



**There are no questions on this page**

**0 1**

This question is about calcium.

**0 1****. 1**

What type of compound is calcium oxide?

**[1 mark]**Tick **one** box.An acid A base A carbonate A salt **0 1****. 2**

Ionic compounds, such as calcium oxide, have high melting points.

Complete the sentences. Use words from the box.

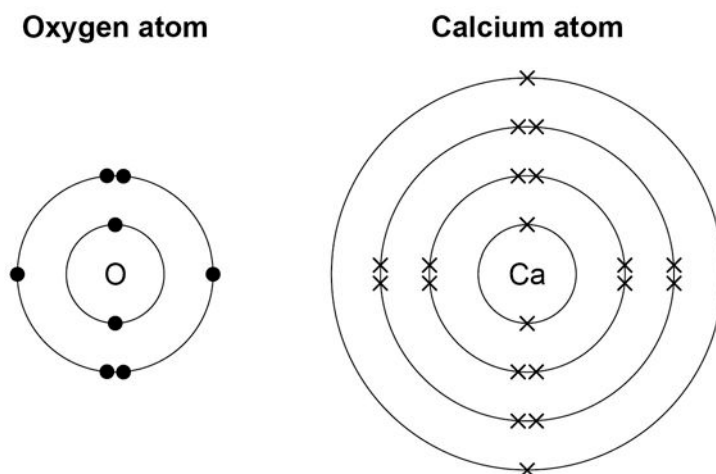
**[1 mark]****bonds****forces****ions****layers**

Calcium oxide has a giant ionic lattice in which there are strong electrostatic \_\_\_\_\_ of attraction in all directions.

**Question 1 continues on the next page**

**0 1 . 3** Figure 1 shows the electronic structure of an oxygen atom and a calcium atom.

**Figure 1**



Describe how the calcium atom and the oxygen atom forms calcium oxide.

You should give the charge on each ion formed.

**[4 marks]**

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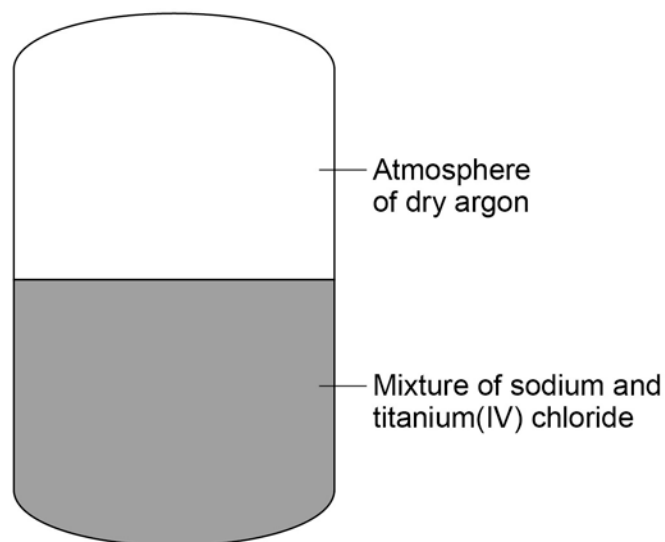
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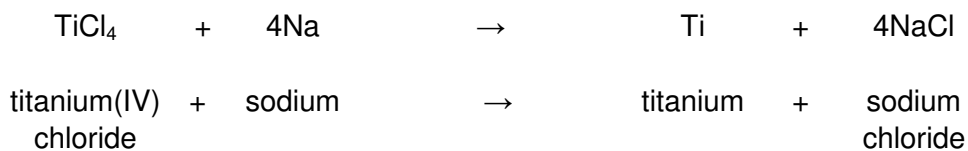
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**0 2****Figure 2** shows a reactor used to produce titanium from titanium(IV) chloride.**Figure 2**

The chemical equation for the reaction of titanium(IV) chloride with sodium is:

**0 2** . **1**

For one reaction:

- 1615 kg titanium(IV) chloride reacted completely with 782 kg sodium
- 1989 kg sodium chloride was produced.

Calculate the mass of titanium produced from this reaction.

**[1 mark]**

\_\_\_\_\_

\_\_\_\_\_

Mass of titanium = \_\_\_\_\_ kg

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**0 2** . **2** **Table 1** shows the solubility of sodium chloride in 100 cm<sup>3</sup> of aqueous solution at different temperatures.

**Table 1**

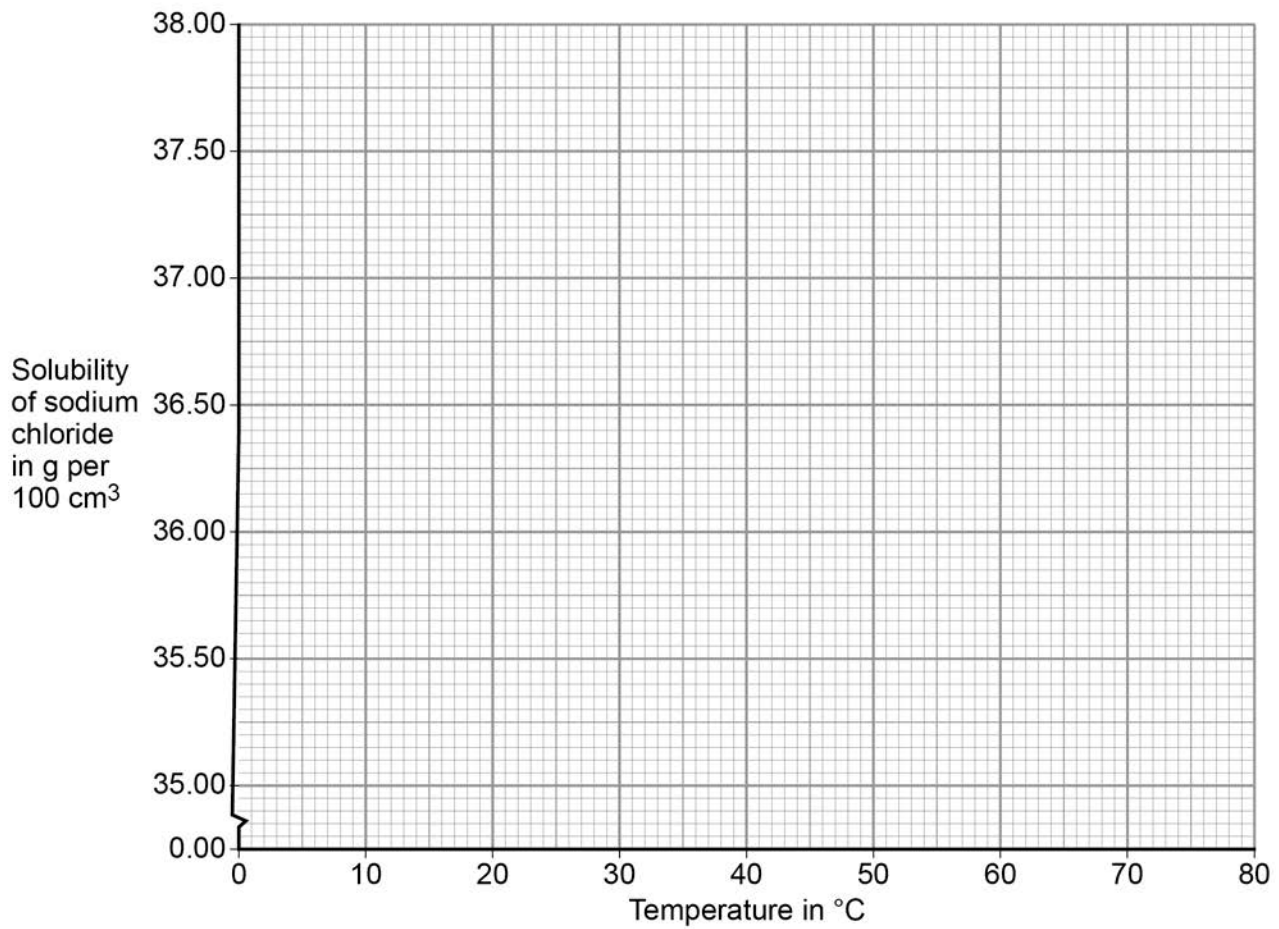
<b>Solubility of sodium chloride in g per 100cm<sup>3</sup></b>	<b>Temperature in °C</b>
35.72	10
35.89	20
36.09	30
37.37	40
36.69	50
37.04	60

On **Figure 3**:

- plot this data on the grid
- draw a line of best fit.

[3 marks]

**Figure 3**



**Question 2 continues on the next page**

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- 0 2** . **3** The product sodium chloride is dissolved in water to separate it from titanium.

At 30 °C the solubility of sodium chloride is 36 kg per 100 dm<sup>3</sup>.

Calculate the minimum volume of water in dm<sup>3</sup>, at 30 °C, needed to dissolve 1989 kg sodium chloride.

**[2 marks]**

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Volume of water = \_\_\_\_\_ dm<sup>3</sup>

- 0 2** . **4** Calculate the percentage by mass of titanium in titanium(IV) chloride (TiCl<sub>4</sub>).

Give your answer to 3 significant figures.

Relative atomic masses (*A<sub>r</sub>*): Cl = 35.5; Ti = 48

**[3 marks]**

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Percentage of titanium by mass = \_\_\_\_\_ %



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**0 2** . **5** Suggest why the reaction is done in an atmosphere of dry argon instead of air containing water vapour.

**[3 marks]**

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**0 2** . **6** Explain why titanium conducts electricity.

**[3 marks]**

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**Turn over for the next question**

**0 3**

Elements are made up of atoms.

**0 3**. **1**

What is the approximate radius of an atom?

**[1 mark]**Tick **one** box. $1 \times 10 \text{ m}$   $1 \times 10^{-1} \text{ m}$   $1 \times 10^{-10} \text{ m}$   $1 \times 10^{-100} \text{ m}$  **Figure 4** shows the atoms of five elements.**Figure 4**The letters are **not** the symbols of these elements.**0 3**. **2**

Complete the sentence.

**[1 mark]**

All of the elements in **Figure 3** are in Group \_\_\_\_\_  
of the periodic table.



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Copper can be produced from copper(II) sulfate solution by two different methods.

### Method 1 – Electrolysis

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To produce copper by electrolysis a student has inert electrodes, a d.c. power supply, a switch and electrical wires for the external circuit.

Draw and label the apparatus set up to produce copper from copper(II) sulfate solution by electrolysis.

**[2 marks]**

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Suggest why the colour of the copper(II) sulfate solution fades during the electrolysis.

**[3 marks]**

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**0 4 . 3**

Explain how copper is produced from copper(II) sulfate solution by electrolysis.

**[4 marks]**

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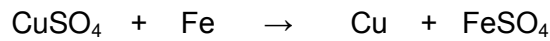
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**Method 2 – Displacement****0 4 . 4**

The chemical equation for the displacement of copper using iron is:



Calculate the minimum mass of iron needed to displace all of the copper from 50 cm<sup>3</sup> of copper(II) sulfate solution.

The concentration of the copper(II) sulfate solution is 80 g CuSO<sub>4</sub> per dm<sup>3</sup>.

Relative atomic masses (*A<sub>r</sub>*): O = 16; S = 32; Fe = 56; Cu = 63.5

Give your answer to 2 significant figures.

**[4 marks]**

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Mass of iron = \_\_\_\_\_ g

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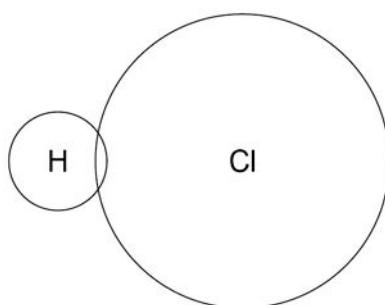
Hydrogen chloride (HCl) is a gas.

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Complete the diagram to show all of the arrangement of the outer shell electrons of the hydrogen and chlorine atoms in hydrogen chloride.

[1 mark]





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Exothermic reactions transfer energy to the surroundings.

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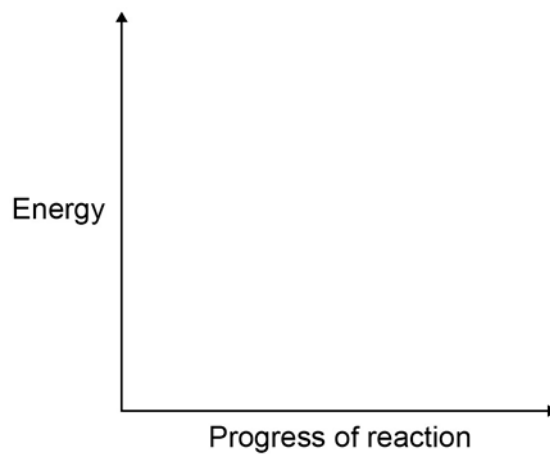
Draw a reaction profile for an exothermic reaction using the axes in **Figure 5**.

Show the:

- relative energies of the reactants and products
- activation energy and overall energy change.

[2 marks]

**Figure 5**

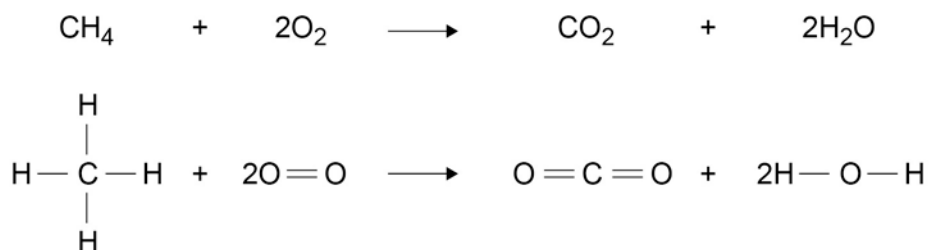




**0 6** . **2** Combustion is an exothermic reaction.

Calculate the overall energy change for the complete combustion of one mole of methane in oxygen.

**[3 marks]**



Bond	Bond energy in kJ/mol
C — H	413
O = O	498
C = O	805
O — H	464

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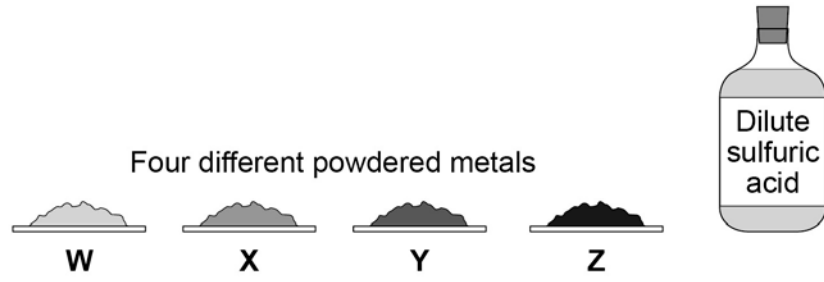
Overall energy change = \_\_\_\_\_ kJ/mol

**Question 6 continues on the next page**

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**Figure 6** shows the chemicals given to a student.

**Figure 6**





Another student used displacement reactions to investigate the relative reactivity of the four metals, **W**, **X**, **Y** and **Z**.

**Table 2** shows the student's results.

**Table 2**

Solution	Observations			
	Metal W	Metal X	Metal Y	Metal Z
Copper nitrate	Brown layer formed on metal	Brown layer formed on metal	Brown layer formed on metal	No change
Magnesium sulfate	No change	No change	No change	No change
Sulfuric acid	Gas bubbles produced	Few gas bubbles produced	Gas bubbles produced	No change
Zinc chloride	Grey layer formed on metal	No change	No change	No change

**0 6** . **4** Give the order of reactivity of metals, **W**, **X**, **Y** and **Z**.

Use the results in **Table 2** to justify your answer.

**[3 marks]**

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