Geophysics 4133
Error Analysis
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Name: _____

For each of the following problems neatly show all steps of your work (partial credit may be given if your work can be easily followed). Clearly indicate your final answers and answer all parts of the question including the 'describe' and 'why' questions.

1. If I've measured elevation (and converted to radius from center of the Earth) to 6381km $\pm$ 0.0001 km, what is the fractional and absolute uncertainty for radius squared? What about for radius cubed? *(15 pt.)*

2. A student measures a section. The thickness of the beds are found to be $A = 10 \pm 0.5m$, $B = 15 \pm 0.6m$, $C = 12 \pm 0.2m$, and $D = 23 \pm 1.m$. *(15 pt.)*

   a) Assuming that the uncertainties are independent what are the sums and associated uncertainties for: $A + B$, $B + C$, and $C + D$.

   b) What if the uncertainties are NOT independent. What are the sums and associated uncertainties for: $A + B$, $B + C$, and $C + D$.

3. A sample of radioactive rock is collected and two students are assigned to count radioactive decays from the sample to determine its activity. The first student counts 425 particles in 30 minutes. The next student counts only for five minutes, but counts 73 particles. *(30 pt.)*

   a) What should student one report as the 30 minute count?

   b) What is the uncertainty?

   c) What is the fractional uncertainty?

   d) What should student two report as the 5 minute count?

   e) What is the uncertainty?

   f) What is the fractional uncertainty?

4. J.J. Thomson measured the charge to mass ratio (r) in a famous experiment. We can duplicate his experiment by accelerating electrons through a voltage V and bending them with a magnetic field. From these measurements we obtain r from the equation (using all SI units):

$$r = \frac{125}{32\mu_0^2 N^2}\frac{D^2 V}{d^2 I^2} \tag{1}$$

μ_0 is the permeability constant of a vacuum (4πx$10^{-7} N/A^2$ exactly). N is the number of turns in the coil producing the magnetic field; D is the diameter of the coil; V is the accelerating voltage; d is the diameter of the electron's curved path; I is the current in the field coils. The following measurements are made in the lab:

$N = 72$ (exactly)
$D = 661 \pm 2$mm
$V = 45.0 \pm 0.2$volts
$d = 91.4 \pm 0.5$mm
$I = 2.48 \pm 0.04$ amps

a) Find the charge to mass ratio from this experiment and the associated uncertainty. *(15 pt.)*

b) How does this compare to the accepted value of $r = 1.759$x10^{11} C/kg? *(15 pt.)*

5. How can this lab class be improved? *(5 pt.)*

6. How can the lab assignments be improved? *(5 pt.)*