

Australian Islamic College 2018

ATAR Chemistry Units 3 and 4

Task 13 (Weighting: 3%)

Empirical Formula and Stoichiometry Test

Test Time: 45 minutes

Please do not turn this page until instructed to do so.

| First Name | Surname |
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| Teacher |
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| Mark / 39 | Percentage |
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Equipment allowed: Pens, pencils, erasers, whiteout, rulers and non-programmable calculators permitted by the Schools Curriculum and Standards Authority.

1. Carbon dioxide is prepared by reacting hydrochloric acid with marble chips (calcium carbonate).

If 3.125 g of marble chips were mixed with 20.0 mL of $2.00 \text{ mol L}^{-1} \text{ HCl}_{(\text{aq})}$

- (a) Write an equation for the reaction occurring.

[1 mark]

- (b) Determine the limiting reagent and calculate the number of moles of the excess reagent remaining after the reaction is completed.

[5 marks]

- (c) What would be the volume of carbon dioxide produced at 25°C and 1.00 atm ?

[2 marks]

2. When solid ammonium sulfite ($(\text{NH}_4)_2\text{SO}_3$) is heated strongly it decomposes to form the gases ammonia (NH_3), sulfur dioxide (SO_2), and water.

A 1.54 g sample of ammonium sulfite decomposed at 302 °C in a sealed gas vessel of volume 1.850 L.

- (a) Write a balanced chemical equation for the reaction. [1 mark]
- (b) Calculate the pressure inside the gas vessel when decomposition is complete. [4 marks]
- (c) The gaseous products are passed through limewater, ($\text{Ca}(\text{OH})_2$ (aq)). What mass of calcium sulfite (CaSO_3) would precipitate? [2 marks]

3. An unknown organic compound X, which was known to contain hydrogen, carbon and chlorine was analysed to find its formula. A 10.15g sample was combusted in air and produced 4.40g of water.

A separate 5.48g of X underwent a substitution reaction to convert the chlorine atoms to chloride ions. On addition of excess silver nitrate solution to the resulting solution, 12.54g of silver chloride was precipitated.

A third 5.00g sample of X was vapourised and found to occupy 1.05 L at 200°C and 150 kPa.

- (a) Calculate the empirical formula of X.

[8 marks]

- (b) Calculate the molar mass of X, and hence work out the molecular formula.

[4 marks]

- (c) Draw and name a possible structure for X that would react readily with aqueous bromine but would not form geometric (*cis/trans*) isomers

[2 marks]

4. The blue-green pigment Chrysocolla, is a hydrated salt that contains copper, silicon and oxygen:



A 10.00 g sample was carefully heated to remove water and the resulting solid had a mass of 7.21g.

To calculate the amount of silicon present, this 7.21g was roasted at high temperature in the presence of oxygen and 3.10g of SiO_2 was produced.

In a separate analysis, it was found that the original hydrated salt was found to contain 32.8% copper.

- (a) Determine the empirical formula of Chrysocolla by calculating the values of w , x , y and Z .

[9 marks]

- (b) Based on the colour of the pigment, state the oxidation number of the copper, and calculate the oxidation state of silicon in the compound.

[1 mark]

Spare paper