

# GCSE Separate Science

## AQA

## 2024 Predicted Paper

Paper 1: Higher Tier

Chemistry



Scan me for  
walkthrough



Name:.....

Date:.....

**1 hour 45 minutes allowed**

You may use a calculator and an AQA periodic table

### Rough Grade Boundaries

These do not guarantee you  
the same mark in the exam.

9 - 70%

8 - 60%

7 - 50%

6 - 45%

5 - 35%

4 - 30%

3 - 25%

Question	Possible Marks	Marks Gained
1	9	
2	9	
3	11	
4	16	
5	13	
6	10	
7	13	
8	19	
<b>Total</b>	<b>100</b>	





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**01** Calcium reacts with oxygen to form calcium oxide.

Calcium is a metal.

- a)** Describe how the position of calcium on the periodic table tell us it is a metal.

**[1 mark]**

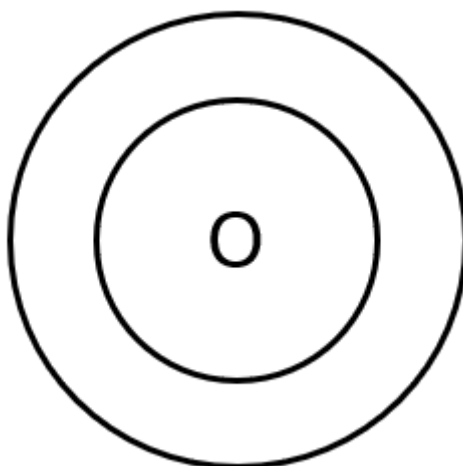
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- b)** The electronic structure of calcium is 2, 8, 8, 2.

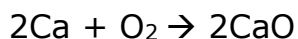
Complete the diagram below to show the electronic structure of **oxygen**.

**[2 marks]**





- c) The reaction between calcium and oxygen is given by:



- i) Describe in terms of electron transfer, what happens when calcium reacts with oxygen.

**[4 marks]**

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- ii) Draw a dot and cross diagram of calcium oxide, CaO.  
Show outer electrons **only**.

**[2 marks]**



**02** The reaction of sodium carbonate with ethanoic acid is an example of an endothermic reaction.

**a)** A method used to investigate the temperature change when 10g of sodium carbonate is added to 50cm<sup>3</sup> ethanoic acid is:

- 1.** Place a polystyrene cup inside a glass beaker.
- 2.** Measure 50cm<sup>3</sup> of ethanoic acid and place in the cup.
- 3.** Measure 10g of sodium carbonate.
- 4.** Put a thermometer in the cup.
- 5.** Record the temperature of the ethanoic acid.
- 6.** Add the sodium carbonate to the cup.
- 7.** Stir.
- 8.** Record the highest and lowest temperature reached by the solution.

**i)** Give two ways that the method could be changed to improve the accuracy of the results.

**[2 marks]**

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**ii)** Suggest why a polystyrene cup was used.

**[1 mark]**

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**b)** Explain what is meant by an endothermic reaction.

**[1 mark]**

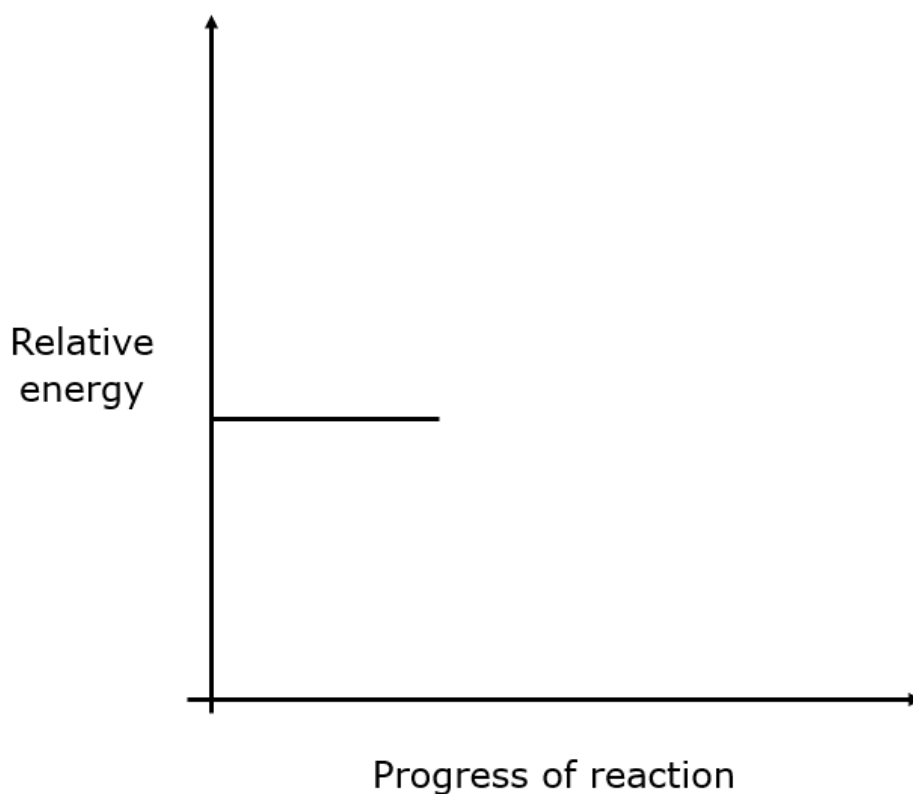
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- c) Complete the enthalpy profile diagram for an endothermic reaction like that observed between sodium carbonate and ethanoic acid. Label the activation energy.

**[2 marks]**



- d) During the reaction of sodium carbonate with ethanoic acid, water is formed.

Calculate how many molecules there are in 100g of water.

**[3 marks]**

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**03** Group 0 molecules are known as the noble gases.

**a)** Noble gases, such as helium, are monoatomic and unreactive.

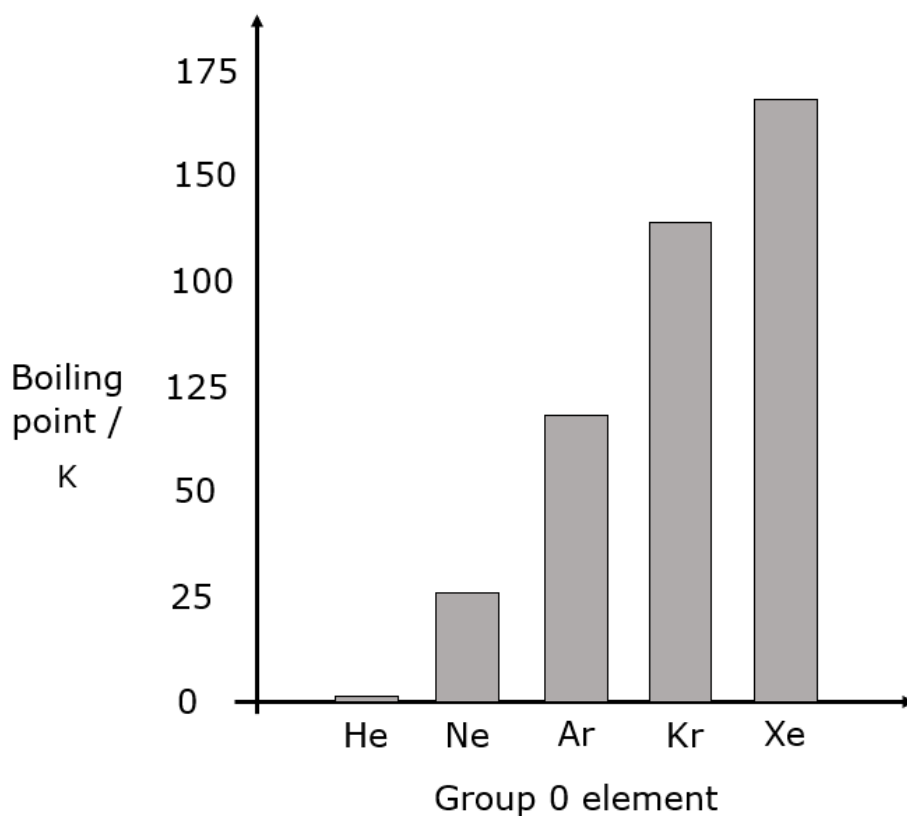
Explain why noble gases are unreactive.

**[1 mark]**

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**b)** The graph below shows the trend of boiling points for the noble gases:



**i)** Describe the relationship between the boiling point of the noble gases and the number of shells.

**[1 mark]**

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- ii) Using your knowledge of intermolecular forces, explain this relationship.

**[3 marks]**

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- c) Group 7 such as fluorine, chlorine, and bromine are diatomic molecules.

- i) State what the Group 7 elements are also known as.

**[1 mark]**

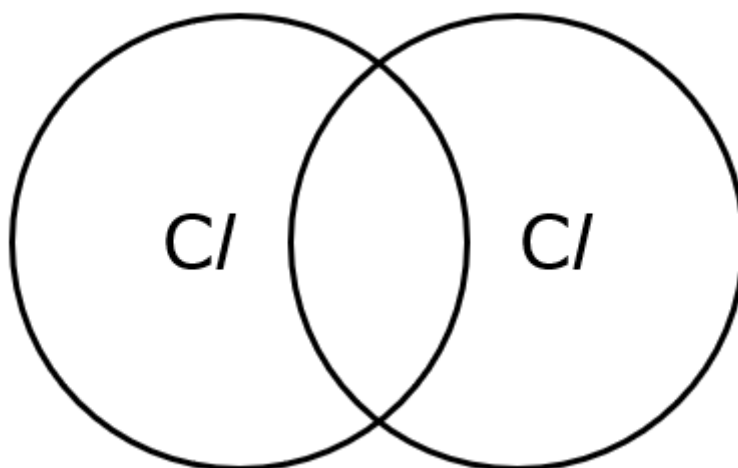
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- ii) Complete the dot and cross diagram for chlorine,  $\text{Cl}_2$ .

Only include the electrons in their **outer** shells.

**[2 marks]**







- d)** When  $\text{Cl}_2$  reacts with potassium iodide,  $\text{KI}$ , a reaction takes place and chlorine displaces iodine.

Explain why chlorine displaces iodine from potassium iodide.

**[3 marks]**

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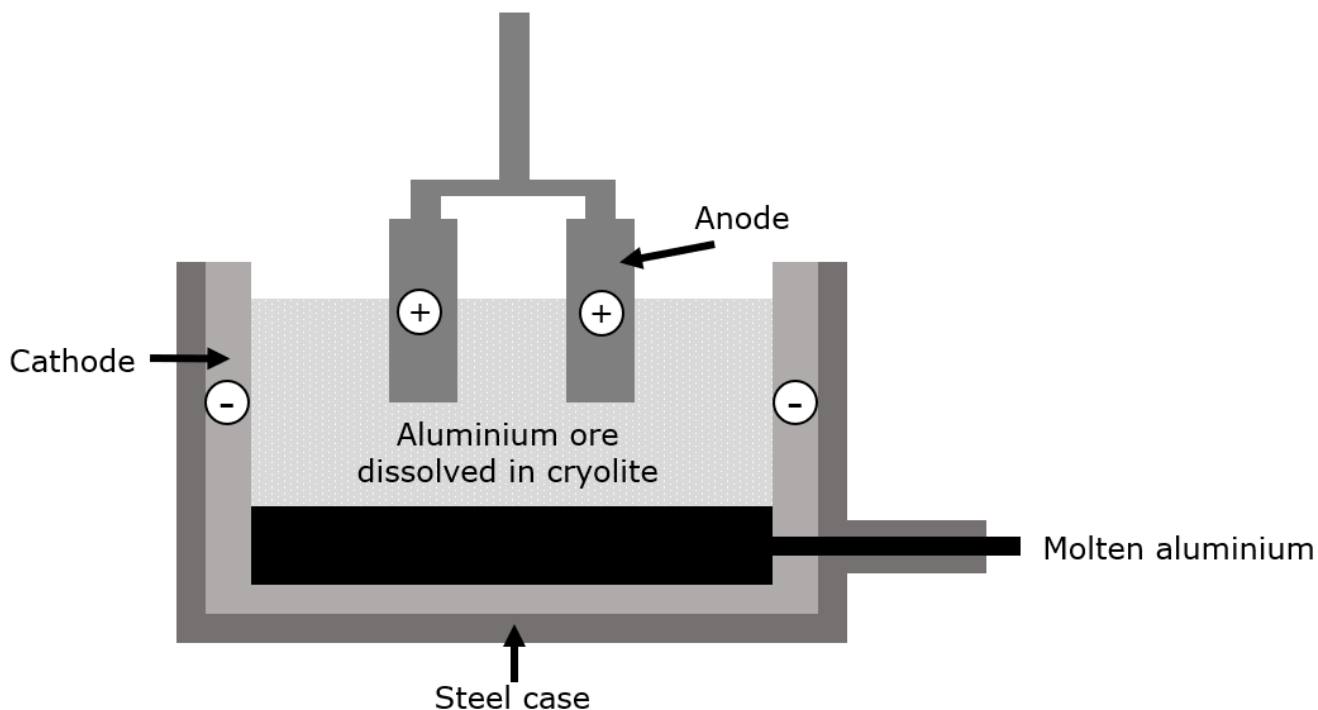
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**04** Bauxite is aluminium ore.

To extract aluminium, the bauxite needs to be purified to aluminium oxide. The process is shown below.



- a)** The process of electrolysis is used to extract aluminium.
- i)** Explain why reduction with carbon cannot be used to extract aluminium.

**[1 mark]**

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- ii)** Name the material that the electrodes are made of for the electrolysis of aluminium.

**[1 mark]**

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- iii)** Molten cryolite is added to the aluminium oxide to make the electrolyte.

Explain why cryolite is added to the aluminium oxide.

**[2 marks]**

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- iv)** Complete the half equations for the reaction that takes place at each electrode.

**[2 marks]**

**Cathode:**

.....  $\rightarrow$  Al

**Anode:**

$2\text{O}^{2-} \rightarrow$  .....



- b)** The balanced equation for the extraction of aluminium from aluminium oxide,  $\text{Al}_2\text{O}_3$ , is:



- i)** 2500kg of aluminium oxide was electrolysed.  
(Relative atomic masses ( $A_r$ ): Al = 27 O = 16)

Work out the expected mass of aluminium produced.  
Give your answer in kg.

**[3 marks]**

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- ii)** The percentage yield of the reaction is 95%.

Use your answer to **04.2a)** to calculate the actual mass of aluminium produced during the electrolysis.

If you have no answer for **04.2a)** assume the expected mass of aluminium produced is 1500kg.

**[2 marks]**

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- iii) Give **two** reasons why electrolysis does not have a 100% yield.  
**[2 marks]**

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- iv) Oxygen is also produced during the electrolysis of aluminium oxide.

Assuming a percentage yield of 100%, calculate the mass of aluminium oxide required to produce 500dm<sup>3</sup> of oxygen at room temperature and pressure.

(1 mole of gas occupies 24dm<sup>3</sup> at room temperature and pressure).

**[3 marks]**

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**05** Diamond and graphite are allotropes of carbon.

The table below compares some of their properties:

Allotrope	Electrical conductivity	Melting point / °C	Hardness
Diamond	Doesn't conduct	4000	Very hard
Graphite	Good conductor	3600	Soft

- a)** Use your knowledge of the structure and bonding of diamond and graphite to explain the differences between the properties shown in the table.

**[6 marks]**

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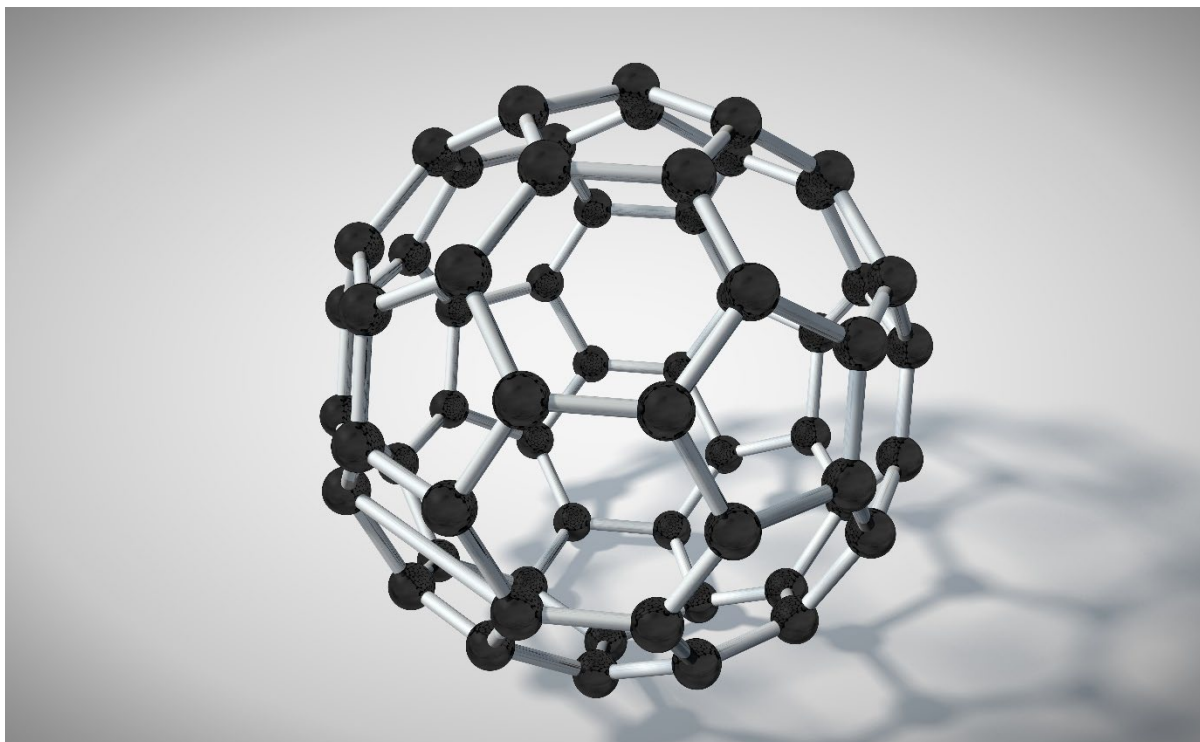
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- b)** Another allotrope of carbon is Buckminsterfullerene, shown below.



- i)** Identify the formula of Buckminsterfullerene.  
Tick **one** box only.

**[1 mark]**

<b>C<sub>6</sub></b>	
<b>C<sub>10</sub></b>	
<b>C<sub>20</sub></b>	
<b>C<sub>60</sub></b>	



- ii)** Buckminsterfullerene has a low melting point and is slippery. Explain why.

**[2 marks]**

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Buckminsterfullerene was one of the first nanoparticles discovered.

It is used to deliver drugs in the body, acts as a catalyst and as a lubricant.

- iii)** State the size range of nanoparticles.

**[1 mark]**

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- iv)** State the property of a nanoparticle which makes it good to use as a catalyst.

**[1 mark]**

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- v)** Some people have expressed concerns about the widespread use of nanoparticles.

Give two possible risks of the use of nanoparticles.

**[2 marks]**

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**06** The air in the atmosphere is an example of a mixture of substances, including oxygen, nitrogen, carbon dioxide and trace amount of argon.

**a)** Describe the difference between a mixture and a compound. **[1 mark]**

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**b)** The different substances in the air can be separated.

**i)** Identify the process that can be used to separate the substances in the air from each other.

Tick **one** box only.

**[1 mark]**

<b>Filtration</b>	
<b>Crystallisation</b>	
<b>Simple distillation</b>	
<b>Fractional distillation</b>	

**ii)** State the property of the substances in air which enables them to be separated using this method.

**[1 mark]**

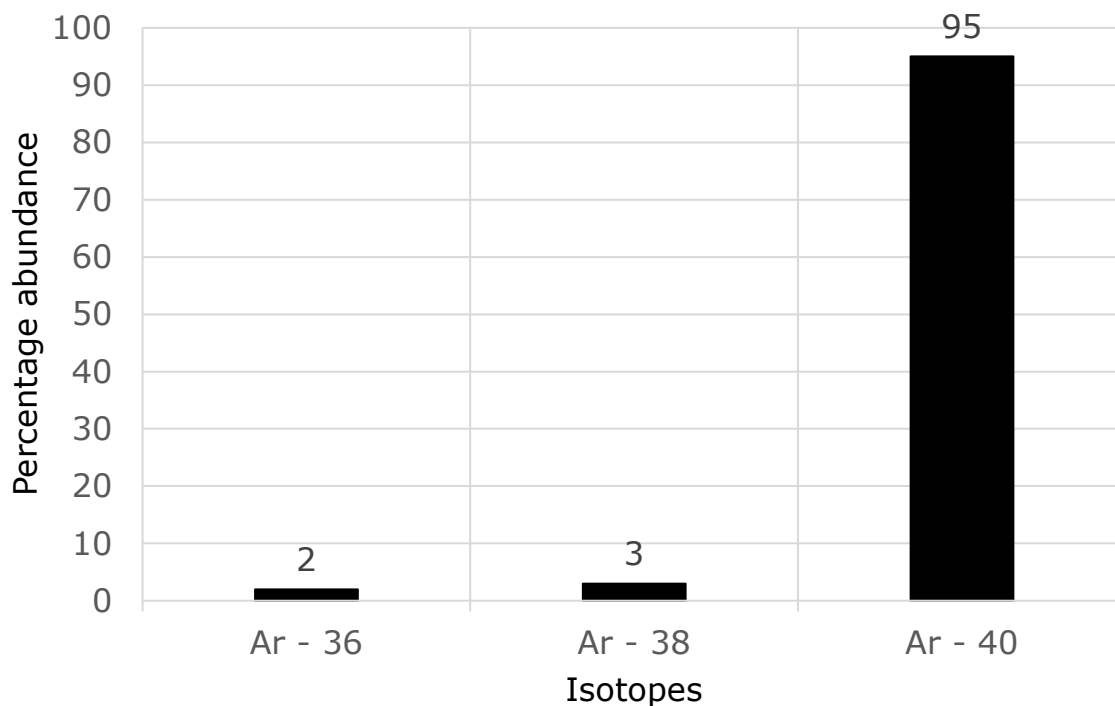
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- c) The mass spectrum of a sample of argon is shown below.

The mass spectrum shows the percentage abundance of the isotopes of the element Argon, Ar.



- i) State the definition of the term 'isotope', in terms of particles.

**[2 marks]**

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- ii)** Using the mass spectrum provided, calculate the relative atomic mass of argon.

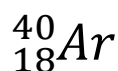
**[2 marks]**

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- d)** In the periodic table, argon is represented as:



Write down the number of protons, neutrons and electrons in an atom of argon-40.

**[3 marks]**

**Number of protons:** .....

**Number of neutrons:** .....

**Number of electrons:** .....



**07** Sulfuric acid,  $\text{H}_2\text{SO}_4$ , is an example of a strong acid.

**a)** Name the ion present in sulfuric acid that makes it an acid.

**[1 mark]**

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**b)** When an alkali is added to the acid a neutralisation reaction takes place.

**i)** Write down the ionic equation that represents a neutralisation reaction.  
Include state symbols.

**[2 marks]**

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**ii)** Identify the pH of the solution formed in a neutralisation reaction.

Tick **one** box only.

**[1 mark]**

<b>1</b>	
<b>5</b>	
<b>7</b>	
<b>14</b>	



- c) Four test tubes, each with a different metal had 20cm<sup>3</sup> of dilute sulfuric acid added to them.

Their observations were recorded below:

Metal	Observation
Sodium	Violent reaction
Gold	No reaction
Zinc	Bubbles of gas formed and metal dissolves
Calcium	Bubbles of gas rapidly released, and heat given off

- i) Write the names of the four metals in order of reactivity, using the information provided in the table.

**[2 marks]**

**Most reactive** .....

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**Least reactive** .....

- ii) Give the word equation for the reaction between zinc and sulfuric acid.

**[2 marks]**

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- d) Explain the difference between a strong acid and a weak acid.

**[2 marks]**

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- e)** Calculate the percentage by mass of hydrogen in sulfuric acid,  $\text{H}_2\text{SO}_4$ .  
(Relative atomic masses:  $\text{H}=1$     $\text{S}=32$     $\text{O}=16$ )

**[3 marks]**

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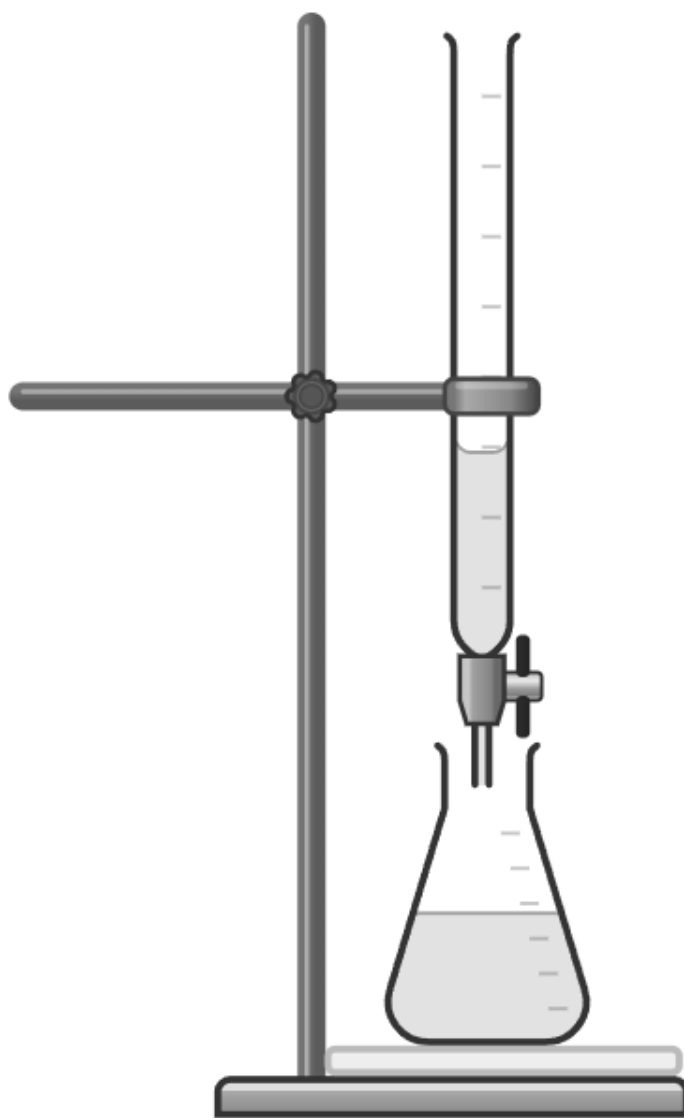
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- 08** A student carried out a titration by adding sodium hydroxide, NaOH, with a concentration of  $0.2\text{mol/dm}^3$  to  $25\text{cm}^3$  hydrochloric acid, HCl.



*Image made using chemix.org*





Describe the method they used to carry out the titration. Include all the apparatus used in your method.



- ii)** There are some potential hazards that can occur when carrying out a titration.

Name a risk present during this titration **and** describe what precautions can be taken to minimise the risk.

**[1 mark]**

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- iii)** Suggest why universal indicator is not a suitable indicator for a titration.

**[1 mark]**

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The student's results are given below.

Titration	Volume of NaOH added (cm <sup>3</sup> )
1	32.05
2	32.65
3	32.55
4	32.58
Mean	

- iv)** Calculate the mean volume of NaOH added.  
Give your answer to 2 decimal places.

**[2 marks]**

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- v)** Explain the importance of repeating your titrations until you obtain concordant results.

**[2 marks]**

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- vi)** Write down the balanced equation for the reaction between HCl and NaOH.  
Include state symbols.

**[2 marks]**

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**vii)** Calculate the concentration of HCl.

**[3 marks]**

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**b)** The concentration of sodium hydroxide is  $0.2\text{mol/dm}^3$ .  
Convert this to  $\text{g/dm}^3$ .

**[2 marks]**

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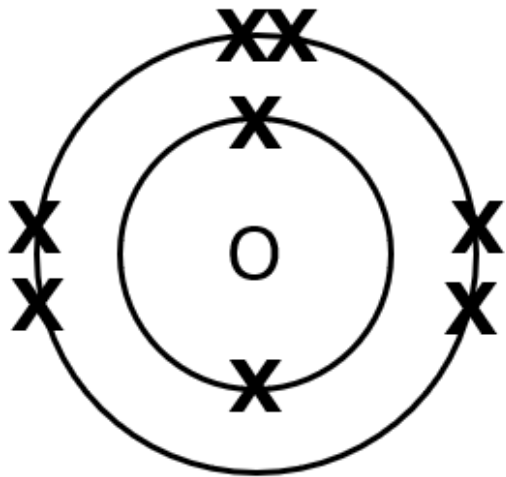
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**END OF QUESTIONS**



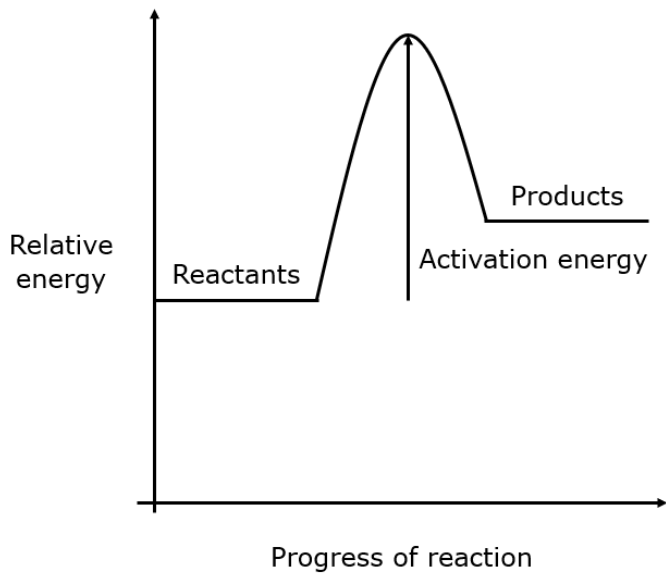
## MARKING GUIDANCE

Question	Answer	Additional Guidance	Marks
01a	Metals (like calcium) are found on the left-hand side of the periodic table		1
01b		2 electrons in the 1 <sup>st</sup> shell 6 electrons in the 2 <sup>nd</sup> shell	2
01ci	Calcium loses 2 electrons Oxygen gains 2 electrons		4



01cii	<p>The diagram shows a calcium ion, <math>[Ca]^{2+}</math>, and an oxide ion, <math>[O]^{2-}</math>. The oxide ion is represented by a circle with the letter 'O' in the center, surrounded by eight 'x' marks representing electrons. The entire circle is enclosed in large square brackets with a '2-' charge indicated outside the top right corner.</p>	1 mark for no outer electrons on calcium and 2+ charge 1 mark for 8 outer electrons on oxygen with 2- charge	2
<b>TOTAL</b>			<b>9</b>



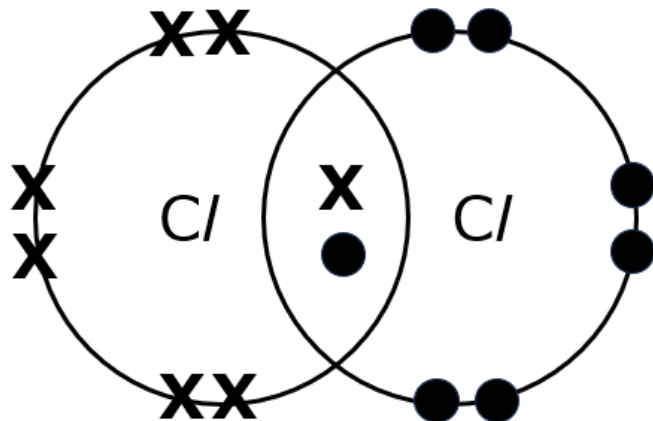
Question	Answer	Additional Guidance	Marks
02ai	Any 2 from: 1. Add a lid 2. Repeat and calculate a mean 3. Use a more accurate thermometer (digital) 4. Use a more accurate balance	Allow other suitable suggestions	2
02aii	To reduce heat loss to the surroundings		1
02b	A reaction that takes in energy from the surroundings		1
02c		1 mark for products line above the reactant line. 1 mark for the activation energy arrow drawn correctly and labelled.	2



02d	Relative formula mass of water = $(2 \times 1) + 16 = 18$  Moles of water = $100 / 18 = 5.56$  Number of molecules of water = $5.56 \times 6.02 \times 10^{23} = 3.35 \times 10^{24}$		3
<b>TOTAL</b>			<b>9</b>





Question	Answer	Additional Guidance	Marks
03a	They have a full outer shell of electrons.		1
03bi	As the number of shells increase the boiling point increases.		1
03bii	<ul style="list-style-type: none"> <li>Greater the number of shells, greater is the size of particles.</li> <li>Greater size of particles, stronger are the <b>intermolecular forces</b>.</li> <li>Hence, more heat/greater thermal energy required to boil/change the state from liquid to gas.</li> </ul>		3
03ci	Halogens		1
03cii		One shared pair of electrons in the overlap between the two circles. 6 other electrons on each circle.	2



03d	<ul style="list-style-type: none"><li>• Chlorine has fewer shells than iodine.</li><li>• Chlorine has a greater attraction between its outer shell electrons and the nucleus.</li><li>• Chlorine is therefore able to gain an electron more easily than iodine.</li></ul>		3
<b>TOTAL</b>			<b>11</b>



Question	Answer	Additional Guidance	Marks
04ai	Aluminium is more reactive than carbon.		1
04aii	Graphite		1
04aiii	<ul style="list-style-type: none"><li>• Cryolite lowers the melting point of the electrolyte.</li><li>• This decreases the cost of extraction as less energy is required.</li></ul>		2
04aiv	$\text{Al}^{3+} + 3\text{e} \rightarrow \text{Al}$ $2\text{O}^{2-} \rightarrow \text{O}_2 + 4\text{e}$		2
04bi	Moles of aluminium oxide = $2500000/102 = 24510$  Moles of aluminium = 49020  Mass of aluminium = 1323540g = 1323.54kg		3
04bii	$1323.54 \times 0.95$ $= 1257.36(3) \text{ kg}$		2
04biii	2 from: <ul style="list-style-type: none"><li>• Loss of product in separation from reaction mixture</li><li>• side reactions</li><li>• may not go to completion</li></ul>		2
04biv	$500 \div 24 = 20.833333$ moles of oxygen  $= 13.88888$ moles of $\text{Al}_2\text{O}_3$ required  $\times 102 = 1416.67\text{g}$ (1.417kg)		3
<b>TOTAL</b>			<b>16</b>



Question	Answer	Additional Guidance	Marks
05a	<p>Relevant content:</p> <p><b>Diamond</b></p> <ul style="list-style-type: none"><li>• Each carbon in diamond forms 4 strong covalent bonds</li><li>• Diamond has a giant covalent structure.</li><li>• Diamond has a high melting point and is very hard as it takes a lot of energy to break the strong covalent bonds.</li><li>• Diamond has no delocalised electrons, so it doesn't conduct electricity.</li></ul> <p><b>Graphite:</b></p> <ul style="list-style-type: none"><li>• Each carbon atom in graphite forms 3 strong covalent bonds with 3 other carbon atoms.</li><li>• Graphite has a lower melting point and is soft because layers form in graphite which have weak intermolecular forces between them. It doesn't take much energy to overcome these forces.</li><li>• One electron from each carbon atom is delocalised and free to move through the layers and carry charge – this is why graphite is a good conductor of electricity.</li></ul>	<p>Level 3: All relevant points are identified, and a high level of detail given (5-6 marks)</p> <p>Level 2: Some relevant points given though answer not completely clear. (3-4 marks)</p> <p>Level 1: Some relevant points given know they are not logically linked and not clear why they are relevant (1-2 marks)</p>	6



05bi	C <sub>60</sub>		1
05bii	There are weak intermolecular forces between buckminsterfullerene molecules. They need only a little energy to overcome.		2
05biii	1-100nm		1
05biv	The large surface area to volume ratio.		1
05bv	Any 2 from: <ul style="list-style-type: none"><li>• They may be able to catalyse harmful reactions in the body</li><li>• Toxic substances may be able to bind to them and enter the body</li><li>• They could enter and accumulate in our lungs and cause damage</li></ul>		2
<b>TOTAL</b>			<b>13</b>



Question	Answer	Additional Guidance	Marks
06a	A mixture is made up of two or more elements or compounds not chemically combined. A compound the elements are chemically combined.		1
06bi	Fractional distillation		1
06bii	They have different boiling points.		1
06ci	An atom of the same element with the same number of protons But a different number of neutrons.		2
06cii	Relative atomic mass = $\frac{(2 \times 36) + (3 \times 38) + (95 \times 40)}{100}$ Relative atomic mass = 39.86		2
06d	Number of protons - 18 Number of neutrons - 22 Number of electrons - 18		3
<b>TOTAL</b>			<b>10</b>



Question	Answer	Additional Guidance	Marks
07a	Hydrogen ions / $H^+$		1
07bi	$H^+_{(aq)} + OH^-_{(aq)} \rightarrow H_2O_{(l)}$	1 mark for equation 1 mark for state symbols	2
07bii	7		1
07ci	Sodium Calcium Zinc Gold		2
07cii	Zinc + sulfuric acid $\rightarrow$ zinc sulfate + hydrogen		2
07d	A strong acid is completely/fully ionised in aqueous solution. A weak acid is only partially ionised in aqueous solution.	Allow completely/fully dissociates into its ions Allow partially dissociates into its ions	2
07e	Relative formula mass of sulfuric acid = $(2 \times 1) + 32 + (4 \times 16) = 98$ Percentage by mass of hydrogen = $2/98 \times 100$ Percentage by mass of hydrogen = 2.04%		3
<b>TOTAL</b>			<b>13</b>



Question	Answer	Additional Guidance	Marks
08ai	<ul style="list-style-type: none"> <li>• Measure 25cm<sup>3</sup> of hydrochloric acid using a pipette.</li> <li>• Add the hydrochloric to a conical flask.</li> <li>• Add a few drops of indicator to the conical flask.</li> <li>• Use a burette to add sodium hydroxide to the acid drop by drop</li> <li>• Until the indicator changes colour</li> <li>• Record the volume of sodium hydroxide used from the burette</li> <li>• Repeat several times until you have concordant results</li> <li>• Calculate the mean.</li> </ul>	<p>Level 3: All relevant points are identified, and a high level of detail given (5-6 marks)</p> <p>Level 2: Some relevant points given though answer not completely clear. (3-4 marks)</p> <p>Level 1: Some relevant points given know they are not logically linked and not clear why they are relevant (1-2 marks)</p> <p>Allow suitable named indicator and correct colour change.</p>	6
08aii	<p>The sodium hydroxide/hydrochloric acid could cause eye and skin irritation</p> <p>Minimise risk by wearing gloves/goggles</p>	<p>Allow other suitable risks and precautions</p> <p>Risk AND precaution needed for mark.</p>	1
08aiii	It has a range of colours/doesn't show a distinct colour change		1
08aiv	$\frac{32.55 + 32.65 + 32.58}{3}$ $= 32.59\text{cm}^3$	1 mark if mean taken of all 4 values (32.46)	2
08av	<p>It ensures that's our mean final titre is accurate.</p> <p>This will decrease the effect on our result by random errors</p>		2
08avi	$\text{HCl}_{(\text{aq})} + \text{NaOH}_{(\text{aq})} \rightarrow \text{NaCl}_{(\text{aq})} + \text{H}_2\text{O}_{(\text{l})}$	<p>1 mark for equation</p> <p>1 mark for state symbols</p>	2





08avii	Moles of NaOH = $\frac{0.2 \times 32.59}{1000} = 6.518 \times 10^{-3}$  Moles of HCl = $6.518 \times 10^{-3}$  Concentration of HCl = $\frac{6.518 \times 10^{-3}}{25} \times 1000$ = 0.26 mol/dm <sup>3</sup>	Allow ecf from 07.6d	3
08b	0.2 x 40  8g/dm <sup>3</sup>		2
<b>TOTAL</b>			<b>19</b>