Physics 235. Heat, Sound and Light Laboratory

Error Propogation

1. Q is a **sum or difference** of independent measurements x_i, x_j, x_k, ... with errors δx_i, δx_j, δx_k, ...
$$\delta Q = \sqrt{\delta {x_i}^2 + \delta {x_j}^2 + \delta {x_k}^2 + \cdots}$$
   - Ex.) If $Q = a + b - c$, then $\delta Q = \sqrt{\delta a^2 + \delta b^2 + \delta c^2}$.
     Suppose $a \pm \delta a$=5±2, $b \pm \delta b$=6±2, $c \pm \delta c$=3±1. Then $Q \pm \delta Q = 8 \pm 3$.
2. Q is a **product or ratio** of independent measurements x_i, x_j, x_k, ... , with errors δx_i, δx_j, δx_k, ...
$$\frac{\delta Q}{Q} = \sqrt{(\frac{\delta x_i}{x_i})^2 + (\frac{\delta x_j}{x_j})^2 + (\frac{\delta x_k}{x_k})^2 + \cdots}$$
   - Ex) $Q = \frac{ab}{c}$. Then $\delta Q = Q\sqrt{(\frac{\delta a}{a})^2 + (\frac{\delta b}{b})^2 + (\frac{\delta c}{c})^2}$
     Suppose $Q = \frac{(9\pm1)\cdot(50\pm5)}{4\pm0.5}$, then $Q \pm \delta Q = 113 \pm 22$ which rounds to 110 ± 20.
3. $Q = kx$, where k is known exactly (i.e., a constant like π).
$$\delta Q = |k|\delta x$$
4. $Q = x^n$, where n is a power and x is the measurement.
$$\frac{\delta Q}{Q} = |n|\frac{\delta x}{|x|}$$
5. Q is *any* function of one variable x.
$$\delta Q = \left|\frac{dq}{dx}\right| \delta x$$