

Chemical Bonds; Ionic; Covalent; Metal

Question Paper 1

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|------------------|--|
| Level | GCSE (9-1) |
| Subject | Combined Science: Trilogy - Chemistry |
| Exam Board | AQA |
| Topic | 5.2 Bonding Structure + Props Matter |
| Sub-Topic | Chemical Bonds; Ionic; Covalent; Metal |
| Difficulty Level | Silver Level |
| Booklet | Question Paper 1 |

Time Allowed: 56 minutes

Score: /55

Percentage: /100

Grade Boundaries:

Q1. This question is about calcium.

- (a) What type of compound is calcium oxide?

Tick **one** box.

An acid

☐

A base

☐

A carbonate

☐

A salt

☐

(1)

- (b) Ionic compounds, such as calcium oxide, have high melting points.

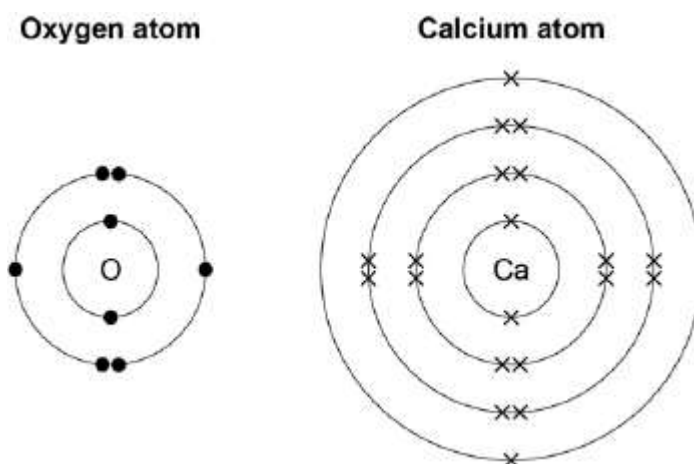
Complete the sentences. Use words from the box.

| | |
|--------------|---------------|
| bonds | forces |
| ions | layers |

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

(1)

- (c) The figure below shows the electronic structure of an oxygen atom and a calcium atom.



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

You should give the charge on each ion formed.

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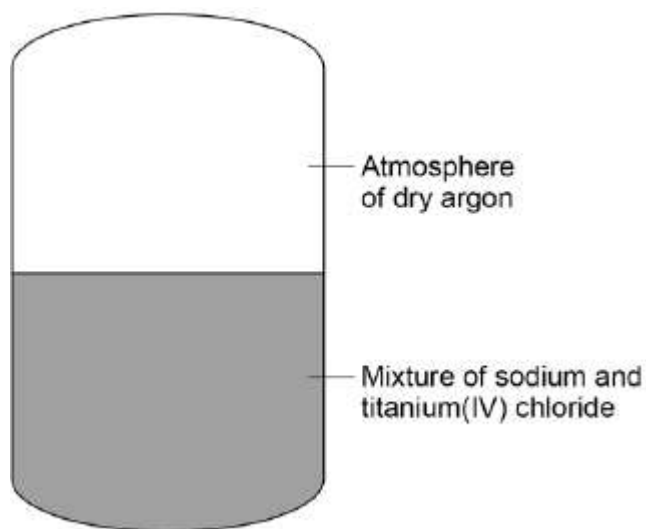
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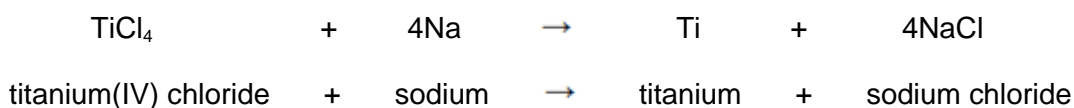
(4)
(Total 6 marks)

Q2.Figure 1 shows a reactor used to produce titanium from titanium(IV) chloride.

Figure 1



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



(a) 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.

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Mass of titanium = kg

(1)

(b) The table below shows the solubility of sodium chloride in 100 cm³ of aqueous solution at different temperatures.

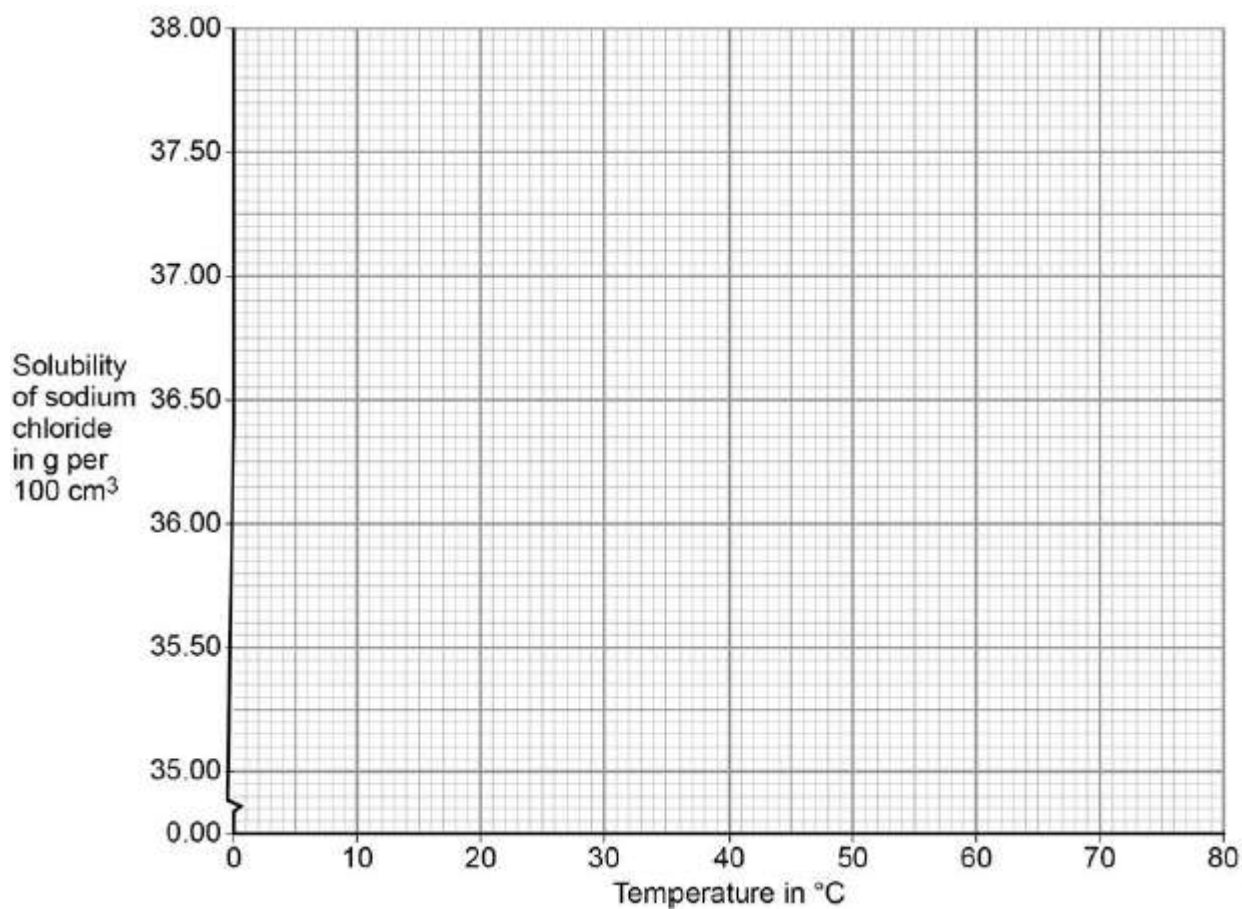
| Solubility of sodium chloride in g per 100cm ³ | Temperature in °C |
|---|-------------------|
| 35.72 | 10 |
| 35.89 | 20 |
| 36.09 | 30 |
| 37.37 | 40 |

| | |
|-------|----|
| 36.69 | 50 |
| 37.04 | 60 |

On **Figure 2**:

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

Figure 2



(3)

(c) 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 dm³.

Calculate the minimum volume of water in dm³, at 30 °C, needed to dissolve 1989 kg sodium chloride.

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Volume of water = dm³

(2)

- (d) Calculate the percentage by mass of titanium in titanium(IV) chloride (TiCl₄).

Give your answer to 3 significant figures.

Relative atomic masses (*A_r*): Cl = 35.5; Ti = 48

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Percentage of titanium by mass = %

(3)

- (e) Suggest why the reaction is done in an atmosphere of dry argon instead of air containing water vapour.

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(3)

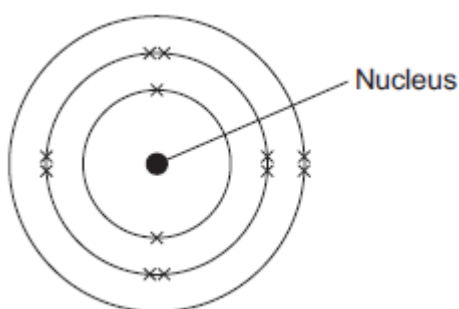
- (f) Explain why titanium conducts electricity.

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(3)
(Total 15 marks)

Q3. This question is about magnesium.

- (a) (i) The electronic structure of a magnesium atom is shown below.



Use the correct answer from the box to complete each sentence.

| | | | |
|-----------|----------|---------|--------|
| electrons | neutrons | protons | shells |
|-----------|----------|---------|--------|

The nucleus contains protons and

The particles with the smallest relative mass that move around the nucleus are called

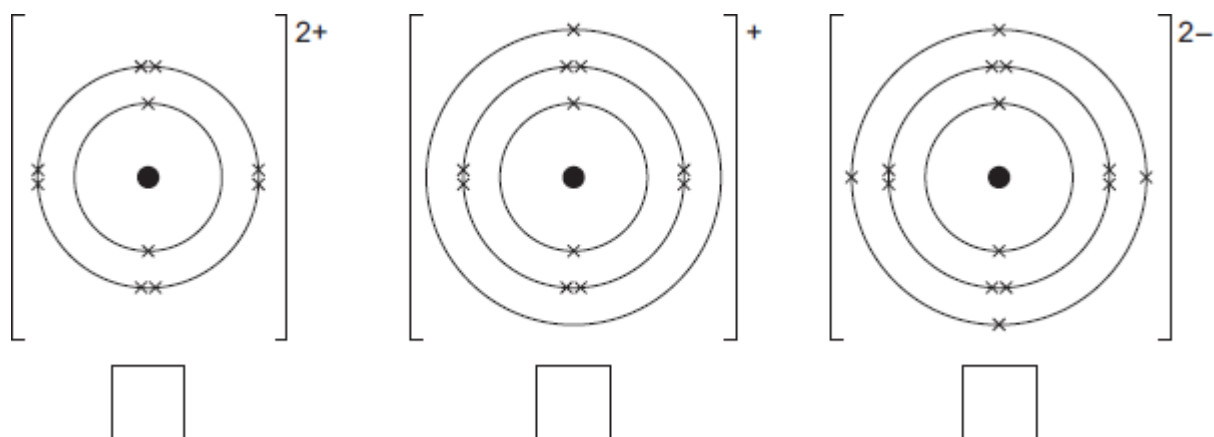
Atoms of magnesium are neutral because they contain the same number of electrons and

(3)

- (ii) A magnesium atom reacts to produce a magnesium ion.

Which diagram shows a magnesium ion?

Tick (✓) **one** box.



(1)

- (b) Magnesium and dilute hydrochloric acid react to produce magnesium chloride solution and hydrogen.



- (i) State **two** observations that could be made during the reaction.

1

2

(2)

- (ii) **In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.**

Describe a method for making pure crystals of magnesium chloride from magnesium and dilute hydrochloric acid.

In your method you should name the apparatus you will use.

You do **not** need to mention safety.

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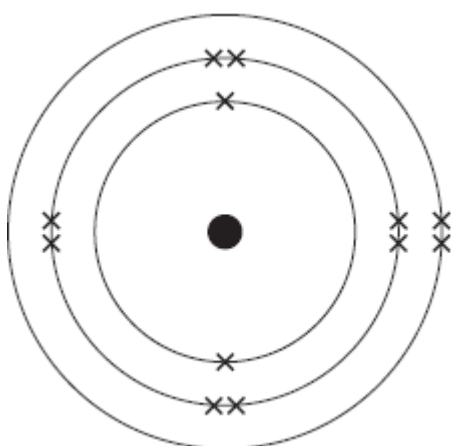
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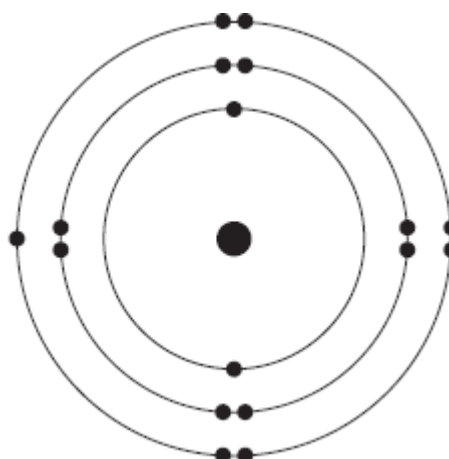
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(6)
(Total 12 marks)

Q4.(a) The diagram shows an atom of magnesium and an atom of chlorine.



Magnesium



Chlorine

Describe, in terms of electrons, how magnesium atoms and chlorine atoms change into ions to produce magnesium chloride (MgCl_2).

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(4)

- (b) Calculate the relative formula mass (M_r) of magnesium chloride (MgCl_2).

Relative atomic masses (A_r): magnesium = 24; chlorine = 35.5

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Relative formula mass (M_r) =

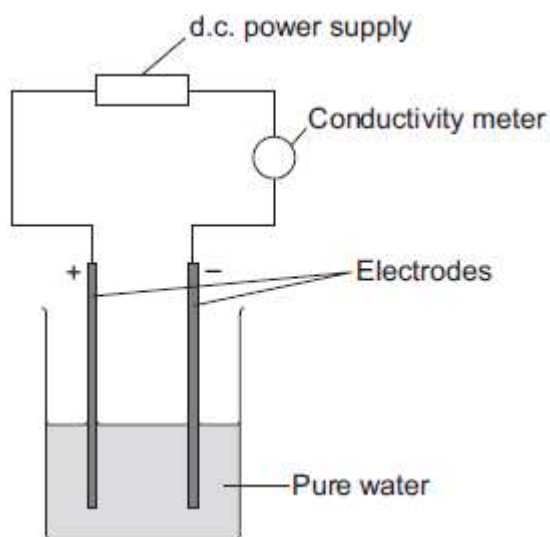
(2)

(Total 6 marks)

Q5. A student investigated the conductivity of different concentrations of sodium chloride solution.

The student set the apparatus up as shown in **Figure 1**.

Figure 1



The student measured the conductivity of the pure water with a conductivity meter.

The reading on the conductivity meter was zero.

- (a) The student:

- added sodium chloride solution one drop at a time
- stirred the solution
- recorded the reading on the conductivity meter.

The student's results are shown in the table below.

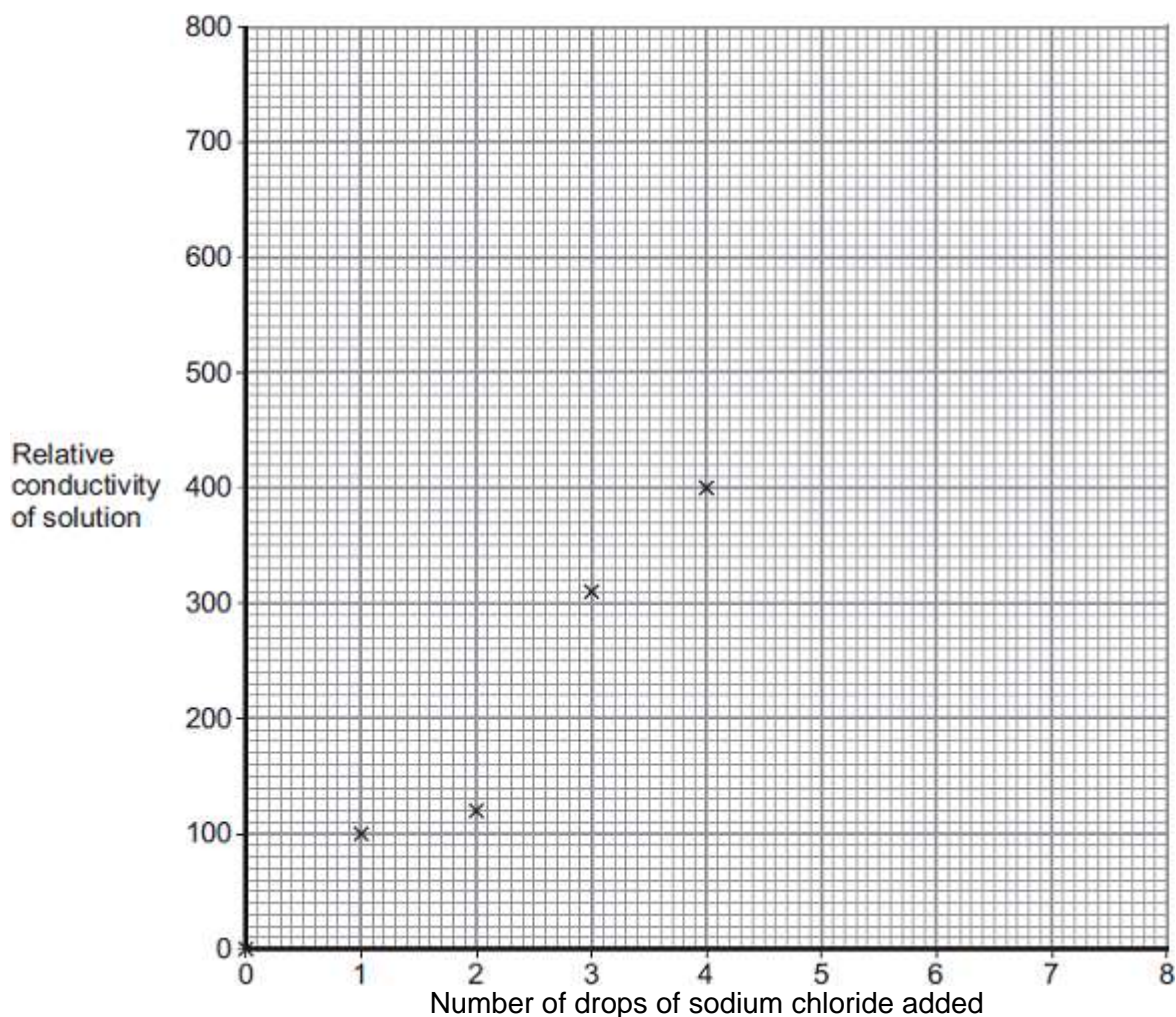
| Number of drops of sodium chloride solution added | Relative conductivity of solution |
|---|-----------------------------------|
| 0 | 0 |
| 1 | 100 |
| 2 | 120 |
| 3 | 310 |
| 4 | 400 |
| 5 | 510 |
| 6 | 590 |
| 7 | 710 |
| 8 | 800 |

- (i) The student plotted the results on the grid shown in **Figure 2**.

Plot the four remaining results.

Draw a line of best fit, ignoring the anomalous result.

Figure 2



(3)

- (ii) One of the points is anomalous.

Suggest **one** error that the student may have made to cause the anomalous result.

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(1)

- (iii) The student wanted to compare the conductivity of sodium chloride solution with the conductivity of potassium chloride solution.

State **one** variable he should keep constant when measuring the conductivity of the two solutions.

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(1)

- (b) (i) Explain, in terms of bonding, why pure water does **not** conduct electricity.

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(2)

- (ii) Explain why sodium chloride solution conducts electricity.

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(2)

- (iii) After he had added sodium chloride solution, the student noticed bubbles of gas at the negative electrode.

Complete the sentence.

The gas produced at the negative electrode is

(1)

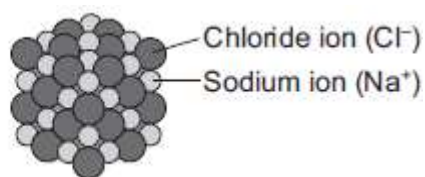
(Total 10 marks)

Q6.In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.

Explain why chlorine (Cl_2) is a gas at room temperature, but sodium chloride (NaCl) is a solid at room temperature.

Chlorine

Sodium chloride



Include a description of the bonding and structure of chlorine and sodium chloride in your answer.

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Extra space

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(Total 6 marks)