium hydroxide. 1
- (b) (i) Complete the table to show the cost of using magnesium carbonate to neutralise 20 cm³ of acid. 1
- (ii) Using information from the table, state which **one** of the four active ingredients **you** would use to neutralise excess stomach acid. Explain your choice. 1

[Turn over



4. Sulfur dioxide gas is produced when fossil fuels containing sulfur are burned.

(a) When sulfur dioxide dissolves in water in the atmosphere “acid rain” is produced.

Circle the correct phrase to complete the sentence.

Compared with pure water, acid rain contains $\left. \begin{array}{l} \text{a higher} \\ \text{a lower} \\ \text{the same} \end{array} \right\}$ concentration of hydrogen ions.

1

(b) The table gives information about the solubility of sulfur dioxide.

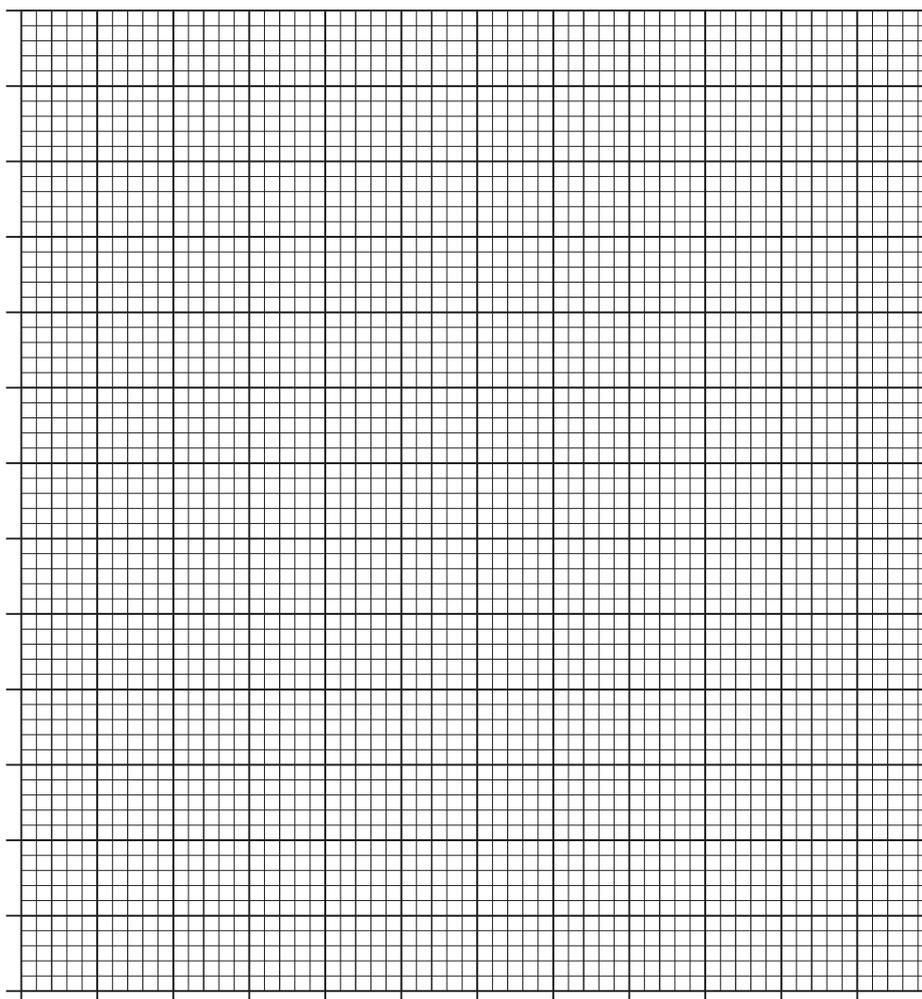
Temperature (°C)	18	24	30	36	42	48
Solubility (g/100 cm ³)	11.2	9.2	7.8	6.5	5.5	4.7

(i) Draw a graph of solubility against temperature.

Use appropriate scales to fill most of the graph paper.

(Additional graph paper, if required, can be found on page 28.)

4



MARKS

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WRITE IN
THIS
MARGIN

4. (b) (continued)

(ii) Estimate the solubility of sulfur dioxide, in g/100 cm³, at 21 °C.

1

[Turn over



* S 8 1 3 7 5 0 1 1 1 *

5. A student investigated the reaction of carbonates with dilute hydrochloric acid.

(a) In one reaction lithium carbonate reacted with dilute hydrochloric acid.

The equation for the reaction is:



(i) Balance this equation.

1

(ii) Identify the salt produced in this reaction.

1

(b) In another reaction 1.0 g of calcium carbonate reacted with excess dilute hydrochloric acid.



(i) Calculate the mass, in grams, of carbon dioxide produced.

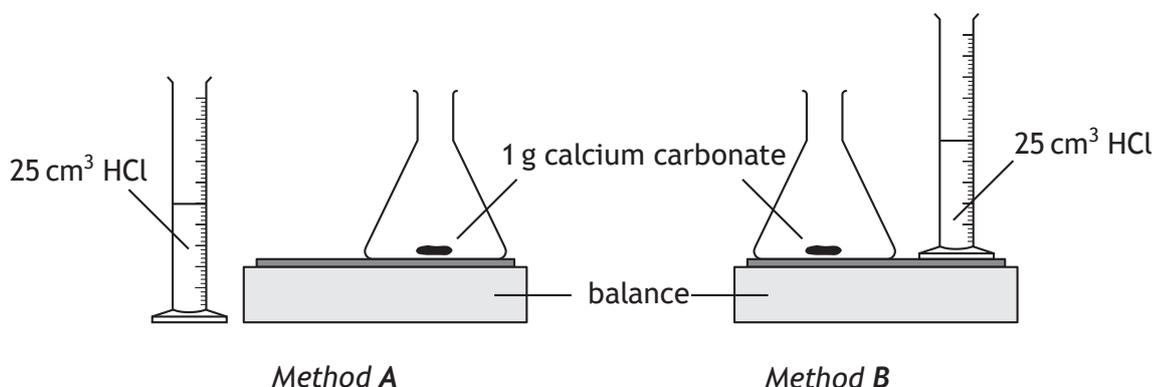
3

Show your working clearly.



5. (b) (continued)

(ii) The student considered two methods to confirm the mass of carbon dioxide gas produced in this reaction.



Method A	Method B
1. Add the acid from the measuring cylinder to the calcium carbonate in the flask.	1. Weigh the flask with the calcium carbonate and the acid in the measuring cylinder together.
2. Weigh the flask and contents.	2. Add the acid from the measuring cylinder to the calcium carbonate in the flask and replace the empty measuring cylinder on the balance.
3. Leave until no more bubbles are produced.	3. Leave until no more bubbles are produced.
4. Reweigh the flask and contents.	4. Reweigh the flask, contents and the empty measuring cylinder together.

Explain which method would give a more reliable estimate of the mass of carbon dioxide produced during the reaction.

2

[Turn over



6. Read the passage below and answer the questions that follow.

Potassium Permanganate (KMnO₄)

Potassium permanganate's strong oxidising properties make it an effective disinfectant. Complaints such as athlete's foot and some fungal infections are treated by bathing the affected area in KMnO₄ solution.

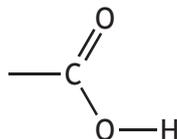
In warm climates vegetables are washed in KMnO₄ to kill bacteria such as *E. coli*. Chemists use KMnO₄ in the manufacture of saccharin and benzoic acid.

Baeyer's reagent is an alkaline solution of KMnO₄ and is used to detect unsaturated organic compounds. The reaction of KMnO₄ with alkenes is also used to extend the shelf life of fruit. Ripening fruit releases ethene gas which causes other fruit to ripen. Shipping containers are fitted with gas scrubbers that use alumina or zeolite impregnated with KMnO₄ to stop the fruit ripening too quickly.



Adapted from an article by Simon Cotton on "Soundbite molecules" in "Education in Chemistry" November 2009.

- (a) Suggest an experimental test, including the result, to show that potassium is present in potassium permanganate. 1
 You may wish to use the data booklet to help you.
- (b) Suggest a pH for Baeyer's reagent. 1
- (c) Name the gas removed by the scrubbers. 1
- (d) Name a chemical mentioned in the passage which contains the following functional group. 1



- (e) Zeolite is a substance that contains aluminium silicate. 1
 Name the elements present in aluminium silicate.



7. In the 2012 London Olympics, alkanes were used as fuels for the Olympic flame.

(a) The torches that carried the Olympic flame across Britain burned a mixture of propane and butane.

Propane and butane are members of the same homologous series.

State what is meant by the term homologous series.

1

(b) Natural gas, which is mainly methane, was used to fuel the flame in the Olympic cauldron.

(i) Draw a diagram to show how **all** the outer electrons are arranged in a molecule of methane, CH₄.

1

(ii) Methane is a covalent molecular substance. It has a low boiling point and is a gas at room temperature.

Explain why methane is a gas at room temperature.

2

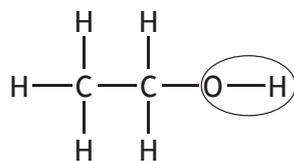
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* S 8 1 3 7 5 0 1 1 5 *

8. Car manufacturers have developed vehicles that use ethanol as fuel.

(a) The structure of ethanol is shown below.



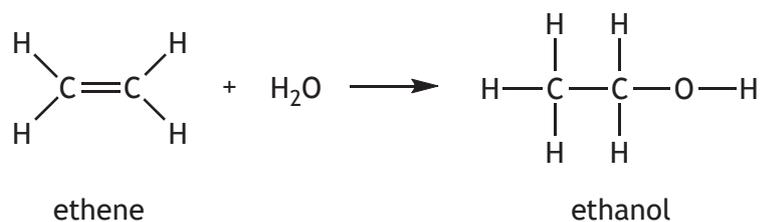
Name the functional group circled in the diagram.

1

(b) Name the two substances produced when ethanol burns in a plentiful supply of oxygen.

1

(c) Ethanol can be produced from ethene as shown.



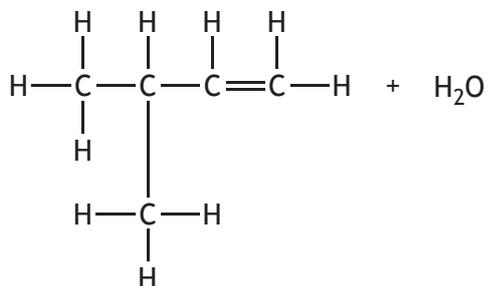
(i) Name the **type** of chemical reaction taking place.

1



8. (c) (continued)

(ii) Draw a structural formula for a product of the following reaction. 1



(d) Ethanol can be used to produce ethanoic acid.

(i) Draw a structural formula for ethanoic acid. 1

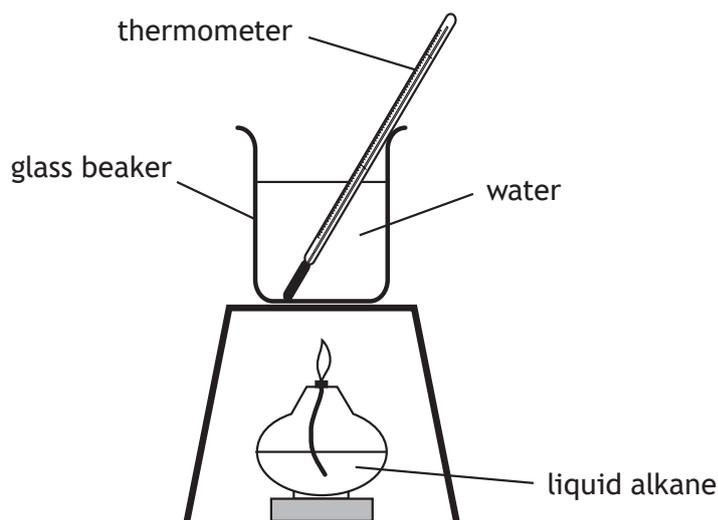
(ii) Name the family of compounds to which ethanoic acid belongs. 1

[Turn over



9. Alkanes burn, releasing heat energy.
- (a) State the term used to describe all chemical reactions that release heat energy.
- (b) A student investigated the amount of energy released when an alkane burns using the apparatus shown.

1



The student recorded the following data.

Mass of alkane burned	1 g
Volume of water	200 cm ³
Initial temperature of water	15 °C
Final temperature of water	55 °C

- (i) Calculate the energy released, in kJ.
Show your working clearly.

3



9. (b) (continued)

(ii) Suggest **one** improvement to the student's investigation.

1

(c) The table gives information about the amount of energy released when one mole of some alkanes are burned.

<i>Name of alkane</i>	<i>Energy released when one mole of alkane is burned (kJ)</i>
methane	891
ethane	1561
propane	2219
butane	2878

(i) Write a statement linking the amount of energy released to the number of carbon atoms in the alkane molecule.

1

(ii) Predict the amount of heat released, in kJ, when one mole of pentane is burned.

1

[Turn over



10. Essential oils can be extracted from plants and used in perfumes and food flavourings.

(a) Essential oils contain compounds made up of a number of isoprene molecules joined together.

The shortened structural formula for isoprene is $\text{CH}_2\text{C}(\text{CH}_3)\text{CHCH}_2$.

Draw the full structural formula for isoprene.

1

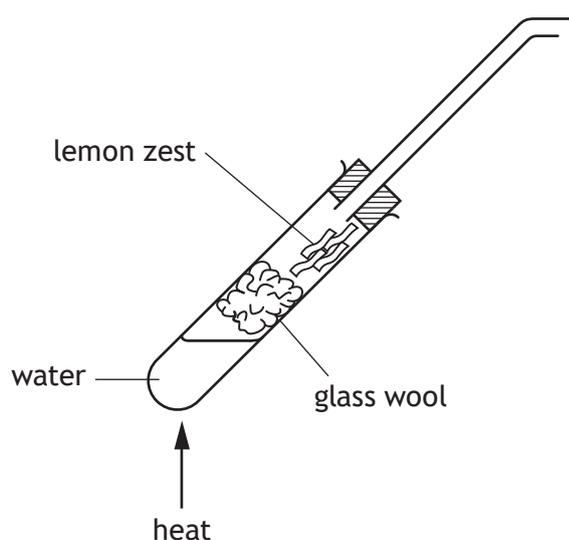
(b) Essential oils can be extracted from the zest of lemons in the laboratory by steam distillation.

The process involves heating up water in a boiling tube until it boils. The steam produced then passes over the lemon zest which is separated from the water by glass wool. As the steam passes over the lemon zest it carries essential oils into the delivery tube. The condensed liquids (essential oils and water) are collected in a test tube placed in a cold water bath.

Complete the diagram to show the apparatus needed to collect the essential oils.

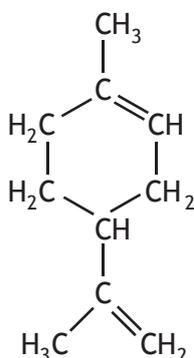
1

(An additional diagram, if required, can be found on page 29.)



10. (continued)

(c) Limonene, $C_{10}H_{16}$, is a compound found in lemon zest.



Write the molecular formula for the product formed when limonene reacts completely with bromine solution.

1

[Turn over

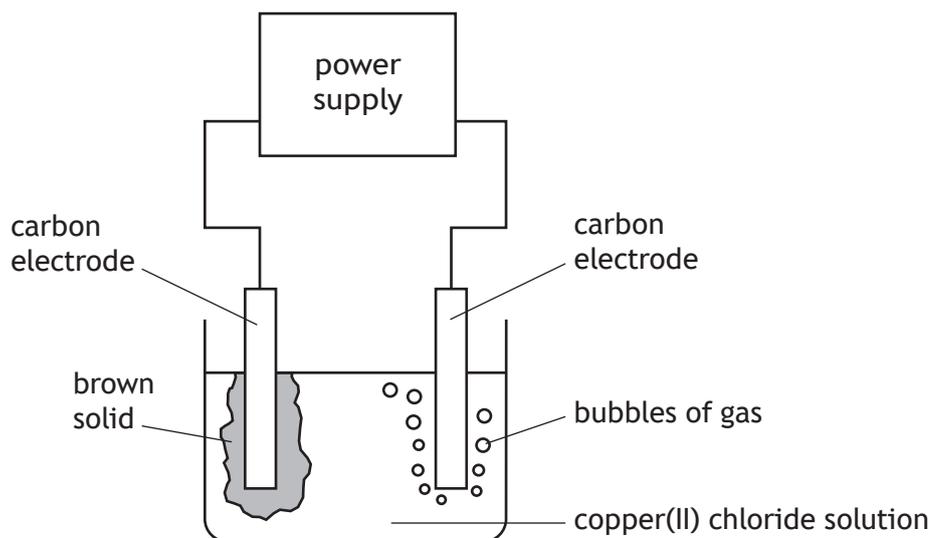


11. Metals can be extracted from metal compounds by electrolysis.

(a) During electrolysis, metal ions are changed to metal atoms.
Name this type of chemical reaction.

1

(b) A student set up the following experiment to electrolyse copper(II) chloride solution.



(i) Name the type of power supply that **must** be used to electrolyse the solution.

1

(ii) Complete the table by adding the charge on each electrode.

1

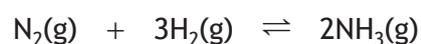
<i>Observation at the</i> _____ <i>electrode</i>	<i>Observation at the</i> _____ <i>electrode</i>
brown solid formed	bubbles of gas

12. Urea, H_2NCONH_2 , can be used as a fertiliser.

(a) Calculate the percentage of nitrogen in urea.

3

(b) Other nitrogen based fertilisers can be produced from ammonia. Ammonia is produced in an industrial process using a catalyst.



(i) Name the industrial process that produces ammonia.

1

(ii) Suggest why a catalyst may be used in an industrial process.

1

(c) In another industrial process, ammonia is used to produce nitric acid. Name the catalyst used in this process.

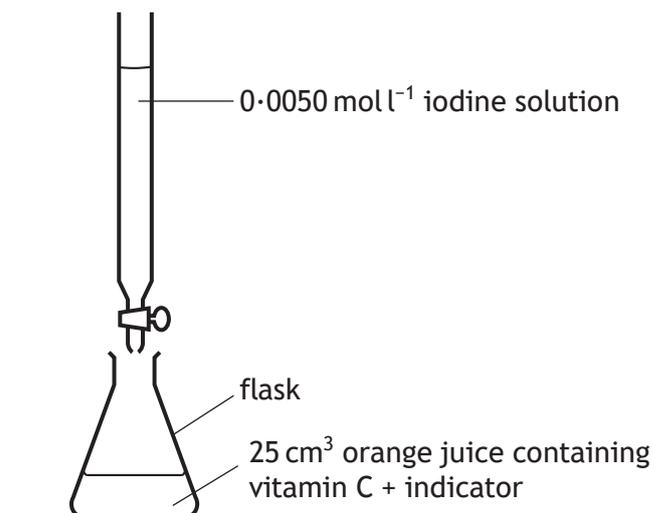
1

[Turn over



13. Vitamin C is found in fruits and vegetables.

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Using iodine solution, a student carried out experiments to determine the concentration of vitamin C in orange juice.

The results of the experiments are shown.

<i>Experiment</i>	<i>Initial volume of iodine solution (cm³)</i>	<i>Final volume of iodine solution (cm³)</i>	<i>Volume of iodine solution added (cm³)</i>
1	1.2	18.0	16.8
2	18.0	33.9	15.9
3	0.5	16.6	16.1

- (a) (i) Name the piece of apparatus used to measure the volume of iodine solution added to the orange juice. 1
- (ii) Calculate the average volume, in cm³, of iodine solution that should be used in calculating the concentration of vitamin C. 1
Show your working clearly.
- (b) Name the experimental method, carried out by the student, to accurately determine the concentration of vitamin C in the orange juice. 1



14. In medicine, technetium-99m is injected into the body to detect damage to heart tissue.

It is a gamma-emitting radioisotope with a half-life of 6 hours.

- (a) A sample of technetium-99m has a mass of 2 g.

Calculate the mass, in grams, of technetium-99m that would be left after 12 hours.

2

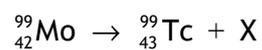
Show your working clearly.

- (b) Suggest one reason why technetium-99m can be used safely in this way.

1

- (c) Technetium-99m is formed when molybdenum-99 decays.

The decay equation is:



Identify X.

1

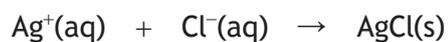
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15. The concentration of chloride ions in water affects the ability of some plants to grow.

A student investigated the concentration of chloride ions in the water at various points along the river Tay.

The concentration of chloride ions in water can be determined by reacting the chloride ions with silver ions.



A 20 cm³ water sample gave a precipitate of silver chloride with a mass of 1.435 g.

- (a) Calculate the number of moles of silver chloride, AgCl, present in this sample.

2

- (b) Using your answer to part (a), calculate the concentration, in mol l⁻¹, of chloride ions in this sample.

2



16. Nitrogen, phosphorus and potassium are elements essential for plant growth. A student was asked to prepare a dry sample of a compound which contained two of these elements. The student was given access to laboratory equipment and the following chemicals.

<i>Chemical</i>	<i>Formula</i>
ammonium hydroxide	NH ₄ OH
magnesium nitrate	Mg(NO ₃) ₂
nitric acid	HNO ₃
phosphoric acid	H ₃ PO ₄
potassium carbonate	K ₂ CO ₃
potassium hydroxide	KOH
sodium hydroxide	NaOH
sulfuric acid	H ₂ SO ₄
water	H ₂ O

Using your knowledge of chemistry, comment on how the student could prepare their dry sample.

3

[END OF SPECIMEN QUESTION PAPER]

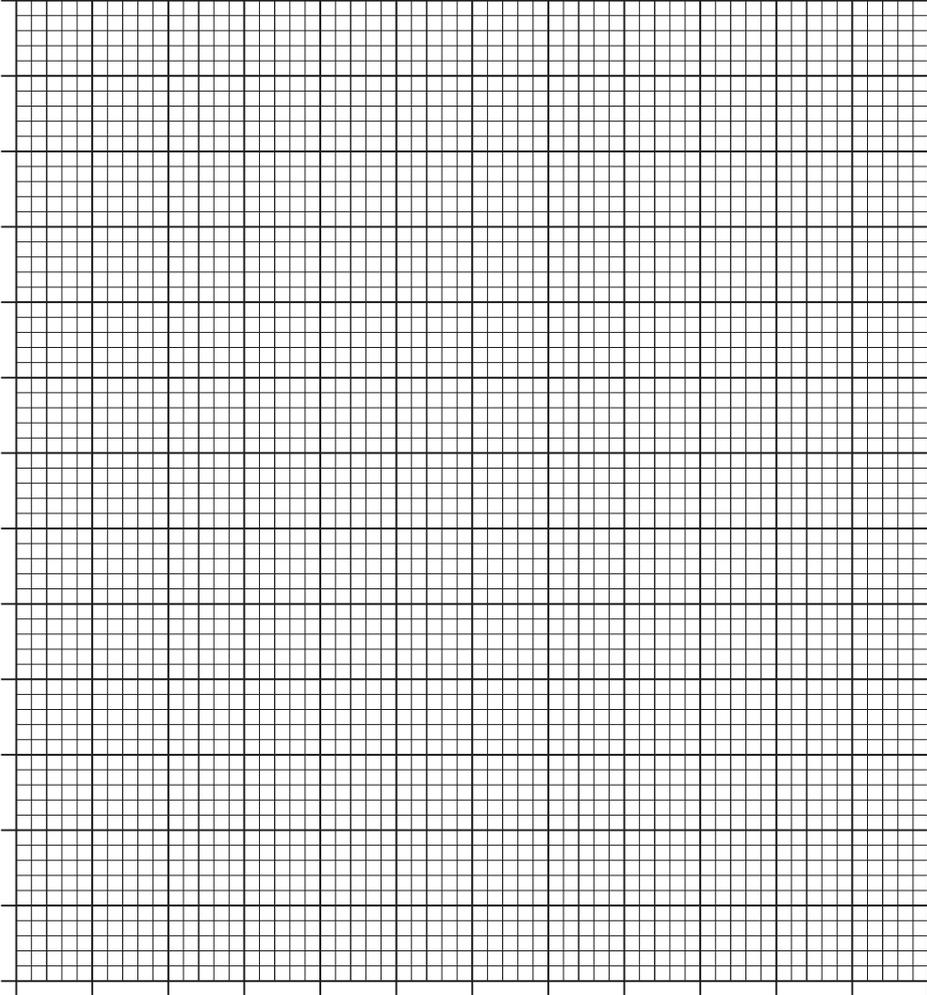


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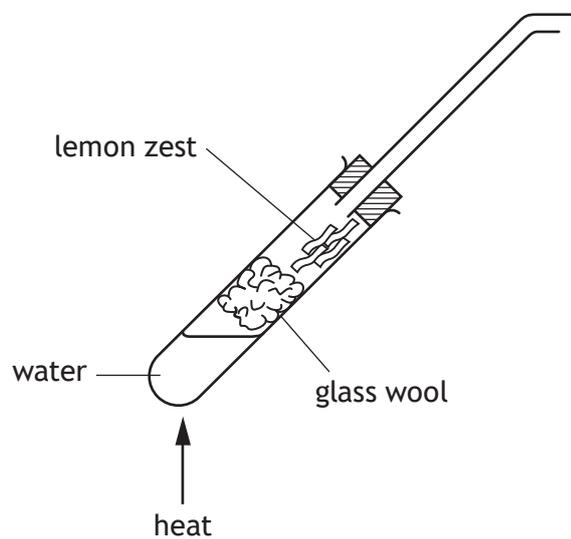
ADDITIONAL SPACE FOR ANSWERS

Additional graph paper for Question 4 (b) (i)



ADDITIONAL SPACE FOR ANSWERS

Additional diagram for Question 10 (b)



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ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK



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ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK

Acknowledgement of Copyright

Section 2 Question 6 Article is adapted from “Soundbite Molecules — Potassium Permanganate” by Simon Cotton, taken from *Education in Chemistry*, November 2009. ISSN: 0013-1350.
<https://eic.rsc.org/soundbite/potassium-permanganate/2021252.article>.
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* S 8 1 3 7 5 0 1 3 1 *



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Chemistry

Marking Instructions

These marking instructions have been provided to show how SQA would mark this specimen question paper.

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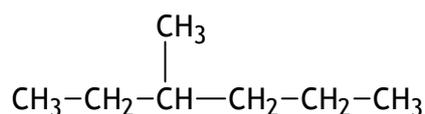
General marking principles for National 5 Chemistry

This information is provided to help you understand the general principles you must apply when marking candidate responses to questions in this paper. These principles must be read in conjunction with the detailed marking instructions, which identify the key features required in candidate responses.

- (a) Marks for each candidate response must always be assigned in line with these general marking principles and the detailed marking instructions for this assessment.
- (b) If a specific candidate response does not seem to be covered by either the principles or detailed marking instructions, and you are uncertain how to assess it, you must seek guidance from your team leader.
- (c) Marking should always be positive. This means that, for each candidate response, marks are accumulated for the demonstration of relevant skills, knowledge and understanding: they are not deducted from a maximum on the basis of errors or omissions.

A guiding principle in marking is to give credit for correct chemistry rather than to look for reasons not to award marks.

Example 1: The structure of a hydrocarbon found in petrol is shown below.



Name the hydrocarbon.

Although the punctuation is not correct, '3, methyl-hexane' should gain the mark.

Example 2: A student measured the pH of four carboxylic acids to find out how their strength is related to the number of chlorine atoms in the molecule.

The results are shown in the table.

<i>Structural formula</i>	<i>pH</i>
CH ₃ COOH	1.65
CH ₂ ClCOOH	1.27
CHCl ₂ COOH	0.90
CCl ₃ COOH	0.51

State how the strength of the acids is related to the number of chlorine atoms in the molecule.

Although not completely correct, an answer such as 'the more Cl₂, the stronger the acid' should gain the mark.

- (d) There are no half marks awarded.
- (e) Candidates must respond to the 'command' word as appropriate and may be required to write extended answers in order to communicate fully their knowledge and understanding.

- (f) Marks should be awarded for answers that have incorrect spelling or loose language **as long as the meaning of the word(s) is conveyed.**

Example: Answers like ‘distilling’ (for ‘distillation’) and ‘it gets hotter’ (for ‘the temperature rises’) should be accepted.

However, the example below would not be given any credit, as an incorrect chemical term, which the candidate should know, has been given.

Example: If the correct answer is ‘ethene’, and the candidate’s answer is ‘ethane’, this should not be accepted.

- (g) A correct answer followed by a wrong answer should be treated as a cancelling error and no marks should be awarded.

Example: State what colour is seen when blue Fehling’s solution is warmed with an aldehyde.

The answer ‘red, green’ gains no marks.

If a correct answer is followed by additional information which does not conflict, the additional information should be ignored, whether correct or not.

Example: State why the tube cannot be made of copper.

If the correct answer is related to a low melting point, ‘Copper has a low melting point and is coloured grey’ would not be treated as having a cancelling error.

- (h) Unless a numerical question specifically requires evidence of working to be shown, full marks should be awarded for a correct final answer (including units if required) on its own.

The partial marks shown in the marking scheme are for use when working is given but the final answer is incorrect. An exception is when candidates are asked to ‘Find, by calculation’, when full marks cannot be awarded for the correct answer without working.

- (i) In many questions, the unit in which the answer is to be expressed is given. In these questions the candidate does not need to state a unit in their answer; but if they do the unit must be correct. The full mark allocation cannot be awarded if an incorrect unit is shown.

In these questions, incorrect units would only be penalised once in any paper.

- (j) Where the marking instructions specifically allocate a mark for units in a calculation, this mark should not be awarded if the units are incorrect or missing. Missing or incorrect units at intermediate stages in a calculation should be ignored.

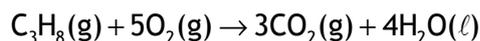
- (k) As a general rule, where a wrong numerical answer (already penalised) is carried forward to another step, credit will be given provided the result is used correctly. The exception to this rule is where the marking instructions for a numerical question assign separate ‘concept marks’ and an ‘arithmetic mark’. In such situations, the marking instructions will give clear guidance on the assignment of partial marks.

- (l) Ignore the omission of one H atom from a full structural formula provided the bond is shown or one carbon to hydrogen bond missing provided the hydrogen is shown.

- (m) A symbol or correct formula should be accepted in place of a name **unless stated otherwise in the marking instructions.**

- (n) When formulae of ionic compounds are given as answers it will only be necessary to show ion charges if these have been specifically asked for. However, if ion charges are shown, they must be correct. If incorrect charges are shown, no marks should be awarded.
- (o) If an answer comes directly from the text of the question, no marks should be awarded.

Example: A student found that 0.05 mol of propane, C₃H₈ burned to give 82.4 kJ of energy.



Name the type of enthalpy change which the student measured.

No marks should be awarded for 'burning' since the word 'burned' appears in the text.

- (p) Unless the question is clearly about a non-chemistry issue, eg costs in industrial chemical process, a non-chemical answer gains no marks.

Example: Suggest why the (catalytic) converter has a honeycomb structure.

A response such as 'to make it work' may be correct but it is not a chemical answer and the mark should not be awarded.

Marking instructions for each question

Section 1

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

Section 2

Question		Expected response	Max mark	Additional guidance
1.	(a)	86–90 (seconds)	1	Units are not required, but 0 marks can be awarded for the correct answer if incorrect unit is given
	(b)	1.5 cm ³ s ⁻¹ (3) Partial marking: 1.5 with no unit/incorrect unit (2) $\frac{30-0}{20-0}$ or $\frac{30}{20}$ or $\frac{0-30}{0-20}$ (1) Correct unit cm ³ s ⁻¹ (1)	3	Accept cm ³ /s Do not accept cm ³ /s ⁻¹
	(c)	Less reactants or concentration of reactants decreases or reactants are used up or less chance of particles colliding or equivalent answer	1	
2.	(a)	Atoms with same atomic number/number of protons/positive particles but different mass number/number of neutrons	1	
	(b)	Protons = 35 Neutrons = 44	1	Both required for 1 mark
	(c)	Equal amounts/proportions/abundance or same number of each or 50:50 or equivalent answers	1	

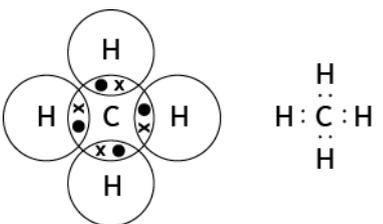
Question	Expected response	Max mark	Additional guidance
(d)	<p>This is an open ended question.</p> <p>1 mark: The candidate has demonstrated a limited understanding of the chemistry involved. The candidate has made a/some statement(s) which is/are relevant to the situation, showing that at least a little of the chemistry within the problem is understood.</p> <p>2 marks: The candidate has demonstrated a reasonable understanding of the chemistry involved. The candidate has made a/some statement(s) which is/are relevant to the situation, showing that the problem is understood.</p> <p>3 marks: The candidate has demonstrated a good understanding of the chemistry involved. The candidate shows a good comprehension of the chemistry of the situation and has provided a logically correct answer to the question posed. This type of response might include a statement of the principles involved, a relationship or an equation, and the application of these to respond to the problem. This does not mean the answer has to be what might be termed an “excellent” answer or a “complete” one.</p>	3	<p>0 marks: The candidate has demonstrated no understanding of the chemistry involved. There is no evidence that the candidate has recognized the area of chemistry involved or has given any statement of a relevant chemistry principle. This mark would also be given when the candidate merely restates the chemistry given in the question.</p>

Question			Expected response	Max mark	Additional guidance
3.	(a)		$\text{Al}^{3+}(\text{OH}^-)_3$	1	
	(b)	(i)	11.2 (pence)	1	
		(ii)	<p>Named active ingredient with an appropriate reason.</p> <p>e.g. magnesium hydroxide – cheapest / doesn't fizz</p> <p>aluminium hydroxide – need to take least amount</p>	1	

Question		Expected response	Max mark	Additional guidance
4.	(a)	a higher	1	
	(b)	(i) For appropriate format: scatter graph – ie a graph in which points are plotted with their x and y values representing temperature and solubility (1) The axis/axes of the graph has/have suitable scale(s). For the graph paper provided within the question paper, the selection of suitable scales will result in a graph that occupies at least half of the width and half of the height of the graph paper (1) The axes of the graph have suitable labels and units (1) All data points plotted accurately with a line of best fit drawn (1)	4	Where the candidate has drawn a bar graph the format mark is not awarded, but the remaining three marks can still be accessed. For bar graphs, this mark is awarded for the selection of a suitable scale on the y-axis. Spelling mistakes or the use of abbreviations should not be penalised if the meaning of an axis label may be clearly understood. Where the candidate has drawn a bar graph, the mark for accurate plotting can be awarded if the heights of bars are plotted accurately but in this case no line of best fit is required.
		(ii) $10.2 - 10.3 \text{ (g/100 cm}^3\text{)}$ or a value correctly read from candidate's graph (allow $\frac{1}{2}$ box tolerance)	1	Units are not required, but 0 marks can be awarded for correct answer if incorrect unit is given.

Question			Expected response	Max mark	Additional guidance
5.	(a)	(i)	$\text{Li}_2\text{CO}_3 + 2\text{HCl} \rightarrow 2\text{LiCl} + \text{CO}_2 + \text{H}_2\text{O}$	1	Accept correct multiples
		(ii)	LiCl or lithium chloride	1	Accept formula for LiCl circled or highlighted in the equation.
	(b)	(i)	0.44 (g) (3) Partial marking: Both <i>GFM</i> s 100 and 44 (1) Correct application of the relationship between moles and mass (1) This could be shown: <ul style="list-style-type: none"> by working containing the two expressions $\frac{1}{\text{candidate's } GFM \text{ for } \text{CaCO}_3}$ and <i>no. moles</i> $\text{CO}_2 \times \text{candidate's } GFM \text{ CO}_2$ or <ul style="list-style-type: none"> by working showing correct proportionality $1 \leftrightarrow \frac{\text{candidate } GFM \text{ CO}_2}{\text{candidate } GFM \text{ CaCO}_3}$ Where the candidate has been awarded the mark for the correct application of the relationship between moles and mass, a further mark can be awarded for correct follow through to a final answer. (1)	3	Units are not required, but a maximum of 2 marks can be awarded for the correct answer if incorrect unit is given.

Question		Expected response	Max mark	Additional guidance
	(ii)	Method B (1) gas is lost in method A before starting mass taken or gas is lost before all acid is added or no total mass of all reactants at the start of experiment or equivalent response (1)	2	

Question		Expected response	Max mark	Additional guidance
6.	(a)	flame test (or correct description) and lilac / purple	1	Both required for 1 mark
	(b)	greater than 7 or any numerical value greater than seven	1	
	(c)	ethene	1	Accept correct formula
	(d)	benzoic acid	1	
	(e)	aluminium, silicon and oxygen	1	Accept correct formulae
7.	(a)	group/family/chemicals/compounds with same general formula and same/similar chemical properties	1	Both parts required for 1 mark
	(b) (i)	Diagram showing carbon with four hydrogen atoms: each of the four overlap areas must have two electrons in or on overlap area (cross, dot, petal diagram). e.g. 	1	The diagram does not need to show tetrahedral shape
	(ii)	weak bond/attraction (1) between molecules (1)	2	

Question		Expected response	Max mark	Additional guidance
8.	(a)	hydroxyl	1	
	(b)	carbon dioxide and water	1	Both required for 1 mark Accept correct formulae.
	(c) (i)	addition or hydration	1	
	(ii)	$ \begin{array}{cccc} \text{H} & \text{H} & \text{H} & \text{H} \\ & & & \\ \text{H}-\text{C} & -\text{C} & -\text{C} & -\text{C}-\text{H} \\ & & & \\ \text{H} & & \text{H} & \text{O}-\text{H} \\ & & & \\ & \text{H}-\text{C}-\text{H} & & \\ & & & \\ & \text{H} & & \end{array} $ <p>or</p> $ \begin{array}{cccc} \text{H} & \text{H} & \text{H} & \text{H} \\ & & & \\ \text{H}-\text{C} & -\text{C} & -\text{C} & -\text{C}-\text{H} \\ & & & \\ \text{H} & & \text{O}-\text{H} & \text{H} \\ & & & \\ & \text{H}-\text{C}-\text{H} & & \\ & & & \\ & \text{H} & & \end{array} $	1	Accept full or shortened structural formula
	(d) (i)	$ \begin{array}{cc} \text{H} & \text{O} \\ & // \\ \text{H}-\text{C} & -\text{C} \\ & \backslash \\ \text{H} & \text{O}-\text{H} \end{array} $	1	Accept full or shortened structural formula
	(ii)	carboxylic acid	1	Accept alkanolic acid

Question		Expected response	Max mark	Additional guidance
9.	(a)	exothermic	1	
	(b)	(i) 33·44 (kJ) (3)	3	Units are not required, but a maximum of 2 marks can be awarded for the correct answer if incorrect unit is given.
		<p>Partial marking:</p> <p>Using $cm\Delta T$ with $c = 4\cdot18$ (1)</p> <p>To be awarded this concept mark, candidates do not specifically need to write $cm\Delta T$. The concept mark is awarded for using this relationship with three values, one of which must be 4·18</p> <p>For values 0·2 (kg) and 40 (°C) (1)</p> <p>A further mark can be awarded for arithmetical follow through to the candidate's answer only if the mark for the $cm\Delta T$ concept has been awarded. (1)</p>		
		(ii) draught insulation or use metal beaker or repeat to get average or any reasonable answer.	1	

Question		Expected response	Max mark	Additional guidance
	(c) (i)	<p>As the number of carbons increases the energy released increases.</p> <p>or</p> <p>As the number of carbons decreases the energy released decreases.</p> <p>or</p> <p>The energy increases as the number of carbons increases.</p> <p>or</p> <p>The energy decreases as the number of carbons decreases.</p>	1	<p>Do not accept:</p> <p>As the energy released increases the number of carbons increases.</p> <p>or</p> <p>As the energy released decreases the number of carbons decreases.</p>
	(ii)	3520 to 3550 (kJ)	1	Units are not required, 0 marks can be awarded for the correct answer if incorrect unit is given.

Question		Expected response	Max mark	Additional guidance
10.	(a)	$ \begin{array}{c} \text{H} \\ \\ \text{H}-\text{C}-\text{H} \\ \\ \text{H} \quad \text{H} \quad \text{H} \\ \quad \quad \\ \text{H}-\text{C}=\text{C}-\text{C}=\text{C}-\text{H} \end{array} $ <p>or</p> $ \begin{array}{c} \text{H} \quad \text{CH}_3 \quad \text{H} \quad \text{H} \\ \quad \quad \quad \\ \text{H}-\text{C}=\text{C}-\text{C}=\text{C}-\text{H} \end{array} $ <p>In the formula above, the bond to the methyl group must be correctly aligned with the C atom of the group.</p>	1	Zero marks awarded for $ \begin{array}{c} \text{CH}_3 \\ \\ \text{H}_2\text{C}=\text{C}-\text{CH}=\text{CH}_2 \end{array} $ or $ \begin{array}{c} \text{CH}_3 \quad \text{H} \\ \quad \\ \text{H}_2\text{C}=\text{C}-\text{C}=\text{CH}_2 \end{array} $
	(b)	<p>Diagram showing delivery tube passing into a test tube which is placed in a water/ice bath.</p> <p>The delivery tube must extend close enough to the neck of the test tube to ensure the vapour can enter the test tube.</p>	1	<p>Do not penalise if boiling tube/measuring cylinder etc has been used in place of test tube.</p> <p>Diagram does not need to be labelled.</p> <p>Delivery tube must be open with no lines drawn across it.</p> <p>Ignore a stopper as long as it does not close off the delivery tube.</p>
	(c)	$\text{C}_{10}\text{H}_{16}\text{Br}_4$	1	
11.	(a)	reduction	1	
	(b) (i)	d.c.	1	
	(ii)	Negative - (brown solid formed) Positive - (bubbles of gas)	1	Both required for one mark

Question		Expected response	Max mark	Additional guidance	
12.	(a)	46.67 / 46.7 / 47 (3)	3		
		Partial marking: $GFM = 60$ (1) $\frac{28}{\text{candidate's } GFM} \times 100$ (1) Calculation of final answer using the relationship $\% \text{ by mass} = \frac{m}{GFM} \times 100$ (1)			
	(b)	(i)	Haber (-Bosch)	1	
		(ii)	Speeds up reaction or Less energy/temperature/ heat required	1	
	(c)		platinum	1	Accept platinum and rhodium (alloy)
13.	(a)	(i)	burette	1	
		(ii)	16 or 16.0 (cm ³)	1	Units are not required, 0 marks can be awarded for the correct answer if incorrect unit is given.
	(b)		titration	1	

Question		Expected response	Max mark	Additional guidance
14.	(a)	<p>0.5 (g) (2)</p> <hr/> <p>Partial marking:</p> <p>1 mark can be awarded for either:</p> <ul style="list-style-type: none"> • 2 half lives <p>or</p> <ul style="list-style-type: none"> • mass correctly calculated for an incorrect number of half-lives shown. 	2	Units are not required but a maximum of 1 mark can be awarded for the correct answer if incorrect unit is given.
	(b)	<p>short half-life</p> <p>or</p> <p>would not last long in the body</p> <p>or</p> <p>gamma would go right through body</p> <p>or</p> <p>equivalent response</p>	1	
	(c)	<p>beta / β / ${}^0_{-1}e$ / ${}^0_{-1}\beta$</p>	1	<p>The charge on the beta particle does not need to be shown.</p> <p>Do not accept electron without atomic and mass numbers, ie e or e⁻</p>

Question		Expected response	Max mark	Additional guidance
15.	(a)	0.01 (mol) (2)	2	Units are not required but a maximum of 1 mark can be awarded for the correct answer if incorrect unit is given.
		Partial marking: 1 mark can be awarded for either <ul style="list-style-type: none"> • 143.5 g or <ul style="list-style-type: none"> • correctly calculated answer for $\frac{1.435}{\text{incorrect GFM}}$ 		
	(b)	0.5 (mol l ⁻¹) (2)	2	Units are not required but a maximum of 1 mark can be awarded for the correct answer if incorrect unit is given.
		Partial marking: 1 mark can be awarded for either <ul style="list-style-type: none"> • $\frac{0.01}{0.02}$ or <ul style="list-style-type: none"> • correctly calculated answer for $\frac{0.01}{20}$ 		Allow follow through from answer to 15(a) If correct relationship is used but volume not converted to litres eg 0.01/20 maximum 1 mark

Question	Expected response	Max mark	Additional guidance
16.	<p>This is an open ended question.</p> <p>1 mark: The candidate has demonstrated a limited understanding of the chemistry involved. The candidate has made a/some statement(s) which is/are relevant to the situation, showing that at least a little of the chemistry within the problem is understood.</p> <p>2 marks: The candidate has demonstrated a reasonable understanding of the chemistry involved. The candidate has made a/some statement(s) which is/are relevant to the situation, showing that the problem is understood.</p> <p>3 marks: The candidate has demonstrated a good understanding of the chemistry involved. The candidate shows a good comprehension of the chemistry of the situation and has provided a logically correct answer to the question posed. This type of response might include a statement of the principles involved, a relationship or an equation, and the application of these to respond to the problem. This does not mean the answer has to be what might be termed an “excellent” answer or a “complete” one.</p>	3	<p>0 marks: The candidate has demonstrated no understanding of the chemistry involved. There is no evidence that the candidate has recognized the area of chemistry involved or has given any statement of a relevant chemistry principle. This mark would also be given when the candidate merely restates the chemistry given in the question.</p>

[END OF SPECIMEN MARKING INSTRUCTIONS]