

Chem Measure; Con Mass + Quant Interp Eq

Question Paper

Level	GCSE (9-1)
Subject	Combined Science: Trilogy - Chemistry
Exam Board	AQA
Topic	5.3 Quantitative Chemistry
Sub-Topic	Chem Measure; Con Mass + Quant Interp Eq
Difficulty Level	Silver Level
Booklet	Question Paper

Time Allowed: 57 minutes

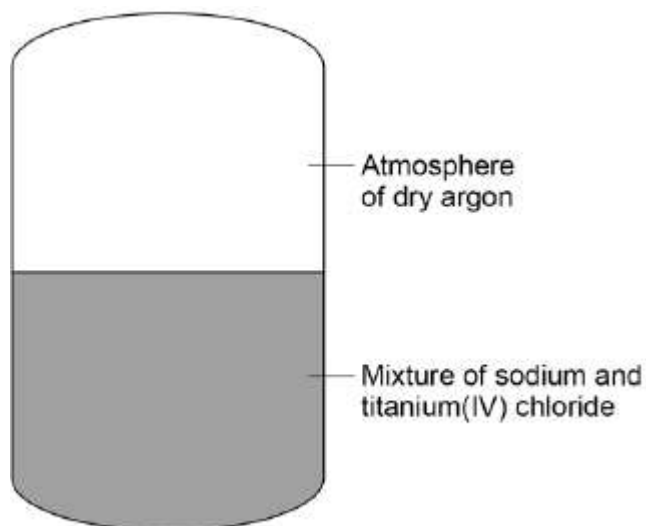
Score: /58

Percentage: /100

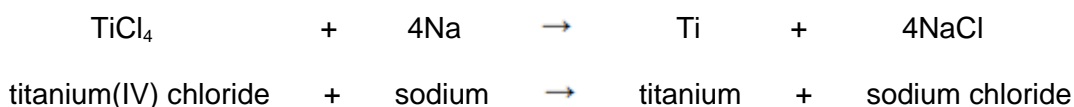
Grade Boundaries:

Q1.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.

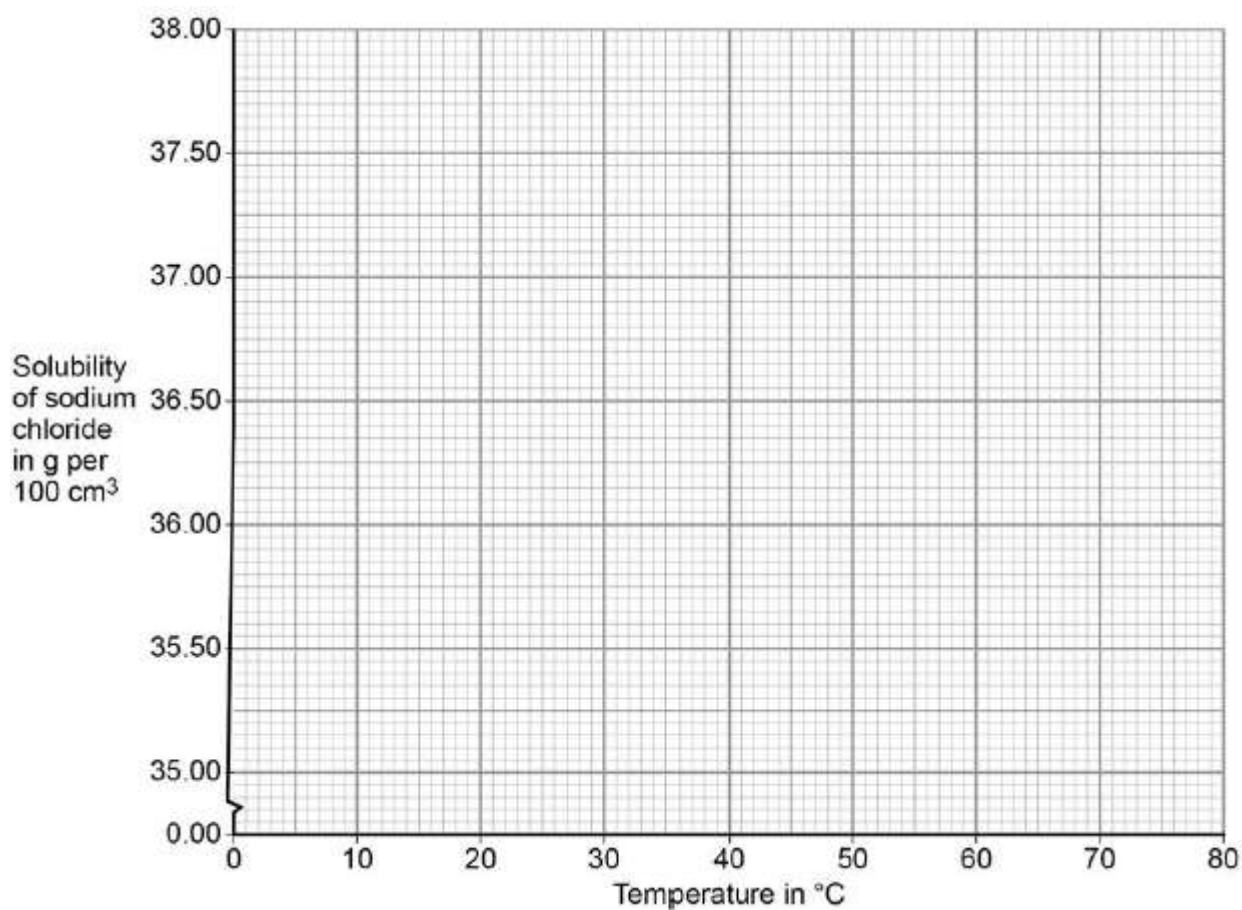
Solubility of sodium chloride in g per 100cm ³	Temperature in °C
35.72	10

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 dm^3 , at $30\text{ }^\circ\text{C}$, needed to dissolve 1989 kg sodium chloride.

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Volume of water = dm^3

(2)

- (d) Calculate the percentage by mass of titanium in titanium(IV) chloride (TiCl_4).

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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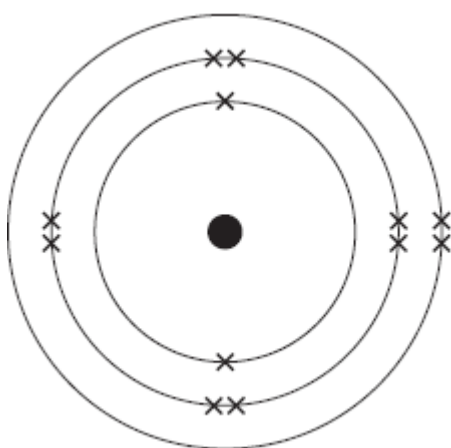
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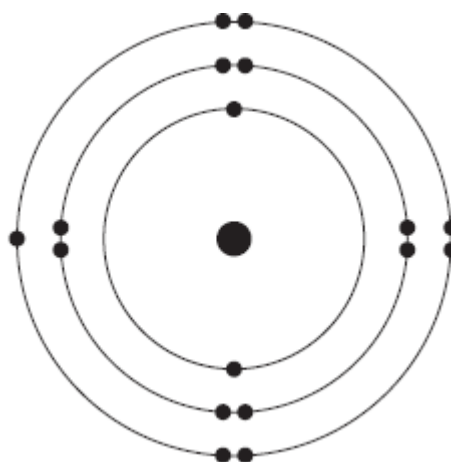
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(3)
(Total 15 marks)

Q2.(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)

Q3. Scientists found that a compound contained:

22.8% sodium; 21.8% boron; and 55.4% oxygen.

Use the percentages to calculate the empirical formula of the compound.

Relative atomic masses (A_r): B = 11; O = 16; Na = 23

To gain full marks you **must** show all your working.

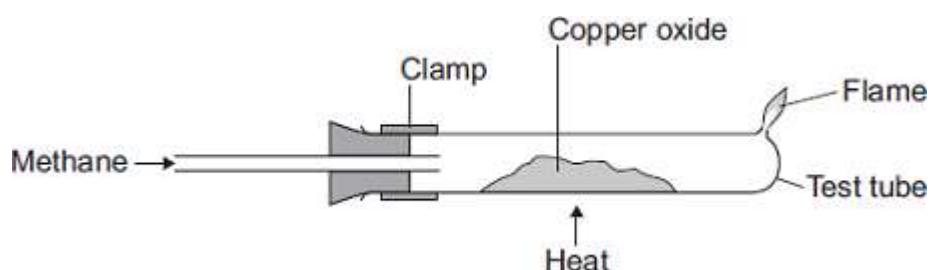
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Empirical formula =

(Total 5 marks)

Q4. This apparatus is used for the reaction of copper oxide (CuO) with methane (CH₄).



- (a) The symbol equation for this reaction is shown below.



The water and carbon dioxide produced escape from the test tube.

Use information from the equation to explain why.

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(1)

- (b) (i) Calculate the relative formula mass (M_r) of copper oxide (CuO).

Relative atomic masses (A_r): O = 16, Cu = 64

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Relative formula mass (M_r) =

(2)

- (ii) Calculate the percentage of copper in copper oxide.

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Percentage of copper = %

(2)

- (iii) Calculate the maximum mass of copper that could be produced from 4.0 g of copper oxide.

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Mass of copper produced = g

(1)

- (c) The experiment was done three times.

The mass of copper oxide used and the mass of copper produced were measured each time.

The results are shown in the table.

	Experiment		
	1	2	3
Mass of copper oxide used in g	4.0	4.0	4.0
Mass of copper produced in g	3.3	3.5	3.2

- (i) Calculate the mean mass of copper produced in these experiments.

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Mean mass of copper produced = g

(1)

- (ii) Suggest how the results of the experiment could be made more precise.

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(1)

- (iii) The three experiments gave different results for the amount of copper produced.

This was caused by experimental error.

Suggest two causes of experimental error in these experiments.

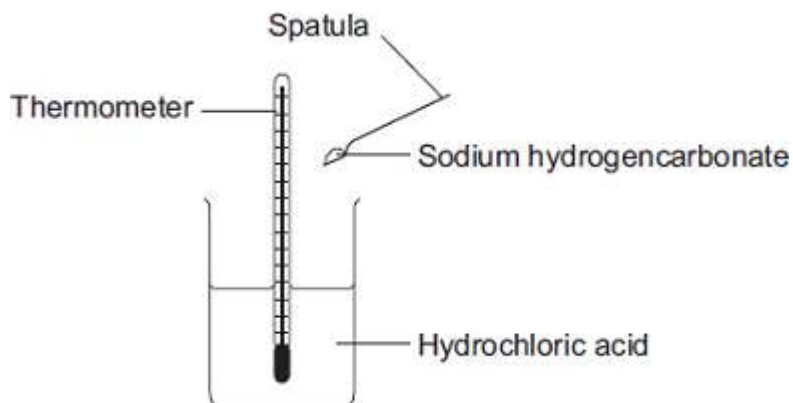
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(2)

(Total 10 marks)

- Q5.(a)** Some students did an experiment to find the temperature change when hydrochloric acid reacts with sodium hydrogencarbonate.



The results are in the table.

Number of spatula	Start temperature	Final	Change in
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measures of sodium hydrogencarbonate	in °C	temperature in °C	temperature in °C
2	20	16	4
4	20	14	6
6	19	11	8
8	20	10	10
10	19	9	10
12	20	10	10

- (i) Describe, as fully as you can, the trends shown in the students' results.

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(3)

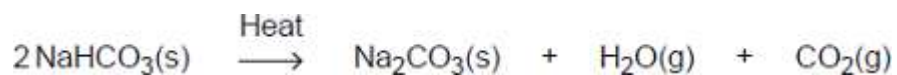
- (ii) State the type of energy transfer for this reaction.

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(1)

- (b) Sodium hydrogencarbonate is used as baking powder for making cakes.
- When the cake mixture is baked the sodium hydrogencarbonate decomposes.
- The equation for the reaction is:



- (i) The cake mixture rises when baked.



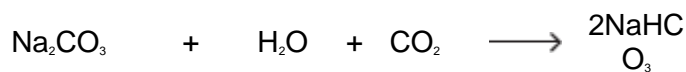
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Use the equation to suggest why.

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(1)

- (ii) The same reaction can be reversed to produce sodium hydrogencarbonate from sodium carbonate.



Do the reactants need to be heated?

Give a reason for your answer.

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(1)

- (c) (i) Calculate the relative formula mass of sodium hydrogencarbonate (NaHCO_3).

Relative atomic masses (A_r): H=1; C=12; O=16; Na=23

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Relative formula mass (M_r) =

(2)

- (ii) Calculate the percentage by mass of carbon in sodium hydrogencarbonate.

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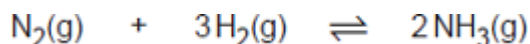
Percentage of carbon = %

(1)

(Total 9 marks)

Q6.Ammonia is produced from nitrogen and hydrogen.

The equation for this reaction is:



- (a) (i) A company wants to make 6.8 tonnes of ammonia.

Calculate the mass of nitrogen needed.

Relative atomic masses (A_r): H = 1; N = 14

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Mass of nitrogen = tonnes

(3)

- (ii) The company expected to make 6.8 tonnes of ammonia.

The yield of ammonia was only 4.2 tonnes.

Calculate the percentage yield of ammonia.

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Percentage yield of ammonia = %

(2)

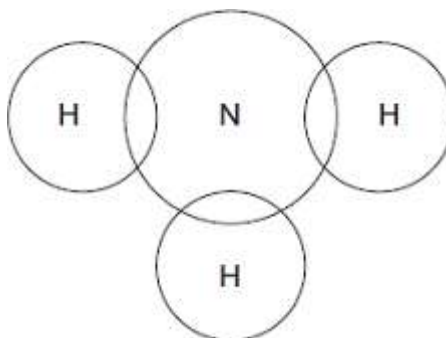
- (iii) Use the equation above to explain why the percentage yield of ammonia was less than expected.

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(1)

- (b) Complete the diagram to show the arrangement of the outer shell electrons of the nitrogen and hydrogen atoms in ammonia.

Use dots (•) and crosses (x) to represent the electrons.



(2)

- (c) Ammonia dissolves in water to produce an alkaline solution.

- (i) Which ion makes ammonia solution alkaline?

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(1)

- (ii) Name the type of reaction between aqueous ammonia solution and an acid.

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(1)

- (iii) Name the acid needed to produce ammonium nitrate.

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(1)

- (iv) The reaction of ammonia with sulfuric acid produces ammonium sulfate.

Use the formulae of the ions on the Chemistry Data Sheet.

Write the formula of ammonium sulfate.

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(1)

(Total 12 marks)