**(Title)—** Replace all headings in parentheses with detailed titles that match your experiment, and delete all red comments before turning in

**(Name, Date, Course)**

**Purpose Question:** Specific Question with a MEASURABLE outcome

**Independent Variable:** Manipulated factor which YOU set the parameters for
**Dependent Variable:** Measured Variable

**Hypothesis:** This is not a requirement, but does help when it comes to writing the conclusion

**Controlled variables:**
List all factors, minimum of 5, which could SIGNIFICANTLY affect your experiment and describe how you have either attempted to control them or how you will be monitoring them. Note: these are great to help you identify sources of error later in the report.

| Variable | How this experiment will control or monitor it |
|---|---|
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |

**Materials:**

**Procedure:**
Write for a peer, another Chemistry student. Include a diagram if possible (be sure to cite any copied diagrams- in a subtitle is fine)
Include at least 5 levels of the independent variable, and at least 3 trials at each level; 5 trials is ideal.

**Diagram:**

**(Data Table- meaningful title)**
A hand-written data table or printed/written is fine
Your lab group **can't** have the same table
Label all columns and rows plus give the table a meaningful title.
Include all units and uncertainties- in the column/row label if everything in the section is the same.
Record and report every measured value
Include QUALITATIVE data in or below the table
Report all significant figures, which you may need to adjust if using Excel

## Calculations

You have to calculate something, average as the absolute minimum, to answer the purpose question

Show work for at least 1 sample calculation and clearly label where every number came from. The easiest way to do that is to provide a word formula (ex: density= mass/volume)

Include uncertainties on the final answer and show your work for the uncertainty

## (Graph- meaningful title)

Must have proper labels and titles on the graph- including units

Graph should clearly answer purpose question

Make sure you have (1) correct sig figs (2) only processed data (3) error bars- whcih you may need to draw in if all values do not have the same error (4) independent variable on x axis, dependent on the y

## Conclusion:

Your actual conclusion is a simple statement that rephrases your purpose question- bam.

Justification= (1) discuss the uncertainties (error bars), (2) consistency of data, (3) % error and/or literature values if applicable and (4) how your result matches theory- the Chemistry involved

## Sources of Error and Improvements:

At least 4 significant sources of systematic error, in other words issues with the procedure NOT mistakes or instrument issues.

For each, explain how the issue would affect your final value (increase, decrease, or both-- but avoid having too many errors which coudl skew your data both up and down because those are usually weak sources of error)

Consider your qualitative data, controlled variables, any assumptions made during the experiment, and any portion which required human judgement

Address each source of error (if possible) with a suggested improvement- a specific amendment to the procedure

Never say "more time" or "better equipment" or "be more careful"

| Weakness/Source of Error | How it could skew the final result | Suggested Procedural Improvement |
|---|---|---|
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |

## Aspect 1: Concluding        CE

- ☐ Conclusion clearly stated using results to answer original aim
- ☐ Explanation should include observations, patterns or trends revealed by data
- ☐ Systematic or random errors should be considered when justifying conclusion
- ☐ Direction of any systematic errors should be commented on

- ☐ Where appropriate , the value of a known physical quantity should be compared with the literature value and literature source referenced
- ☐ % exp. Error should be compared with the total estimated error as derived from propagation of uncertainties.

## Aspect 2: Evaluating procedure(s)        CE

- ☐ Comment on the design and method of the investigation
- ☐ Comment on precision and accuracy of your measurements
- ☐ List the weaknesses and their significance (3 good ones)

## Aspect 3: Improving the investigation        CE

- ☐ Suggestions for improvements based on the weaknesses and limitations identified in aspect 2 (3 good ones)
- ☐ Suggest how to reduce random error and remove systematic error and achieve greater control of variables
- ☐ Modifications should address precision, accuracy and reproducibility of results

- ☐ Modifications are realistic and clearly specified.
- ☐ Modifications to exp. techniques and data range addressed.

Adapted from Stephen Taylor   (After John Burrell's Rubric: http://click4biology.info/index.htm) and other
http://sciencevideos.wordpress.com

## Aspect 1: Recording raw data                     DCP

- ☐ Quantitative data recorded clearly with units and uncertainties
- ☐ Numerical data is recorded clearly in a table with headings
- ☐ Sig figs must be consistent in data
- ☐ Sig figs must be consistent in the stated uncertainties
- ☐ Qualitative data recorded clearly
- ☐

## Aspect 2: Processing raw data                    DCP

- ☐ Has processed raw data correctly
  - ▪ Data manipulated to determine value of a physical quantity
  - ▪ Readings have been averaged
  - ▪ Data has been transformed into a suitable form for graphing
  - ▪ Graph has been plotted and slope determined from best-fit line

## Aspect 3: Presenting processed data              DCP

- ☐ Suitable presentation format
  - • Table, chart, graph, spreadsheet etc
- ☐ Graphs have appropriate scales, labeled axes with units and points plotted accurately with suitable best-fit line or curve.
- ☐ Uncertainties must be propagated
- ☐ Final derived quantity has clear metric/SI units and expressed to correct number of SF
- ☐ Presentation for all data is clear with all stages shown