What is the Effect of Independent Variable on the Dependent Variable with significant Constant Variables (chemical names, chemical formulas and values/ranges included)? (your Research Q)

Methodology
Paragraph 1 (third person past passive tense ("30mL was placed…")
Point: The (independent/dependent/controlled variable) was changed from ___ to ___. Refer to original method in Appendix A.
Evidence: Give background information, scientific theory, diagrams, chemical equations etc.
Explain: This (improvement/extension/refinement) does this ___ to improve the accuracy/precision/reliability/or validity.

Paragraph 2 (third person past passive tense ("30mL was placed…")
Point: The (independent/dependent/controlled variable) was changed from ___ to ___.
Evidence: Give background information, scientific theory, diagrams, chemical equations etc.
Explain: This (improvement/extension/refinement) does this ___ to improve the accuracy/precision/reliability/or validity.

Paragraph 3 (third person past passive tense ("30mL was placed…")
Point: The (independent/dependent/controlled variable) was changed from ___ to ___.
Evidence: Give background information, scientific theory, diagrams, chemical equations etc.
Explain: This (improvement/extension/refinement) does this ___ to improve the accuracy/precision/reliability/or validity.

Continue paragraphs as needed.

Safety

Chemical	Risk	Action	Environment
Eg. HCl 3M			State "Waste materials to be returned to the prep room" or words to that effect if necessary.

Results
Table 1: Label

Independent variable (± 0.5°C)	Dependent variable (± 0.5°C)						Uncertainty of the mean		Other calculations
	1	2	3	4	5	Average	Absolute	%	
1.0									
2.0									
3.0									
4.0									
5.0									

Qualitative Observations:
You must give qualitative observations to supplement the quantitative data. Always include temperature and pressure of the room.

Data analysis
Graph 1: Graph must have labelling, units, uncertainties, error bars, line of best fit, clear grid lines, axis with the correct significant figures, and relevant annotations.

The graph shows TEMPERATURE (± 0.5°C) on the y-axis versus TIME (± 0.5s) on the x-axis with:

$$y = 0.0304x^3 - 0.7751x^2 + 6.937x$$
$$R^2 = 0.9911$$
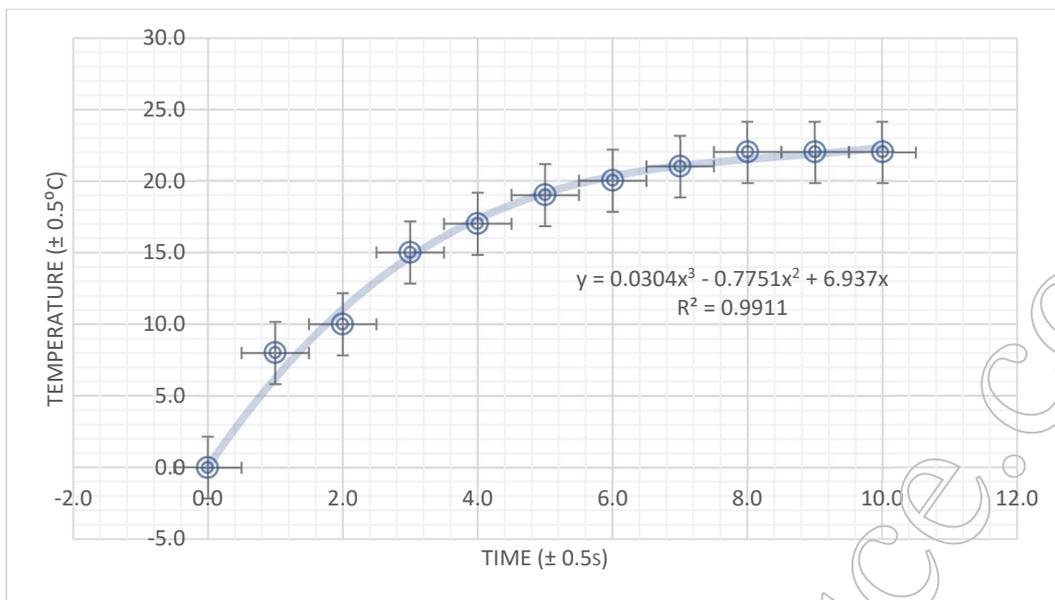
Example calculations must have <u>uncertainty propagation</u> (or absolute uncertainty of the mean if this is bigger) and comparison to literature value (percentage error calculation). Use correct significant figures for final results.

Calculations must be clear (formula, substitution, units) with relevant assumptions and explanations given, and have full uncertainty propagation (random error). Calculations are complete once percentage error is complete (systematic error). Reference the published value.

Example calculations for (trial 1):

Calculations	Uncertainty propagation

Discussion
Paragraph 1: Concluding relationship justified with data and scientific theory.
Point: Conclusion to the research question stated. "in conclusion, as the (independent variable) increases the (dependent variable)... in a linear relationship/exponential/reaches a maximum etc"
Evidence: Justified firstly stating the value/result or description of the graph from the experiment with data (eg equation of the line).
Explain: Justified secondly by using scientific theory to explain the results.

Paragraph 2: Analysis of the validity/accuracy of the data.
Point: State the degree of **validity** (and/or accuracy) of the **data.**
Evidence: This includes comparisons to **published results, percent error, line of best fit and r^2, percent yield, negative or positive controls, etc**
Explain: Justify your points with this evidence.

Paragraph 3: Analysis of the reliability/precision of the data.
Point: State the degree of **reliability** (and/or precision) of the **data.**
Evidence: This includes discussion on **uncertainty, error bars, anomalous results, etc.**
Explain: Justify your points with this evidence.

Limitations to method	Type of error	Effect on the calculated final result	Improvements/Extensions to method
1.	Random (precision) or Systematic (accuracy)	What will this do to the calculations? High, low or just increased uncertainty.	Be sure to explicitly state at least 2 extensions…'An extension would be to…change a variable'
2.			
3.			
4.			
5.			

Word count: _____ words

Reference list
Full references in alphabetical order.

Appendix
Appendix A: (original method label and in-text reference)