PH689-01 – Fall 2006

Statistical methods for physics and astrophysics

SOLUTIONS to Assignment #6

1. Problem 3.2 from Bevington, 2nd edition.

A=$\frac{\pi}{4}D^2$

Since the function is a power, use (3.28) with $a = \frac{\pi}{4}$, b=2

$\frac{\sigma_A}{A} = b \cdot \frac{\sigma_D}{D}$ =2%.

Same conclusions if you use the radius, since $r = \frac{1}{2}D$ and $\frac{1}{2}$ is a (deterministic) constant.

2. Problem 3.3 from Bevington, 2nd edition.

The resistance is given by

$R = a\frac{L}{\pi r^2}$

$\sigma_R^2 = \sigma_L^2(\frac{dR}{dL})^2 + \sigma_r^2(\frac{dR}{dr})^2$

assuming that L and r are measured independently.

$\frac{dR}{dL} = \frac{R}{L}$

$\frac{dR}{dr} = -\frac{2R}{r}$

$\Rightarrow (\frac{\sigma_R}{R})^2 = (\frac{\sigma_L}{L})^2 + 4(\frac{\sigma_r}{r})^2$

In order for the relative uncertainty $(\frac{\sigma_R}{R})$ to be equally coming from r and L, then the relative uncertainty in r should be twice as small as that in L.

3. Problem 3.5 from Bevington, 3rd edition.

Smell's la w is $n_2 sin(\theta_2) = n_1 sin(\theta_1)$, n_1 is known.

From the measurements of θ_1 and θ_2 one obtains n_2 as

$n_2 = n_1\frac{sin(\theta_1)}{sin(\theta_2)}$

$\frac{dn_2}{d\theta_1} = \frac{n_1 cos(\theta_1)}{sin(\theta_2)}$ $\frac{dn_2}{d\theta_2} = -\frac{n_1 sin(\theta_1)cos(\theta_2)}{sin(\theta_2)^2}$

$\sigma_{n_2}^2 = n_2^2(\sigma_{\theta_1}^2 \cdot cot(\theta_1)^2 + \sigma_{\theta_2}^2 \cdot cot(\theta_2)^2)$

$n_2 = 1.503$ from the best-fit values measured.

$\sigma_{n_2}^2 = 5.8 \cdot 10^{-4}$ (remember to use radians) $\Rightarrow n_2 = 1.503 \pm 0.024$