

The Reminder Form of the Rules and Methods of the first year Cap Physics Laboratory:

Notebook Marking (out of 5)

- 1 mark off for each error in: Table of Contents; Expt. #; Title; Date; Objective; Introduction.
- 1 mark off for each missing handback.
- An Introduction requires: The solved working equation(s); Def. of all Vars and all Subscripts.
- The Header, Objective, and Introduction must be atomic in the notebook.

Data in the notebook (out of 5):

- Data is a collection of originating datum.
- A collection of datum may be tabulated.
- Every originating datum must be an value together with its unique identifier.
- An identifier must be a Variable, and may include a subscript and an index datum.
- Data must be atomic in the notebook.

Symbols and Definitions:

- The symbol for 'the uncertainty of' is ' Δ '.
- The symbol for 'the best estimate' is an overbar. (or overline or overscore)
- No Variable or Subscript may contain a whole word or space

Estimating Uncertainties:

- Start safe at 10^n
- Drop by tens until unsafe
- Go back up either 2, 5 or 10 to where you are uncertain.

Rough Calculations:

- write the solved working equation.
- Sub in the measurement units and solve.
- Using 1 sig fig, sub in the measured values and solve.

Proper Final Form:

- Powers of 10 and units are outside the bracket.
- 2 sig fig for the uncertainty
- Matching decimal places for the best estimate.

Every Calculation

- begins with a rough calculation
- follows with a 'good' calculation
- is atomic on a page.

All Calculated Values:

- require the calculation of a best estimate
- require the calculation of an uncertainty
- conclude with a statement in proper final form

Solve Complex Problems by:

- Turning the complex problem into a compound problem.
- Solving a part using known methods.
- Substituting.
- Repeating until done.

Rules for Calculating Uncertainties:

- the **2 Sig Fig Rule:**
 - All calculated uncertainties are 2 sig fig
 - the 'good' calculation of the uncertainty uses best estimates rounded to 2 sig figs.
- Uncertainties are always quoted as positive, even when they are calculated as negative.
- if $f = y + x$ or $f = y - x$ then $\Delta f = \Delta y + \Delta x$
- if $f = y * x$ or $f = \frac{y}{x}$ then $\Delta f = \bar{f} * (\frac{\Delta y}{\bar{y}} + \frac{\Delta x}{\bar{x}})$
- if $f = y^n$ then $\Delta f = \bar{f} n \frac{\Delta y}{\bar{y}}$
- if $f = \ln(y)$ then $\Delta f = \frac{\Delta y}{\bar{y}}$
- if $f = \exp(y)$ then $\Delta f = \Delta y * \exp(y)$
- if $f = \sin(y)$ then $\Delta f = \Delta y * \cos(y)$
- if $f = \cos(y)$ then $\Delta f = \Delta y * \sin(y)$
- General form: if $y = F(x)$ then $\Delta y = \Delta x * \frac{dF(\bar{x})}{dx}$

Comparison by Percent Difference of quantity 'A' to quantity 'B':

- The order matters.
- There is no standard symbol for 'the percent difference'
- The value is calculated as: $\frac{(A - B)}{B} * 100\%$
- The required statement reads like: "A is 12% greater than B"

Percent Uncertainty:

- The percent uncertainty of x $\equiv \frac{\Delta x}{x} * 100\% = \frac{\Delta x}{x}$

To Scale an Axis, find the scale and value of a tick:

- The scale of a tick is the range divided by the tick count, then rounded up to 1, 2, or 5
- The value of the highest tick is the range maximum, rounded up to the scale.

Formal scaling of an axis

- $C_t \equiv$ the number of available ticks on the axis
- $S_t \equiv \frac{X_{max} - X_{min}}{C_t}$; Round S_t up to the nearest 2, 5 or 10
- $X_g = \frac{X}{S_g} + B$

The slope of a line:

- The slope of any line is the constant ratio of rise over run.
- The best estimate of the slope is the slope of the line that fits the best.
- There are two 'worst fits': m_+ and m_- .
- To find m_+ :
 - start safe at infinity
 - rotate clockwise to half the distance to the best fit line
 - repeat until unsafe.
 - Rotate counter-clockwise until uncertain.
- To find m_- :
 - start safe at negative infinity
 - rotate counter-clockwise to half the distance to the best fit line
 - repeat until unsafe.
 - Rotate clockwise until uncertain.
- The uncertainty in the slope is given by $\Delta m = \frac{m_+ - m_-}{2}$

Uncertainty of Slope of Line, Special Case:

A special case is if the worst fit lines are the same as the best fit line.

Uncertainties can never be zero. Therefore, a different method is used:

- The best estimate of the slope is the slope of the line that fits the best.
- The uncertainty is given by $\Delta m = m * (\frac{\Delta Y}{Y})$
- $(\frac{\Delta Y}{Y})$ is the relative measurement uncertainty of the rise on your graph