Author:

Title: **An investigation into the effect of HCl concentration on the reaction rate with CaCO3.**

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| **Title**  𝤿 Let the reader know what the investigation is testing.  𝤿 Reads like the research question  *An investigation into the effect of \_\_\_\_’IV’\_\_\_\_ on \_\_\_\_’DV’\_\_\_\_\_\_\_.* |

Introduction:

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| **Introduction/Aim/Purpose**  𝤿 Use present tense.  𝤿 Restate the research question.  𝤿 Talk about the observations /questions that led to this experiment.  𝤿 Identify the science concepts that will be explored. Give detail on how the problem /question is connected to the topic of interest.  𝤿 Say what is already known and how it is related to the investigation.  𝤿 Provide definitions if relevant.  𝤿 Write at least one long paragraph.  *The purpose of this investigation is to understand \_\_\_.*  *This investigation looks at the effect of \_\_IV\_\_ on \_\_DV\_\_\_.*  *This is of interest because \_\_\_.*  *This investigation is worthwhile because \_\_\_\_\_\_.*  *I have observed that \_\_\_.*  *\_\_\_\_\_\_\_\_ occurs when \_\_\_.*  *The type of heat transfer being looked at in the investigation is \_\_\_.*  *In this case \_\_\_\_.* |

Independent Variable:

The concentration (molarity) of the HCl used in this acid + carbonate reaction will be manipulated to see if it has an effect on the production of the salt (CaCl2), H2O and CO2. The following HCl molarities will be used; 0.01M, 0.1M, 1M, 2M, 3M and 4M.

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| **Independent Variable**  𝤿 Use present tense.  𝤿 State what the independent variable is and outline how it will be manipulated.  You are changing something at the beginning of each test in order to compare the results at the end. Make it clear what that deliberate change is, and how you created that change.  𝤿 Write at least one paragraph.  *The independent variable in this experiment is \_\_\_.*  *The \_\_\_ will be changed by \_\_\_.*  *This will be done in increments of \_\_\_.* |

Dependent Variable:

The reaction rate will be measured using the duration of time from when HCl is added to the marble chips (CaCO3) until the CO2 bubbles being produced are formed at less than one bubble per second.

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| **Dependent Variable**  𝤿 Use present tense.  𝤿 Outline the ‘result’ being measured and how it is being measured, including the units and equipment being used.  𝤿 Outline how you will know that the DV is dependent on the IV.  𝤿 State how many times (trials) the measurements will be taken and why this is important.  𝤿 Long paragraph.  *The dependent variable in this experiment is \_\_\_.*  *This will be measured by using a \_\_\_\_\_\_ to\_\_\_\_.*  *It will be known that there is a direct relationship between the DV and IV when \_\_\_.*  *In order to make the data more reliable, the \_\_\_\_\_\_.* |

Controlled Variables:

The temperature of solutions and the surroundings needs to be controlled as temperature is known to have an effect on reaction rate.

It is also important to maintain the concentration of each of the test solutions by not having them mix or contaminate via the flasks used. A clean flask with be used for each trial.

The volume of each test solution and mass and shape of marble chips also needs to be controlled so that this factor does not affect the data.

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| **Controlled Variables**  𝤿 Use present tense.  𝤿 List at least three controlled variables and outline the procedures that you will put in place to ensure that each does not influence the data.  𝤿 State what might happen if you do not ‘control’ each variable.  𝤿 Paragraph or a table.  *It is possible that \_\_\_could influence\_\_\_\_.*  *This variable will be controlled by\_\_\_.* |

Hypothesis:

If there is a relationship between acid concentration and the rate at which products are produced, then as HCl concentration is increased then the CO2 bubbling time will also increase. This positive relationship will be a result of there being an increased density and number of H+ ions being available for reaction with the CaCO3 chips in the higher molarity HCl solutions. In strong acids virtually all of the molecules present are known to disassociate. As HCl is a strong acid, there is full disassociation into H+ and Cl- ions. Higher concentration implies that there will be more H+ available as the concentration is increased, and a faster rate of production of CaCl2, H2O and CO2 gas.

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| **Hypothesis**  𝤿 Use present tense.  𝤿 Begin with the format *‘When \_\_IV\_\_\_, the\_\_DV\_\_will (expected result) because (your scientific reasoning based on background knowledge and research)*.  𝤿 Describe the behaviour of molecules or the mechanics of the phenomenon when when giving reasoning. Reveals scientific understanding. Describes something that has been learnt in class.  𝤿 Long paragraph.  *It is predicted that when \_\_\_\_\_is increased/decreased, then \_\_\_\_\_will\_\_\_.*  *This is because\_\_\_.*  *Other information that supports this hypothesis is \_\_\_.*  *I know that this experiment is a valid test of the relationship between \_\_IV\_\_ and \_\_DV\_\_\_ because\_\_\_.* |

Materials:

30mL each of 0.01M, 0.1M, 1M, 2M, 3M and 4M HCl

90g marble chips (CaCO3)

6 x small conical flask

1 x flask plug with tube

1 x large test tube

1 x test tube rack

Electronic mass scale

Timer (Stopwatch)

10mL graduated cylinder

Safety glasses for each person.

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| **Materials**  𝤿 List all of the equipment that is needed to conduct your experiment. Be as detailed as possible, just like you would see in a recipe. For example;   * 3 x 200mL glass beakers * 330mL distilled water |

Procedure:

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| **Method** or **Procedure**  Describe what you did. It must be in:  𝤿 Use past tense, e.g.,’ Measured in 10ml of water’ or ‘10ml of water was measured’  𝤿 Passive voice (what was done rather than what you did). e.g., ‘The circuit was set up’ rather than ‘I set up the circuit’  𝤿 Give step by step instructions, like a recipe, with enough detail for another person to repeat your experiment and get the same results.  𝤿 Use dot points or numbered steps.  𝤿 Make sure that you give safety warnings and emphasize how to control variables.  𝤿 State how many times the procedures should be repeated. For example;   1. *Set up the apparatus as shown in Figure 1.* 2. *Prepare solutions by \_\_\_\_.* 3. *Place the beaker for Solution 1 on the metal mesh, 5cms above the tip of a blue flame. When handling \_\_\_\_ be sure to \_\_\_\_\_(safety consideration).*   *9) Repeat this procedure three times to allow for three sets of data to be collected.*  𝤿 Provide a diagram of the experiment design.  𝤿 Name and number the diagram, below the diagram. E.g. Figure 1: Experiment Setup  𝤿 Label or annotate the different parts in the diagram.  𝤿 The diagram must be neat and mostly just 2D lines. See class slides for an example.    Figure 1: Experiment Setup |

Results:

Table 1:

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| HCl (M) | Time (sec.) for CO2 bubbles to form at less than 1/sec. | | | |
| Trial 1 | Trial 2 | Trial 3 | Mean |
| 0.01 |  |  |  |  |
| 0.1 |  |  |  |  |
| 1.0 |  |  |  |  |
| 2.0 |  |  |  |  |
| 3.0 |  |  |  |  |
| 4.0 |  |  |  |  |

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| **Results**  𝤿 Descriptive title written in past tense. Title above the table  Table 1: Time taken for a cube of ice to melt under differing conditions | | | | |
| 𝤿 IV in this column | 𝤿 DV (with units for measurements)  Time taken to completely melt (sec) | | | |
| Colour of underlying paper | Trial 1 | Trial 2 | Trial 3 | Mean |
| White | 268 | 275 | 238 | 260 |
| Matte Black | 217 | 193 | 185 | 198 |
| Aluminium Foil | 305 | 332 | 290 | 309 |

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| Chart |
| 𝤿 Descriptive title written in past tense. Charts or figures are labelled underneath. |

Figure 2:

Discussion:

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| **Discussion**  **First paragraph - discuss results.**  𝤿 Use past tense.  𝤿 Use words to explain what the data shows. Describe how the variables are related.  𝤿 Indicate which data points do not fit the pattern. State whether or not they are likely to be ‘outliers’ and unreliable and why.  𝤿 State whether or not the data supports your hypothesis. Try not to write ‘proves’, ‘correct’, ‘wrong’, or ‘right’.  *The data shows an increase in \_\_\_ as \_\_\_.*  *This suggests that \_\_\_.*  *\_\_\_\_\_\_supports the hypothesis.*  *This data supports/does not support/partially supports \_\_\_*  **Next paragraph - discuss the hypothesis and any conclusions that can be made.**  𝤿 If your data supports your hypothesis, write about what happened at a molecular level. This should be similar to what you wrote in the hypothesis but with extra evidence.  𝤿 Use definitions or text from reputable sources to back up your statements (provide citations).  𝤿 Write about any other possible explanations. If your data does not, or only partially supports your hypothesis, provide alternative explanations using scientific reasoning. Provide research, including quotes, supporting your explanation of what happened at a molecular level.  𝤿 Write a concluding sentence that states whether or not your research question has been answered.  *It was predicted that there would be a \_\_\_\_\_ relationship between \_\_\_\_\_\_.*  *This might be because \_\_\_.*  *Another source that supports this reasoning is \_\_\_.*  *\_\_\_\_ accounts for the relationship that was observed in the data.*  *It can be concluded that \_\_\_.*  **Next paragraph - discuss the validity and reliability of your experiment design and method.**  𝤿 Was your experiment a true test of your hypothesis? Write about the strengths and weaknesses of your methodology.  𝤿 Did you produce valid and reliable data that answered your research question? Write about the improvements that you would make if you were to do the experiment again.  *The methodology used allowed/did not allow for \_\_\_\_.*  *This is because \_\_\_.*  *Some strengths in the method were \_\_\_.*  *A weakness in the method was \_\_\_.*  *One difficulty was \_\_\_.*  *The data can be seen as being in/valid because \_\_\_.*  *The data can be seen as being un/reliable because \_\_\_.*  **Last paragraph - restate findings, discuss ‘next steps’.**  𝤿 Summarize findings in one sentence.  𝤿 Suggest ways to significantly improve the procedure you used, or come up with a completely new procedure which addresses the problems that you just wrote about.  𝤿 If your research question was successfully answered, introduce a new research question and possible methodology which extends on from what you have learnt.  *The method could be improved by \_\_\_.*  *Another option would be to \_\_\_.*  *This would be an improvement because \_\_\_.*  *A logical next step from this experiment would be to \_\_\_.*  *This could be tested by \_\_\_.*  *It would be worthwhile to investigate what effect \_\_\_.* |

Bibliography:

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| **Bibliography**  𝤿 Use in-text citation when quoting.  𝤿 List any sources that you used for ideas or quoted in your text.  List websites and videos:  “Title of Article/Work.” URL.  For images:  Description of image. *Title of Website*, URL. |