PHYS1131 notes

Week 1, 28-9/2/17

Introduction

Data analysis

- Error and uncertainty
  - Every measurement has uncertainty/error
  - Types of error
    - **Systematic error** – due to measuring equipment
      - Non-zero mean – does not average out, i.e. values are consistently off from expected
      - e.g. calibration error, limitation of technique
    - **Random error** – due to human reaction time
      - Zero mean – averages out
      - e.g. precision of equipment
  - Nature of error
    - **Dependent –** errors are based on the same source (e.g. two lengths)
    - **Independent –** errors are based off different sources (e.g. length and mass)
  - Error calculations
    - Dependent – add LINEARLY
      - Adding/subtracting: add **absolute** errors (Δx)
        - e.g. $l = x + y \rightarrow \Delta l = \Delta x + \Delta y$
      - Multiplying/dividing: add **percentage** errors ($\Delta x/x$)
        - e.g. $v = l.h.b \rightarrow \Delta v/v = \Delta l/l + \Delta h/h + \Delta b/b$
        - Then, $\Delta v = v(\Delta l/l + \Delta h/h + \Delta b/b)$
      - Using formulae: Use differential method
        - e.g. $y = f(x) \rightarrow \Delta y = \Delta x \cdot f'(x)$
    - Independent – add in QUADRATURE (perpendicular)
      - Adding/subtracting: add **absolute** errors in quadrature
        - e.g. $l = x + y \rightarrow \Delta l = \sqrt{[(\Delta x)^2 + (\Delta y)^2]}$
      - Multiplying/dividing: add **percentage** errors in quadrature
        - e.g. $v = l.h.b \rightarrow \Delta v/v = \sqrt{[(\Delta l/l)^2 + (\Delta h/h)^2 + (\Delta b/b)^2]}$
        - Then $\Delta v = v\sqrt{[(\Delta l/l)^2 + (\Delta h/h)^2 + (\Delta b/b)^2]}$
      - Using formulae: add partial derivative weighted errors in quadrature
        - e.g. $z = f(x,y) \rightarrow \Delta z = \sqrt{[(\Delta x \cdot df/dx)^2 + (\Delta y \cdot df/dy)^2]}$
  - Error represented **error bars** and **lines of best/worst fit**