Chapter 1- Uncertainties

Addition or subtraction:

$$f(x,y,z) = x + y + z \rightarrow \delta f(x,y,z) = \sqrt{\delta x^2 + \delta y^2 + \delta z^2}$$

Multiplication or division:

$$f(x,y,z) = \frac{xy}{z} \rightarrow \frac{\delta f}{|f|} = \sqrt{\left(\frac{\delta x}{|x|}\right)^2 + \left(\frac{\delta y}{|y|}\right)^2 + \left(\frac{\delta z}{|z|}\right)^2}$$

Multiplication or division by a constant (a):

$$f(x) = ax \rightarrow \delta f = a\delta x$$

Powers:

$$f(x) = x^n \rightarrow \frac{\delta f}{|f|} = |n|\frac{\delta x}{|x|}$$

Special functions:

1. $f(x) = \sin(x) \rightarrow \delta f = \cos(x)\delta x$
2. $f(x) = e^x \rightarrow \delta f = e^x \delta x$
3. $f(x) = \ln(ax) \rightarrow \delta f = \frac{1}{|x|}\delta x$
4. $\mathrm{f(x)} = \log_{10}(x) = \frac{\ln(x)}{\ln(10)} = \frac{1}{\ln(10)}\ln(x) = 0.43\ln(x) \rightarrow \delta f = \frac{0.43}{|x|}\delta x$

Average:

$$f(x) = \bar{x} \rightarrow \delta f = \sigma = \sqrt{\frac{1}{N-1}\sum_{i=1}^{N}(x_i - \bar{x})^2}$$

where σ is the standard deviation.

Standard error of the mean (if $N \geq 5$):

$$SE = \frac{\sigma}{\sqrt{N}}$$