IB DP Chemistry HL IA

Calcium Carbonate content of eggshells

I.B. CHEMISTRY

STANDARD LEVEL_____ HIGHER LEVEL____

Name: ___________________________________

Investigation: ______________________________

ASSESSMENT TABLE

CRITERION	ASPECT	C	P	N	LEVEL
Design	A focused problem/research question is stated clearly and the relevant variables are identified.				
	A realistic method that allows for the effective control of variables (and pays due attention to safety) is designed.				
	A method that allows for collection of sufficient relevant data (and excludes the collection of irrelevant data) is designed.				
Data Collection and **Processing**	Raw data (qualitative/quantitative) is recorded appropriately, including units and uncertainties where necessary.				
	The quantitative raw data is processed correctly.				
	Data/results are presented appropriately and effectively; where relevant, errors and uncertainties are taken into account.				
Conclusion and **Evaluation**	A valid conclusion (based on the correct interpretation of the results), with an explanation, is given; where appropriate, results are compared with literature values.				
	The procedure (apparatus, materials and method) including limitations, weaknesses or errors in manipulation is evaluated (discussion of the limitations of data analysis may be included)				
	Suggestions through realistic improvements on the investigation following the identification of weaknesses and limitations are stated.				
Manipulative Skills	Followed instructions; carried out a range of techniques; showed due attention to safety.				

<u>*KEY*</u>*:* ‘***C***’ = *aspect fulfilled completely* ***(2 marks),***

‘***P***’ = *only partially fulfilled* ***(1 mark),***

‘***N***’ = *not at all* ***(0 marks).***

Introduction:

Calcium carbonate, $CaCO_3$, is a simple chemical compound that most people can find it in their refrigerator, or in other words eggs. The shell of the eggs that we don't paid attention to in daily life is basically composed of Calcium Carbonate, which is the same substance that gives the hardness to seashells or certain rocks, also a quite convenient substance to write on blackboard before the invention of whiteboard and markers. A good quality eggshell will contain, on average 2.2 grams of calcium carbonate and approximately 94% of a dry eggshell is calcium carbonate and has a typical mass of 5.5 grams, though these values can differ depending on sources. The experiment is designed to compare the calcium carbonate contain inside the eggshells of a free-range egg to farmed-eggs and give a conclusion on

Is free-range better or farme egg better in terms of calcium content.

Aim:

Find out the calcium carbonate content of the eggshells of a free-range egg to farmed eggs and which is higher.

Hypothensis:

A free-ranged egg should have a higher calcium content compare to a farmed egg.

Chemicals and Apparatus

Factory eggshell	Conical flask (250 cm^3)
Free-range eggshell	Volumetric flask (500 cm^3) and stopper
1 M Hydrochloric Acid	Wash bottle
1 M sodium hydroxide solution	White tile
Deionised (or distilled) water	Beakers (500 cm^3)
Phenolphthalein indicator	Glass rod
Pipette (25 cm^3 or 50 cm^3 if available)	Filter funnel
Pipette filler	Filter stand
Burette	Filter paper
Retort stand	Mortal and pestal
Clamp	Scale

Variables:

Dependent variable:

- The volume of titrant (NaOH 1M).

Independent variable:

- The pH of the diluted solution.

Controlled Variables:

- The amount of solution used in titration.
- The initial volume of solvent (HCL 1M) used.
- The initial mass of solute (eggshells).

Procedure

1. Remove the membrane inside the eggshells and let it dry over night.
2. (Optional) Using a mortal and pestal, grind the individual eggshells to smaller size.
3. Weight and record the weight of the individual eggshells.
4. Siphen out precisely 300 cm^3 of 1M HCL using the bulk pipette to two beakers.
5. Label the two beakers with the weight of the eggshell and type.
6. Transfer all the eggshells to the two beakers with HCL, according to its label.
7. Stir the mixtures with glass rods and wait for the reaction to finish.
8. Weigh the piece of filter paper use for infiltering and filter out the solution.
9. Collect both the solution and the filter paper with the filtrates on it.
10. Record the weight of the filter papers with the filrates.
11. Transfer each solution to a 500ml volumetric flask, and dilute both to the mark.
12. Transfer 25ml of one of the diluted solution into a conicle flask with a few drops of Phenolphthalein.
13. Start a rough titration with 1M NaOH then proceed 3-5 more accurate trials and record the results
14. Repeat step 14 for the other solution.

Results

	Factory eggshell (cm^3) ±	Free-range eggshell (cm^3) ±
Rough titration result	9.8	10.1
First titre	9.8	10.1
Second titre	9.9	10.0
Third titre	9.8	10.1
Fouth titre	9.8	10.0
Fifth titre	9.9	10.0
Average of accurate titres	9.8	10.0
Volume of diluted solution used in each titration	25	25
Concentration of sodium hydroxide solution	1.0 M	1.0 M

Calculations

Balanced equation:

$$CaCO_3 + HCL \rightarrow CaCl_2 + H_2O + CO_2$$

1 mole   2 mole   1 mole   1 mole   1 mole

Steps

Moles of solvent (HCl) = Volume used (cm^3) × Mole ÷ 1000

Moles of Titrant (NaOH) = Volume used (cm^3) × Mole ÷ 1000

Moles of Calcium Carbonate within Solution = Moles of Solvent – Moles of Titrant

Mass of Calcium Carbonate = Moles of Calcium Carbonate in Solution × Molar mass

Calcium Carbonate of Eggshell

= Mass of Calcium Carbonate ÷ Mass of reacted eggshell × 100

Factory eggshell

Volume of HCL at initial = 300 cm^3 ± 0.36 cm^3

Moles of HCL at initial = 300 ± 0.36 cm^3 ×1M ± ÷1000

= 0.3 moles ± 0.12%

Volume of HCL used in trials = $25\ cm^3 \pm 0.03\ cm^3$

Moles of HCL = $25 \pm 0.03\ cm^3 \times 0.3 \pm 0.12\% \div 500 \pm 0.25\ cm^3$

= 0.015 moles ± 0.29%

Volume of NaOH solution used = $9.8\ cm^3 \pm 0.1\ cm^3$

Moles of NaOH used = 9.8 ± 0.1 ×1M ± ÷1000

= 0.0098 moles ± 1.02%

Moles of reacted HCL = 0.015 ± 0.29% – 0.0098± 1.02 %

= 0.0052 moles ± 1.31%

Moles of Calcium Carbonate = 0.0052 ± 1.31% ÷ 2

= 0.0026 moles ± 1.31%

Mass of Calcium Carbonate = 0.0026 ± 1.31% × 100 × 20

= 5.2 grams ± 1.31%

Precentange of Calcium Carbonate in Eggshell = 5.2 grams ± 1.31%

= 5.2 ± 1.31% ÷ (5.86 ±0.005g - 0.21 ± 0.005g) × 100

= 5.2 ± 1.31% ÷ 5.65 ±0.01 × 100

= 92.0 % ± 1.48%

Free-range eggshell

Volume of HCL at initial = $300\ cm^3 \pm 0.36\ cm^3$

Moles of HCL at initial = $300 \pm 0.36\ cm^3$ ×1M ± ÷1000

= 0.3 moles ± 0.12%

Volume of HCL used in trials = $25\ cm^3 \pm 0.03\ cm^3$

Moles of HCL = $25 \pm 0.03\ cm^3 \times 0.3 \pm 0.12\% \div 500 \pm 0.25\ cm^3$

	= 0.015 moles ± 0.29%
Volume of NaOH solution used	= 10.0 cm^3 ± 0.1 cm^3
Moles of NaOH used	= 10.0 ± 0.1 ×1M ± ÷1000
	= 0.01 moles ± 1.0%
Moles of reacted HCL	= 0.015 ± 0.29% – 0.01± 1.0 %
	= 0.005 moles ± 1.29%
Moles of Calcium Carbonate	= 0.005 ± 1.29% ÷ 2
	= 0.0025 moles ± 1.29%
Mass of Calcium Carbonate	= 0.0025 ± 1.29% × 100 × 20
	= 5.0 grams ± 1.29%
Precentange of Calcium Carbonate in Eggshell	= 5.0 grams ± 1.29%
	= 5.0 ± 1.29% ÷ (6.00 ±0.005g - 0.67 ± 0.005g) × 100
	= 5.0 ± 1.29% ÷ 5.33 ±0.01 × 100
	= 93.8 % ± 1.48%

Conclusion

From the above calculations, the experiment suggested that a free-range egg had higher calcium content in its eggshell as predicted in the hypothesis. The calculations show that free-range eggs'shell contents about 93.8%% of calcium carbonate, which is about 1.8 % higher than the factory farmed eggs' shell. As there are uncertainties from the various different uses of apparatus it gives both about a 1.48% of uncertain range from the true value. Still, as the result and calculations show, it is obvious that a free-range egg is better than a factory farmed egg in terms of its calcium content in its eggshells.

Evaluation

Although random error had been taken into account from the calculations and measurements, still the experiment had not been able to proof the result since there is only a single egg of each type used in the experiment. This results that the experiment could only answer the guilding question, but not to proof how valid the result is. To acutally also proof that the result is valid, more than one trial should had been done, which means that the experiment not only had to proof one egg to another, but multiply eggs to support its validity. Apart from the fact that the experiment didn’t give a solid proof, also from the uncertainties, it seems to be quite inaccurate. This could have been due to the concentration of the titrant which in the experiment is 1M NaOH. it is obvious that less titrants are needed to titrate or neutralize the solution when the titrant have a high concentration. In this case, the solution that was being titrated had been made up from dissolving eggshells in 300ml of 1M HCL that had been diluted to 500ml. From calculation it does seems that using a 1M NaOH as the titrant doesn’t really seem that appropriate. Instead, the titrant should have been less concentrate which could be suggest be a 0.5M or even 0.2M NaOH. It is natural that it reuiqre more titrant if it is less concentrated, with more Titrant used it should actually reduce the percentage error from uncertainties such as an example be that the uncertainty on the burret is 0.1ml. The difference in percentage error would have a difference of a double when it is 10ml to 20ml of titrant used ($0.1 \div 10 \times 100 = 1\%$ and $0.1 \div 20 \times 100 = 0.5\%$).