

Australian Islamic College 2019

ATAR Chemistry Units 3 and 4

Task 13 (Weighting: 3%)

Calculations Test

Test Time: 45 minutes

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

First Name	Surname

Teacher

Mark / 39	Percentage

Equipment allowed: Pens, pencils, erasers, whiteout, correction tape, rulers and non-programmable calculators permitted by the Schools Curriculum and Standards Authority.

Special conditions:

2 marks will be deducted for failing to write your full name on this test paper.

Teacher help: Your teacher can only help you during your test in one situation.

If you believe there is a mistake in a question show your teacher and your teacher will tell you if there is a mistake in the question and if appropriate, how to fix that mistake.

Spelling of Science words must be correct. Science words with more than one letter wrong (wrong letter and/or wrong place) will be marked wrong.

Unless stated otherwise, **equations** must be written balanced and with correct state symbols or they will be marked wrong.

Questions must be answered in this booklet.

Total marks: 39

Note that in this test ‘follow-on’ marks will not be awarded.

Final answers should be given to the appropriate number of significant figures. Correct units should be given in final answers.

Special note: In empirical formula calculations, a tolerance of 0.1 should be used when rounding mole ratios to whole numbers.

Answer all questions. Write your answers in the spaces provided.

1. An experiment was carried out to determine the amount of calcium present in a sample of seashells collected on City Beach in Perth. 15.65 g of the shells were crushed and then added to excess 2.00 mol L^{-1} hydrochloric acid. The resulting solution was filtered. Approximately 350 mL of 1.0 mol L^{-1} oxalic acid was added to the filtrate, which resulted in a precipitate of calcium oxalate (CaC_2O_4). When dried, this precipitate had a mass of 9.65 g.

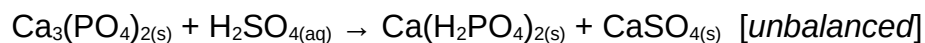
(a) Calculate the % (by mass) of calcium carbonate present in the seashells.

[4 marks]

(b) Calculate the minimum volume (in mL) of the hydrochloric acid required in the first stage of the process.

[3 marks]

2. The fertiliser superphosphate, calcium dihydrogen phosphate ($\text{Ca}(\text{H}_2\text{PO}_4)_2$), was mined for many years on the Pacific island of Nauru. Phosphorus is an essential nutrient to animals and plants. The fertiliser is now manufactured industrially by reacting sulfuric acid (H_2SO_4) with calcium phosphate “rock phosphate”, ($\text{Ca}_3(\text{PO}_4)_2$).



- (a) Write a balanced chemical equation for this process.

[1 mark]

In a given day a reactor combines 35 000 kg of impure rock phosphate (75.0% purity, by mass) with 15 000 L of 18.0 M H_2SO_4 .

- (b) Determine which reactant is the limiting reagent.

[4 marks]

(c) Determine the mass in tonnes of excess reactant remaining after the reaction.
[2 marks]

(d) What mass of superphosphate (in tonnes) would be produced, if the conversion process is 80.0 % efficient?
[2 marks]

3. Chocolate is made from the seeds of a plant called *Theobroma cacao*. Chocolate contains many compounds, including the bitter alkaline substance, theobromine. It is found in the cacao plant and is a water insoluble, crystalline white solid.

The compound theobromine contains the elements carbon, hydrogen, nitrogen and oxygen.

The complete combustion of 3.22 g of the compound released 5.51 g of carbon dioxide and 1.28 g of water.

Further testing of 1.68 g of the compound converted all its nitrogen to NO_2 gas. This gas occupied a volume of 1.12 L, at 100°C and 103 kPa pressure.

- (a) Determine the empirical formula of theobromine.

[8 marks]

- (b) Analysis of the compound indicates that its relative molecular mass is approx.180. Determine its molecular formula.

[2 marks]

- (c) Theobromine is toxic to dogs. The toxicity level is 300 mg per kg of dog. How much chocolate would an 8.00 kg dog need to consume to poison itself if a particular brand of chocolate on offer contains 2.50 % (by mass) theobromine?

[2 marks]

4. Amino acids contain one or more amine groups and one or more carboxylic acid groups. A particular diprotic amino acid, Amino Acid X, which contains carbon, hydrogen, oxygen and nitrogen, underwent analysis to determine its formula. When a 5.00 g sample of Amino Acid X was combusted in oxygen, 7.48 g of carbon dioxide and 2.77 g of water was produced. A separate 3.00 g sample produced 0.938 g of nitrogen dioxide when burnt in oxygen.

4.56 g of Amino Acid X was dissolved in 100.0 mL of water. 20.0 mL of this solution required 24.8 mL of 0.500 mol L⁻¹ sodium hydroxide for complete neutralisation.

- (a) Calculate the molecular mass of Amino Acid X.

[4 marks]

(b) Calculate the empirical formula of Amino Acid X.

[7 marks]

END OF TEST

Blank Page For Student Use. This Page Will Not Be Marked.

