Remark: the background for this problem can be found in the 370 Lab Manual, in the Photometry Lab, under "Air Mass Corrections" (p.84) which is also online at `http://www.physics.csbsju.edu/370/photometry.pdf`.

During the night of September 1 ($D = 244$), light from the star Vega is measured. The table below shows the photon counts during six one minute exposures taken during the night. Throughout these observations Vega was getting closer to the horizon. The angle from zenith, z, can be calculated from the location of the observatory (SJU observatory: longitude= 94° 23' 47", latitude= 45° 34' 30"), the declination of the star (look it up in wiki, you'll also need the RA to calculate the hour angle), and the hour angle (see p.18 in text).

Date	Time	Count	z	$\sec z$
1 Sep	21:00	1688		
	23:00	1585		
2 Sep	1:00	1525		
	2:00	1464		
	3:00	1397		
	3:30	1304		

As discussed in Taylor, under Poisson statistics the expected uncertainty in a count N is $\sqrt{N}$. You will want to use this in your fit! The formula for zenith angle is Eq. 4.38 in the Lab Manual and is also discussed below. The 'air mass' $\sec z$ is proportional to the amount of atmosphere the star's light has traversed, and hence is exponentially related to the light that makes it through the atmosphere. (The more atmosphere the light must traverse, the less that gets through.)

$$N = N_0 \ \exp(-\tau_0 \sec z) = A \exp(Bx) \tag{1}$$

When we report the 'brightness' of the star, we want to remove any atmospheric effects (as these would vary); we want the brightness before the light hits our atmosphere, which is N_0 in the above equation.

Problem Fill in the above table amd WAPP the data to find N_0. Make a nice semi-log plot of your result. Include a fit report.

Remark: Finding z

Consider a coordinate system for an observer with z-axis pointing to the North Celestial Pole, y pointing directly to the East horizon, and x to the Celestial Equator on the meridian. In this coordinate system, the unit vector coordinates of zenith are:

$$\mathbf{r} = (\cos\varphi, 0, \sin\varphi) \tag{2}$$

where φ is the latitude of the observer. (This is simply saying that zenith is on the meridian and angle φ from the Celestial Equator.) In this coordinate system the Hour Angle (h) increases in the opposite direction as the usual ϕ of spherical coordinates, so the unit vector pointing at a star is

$$\mathbf{r} = (\cos\delta\cos h, -\cos\delta\sin h, \sin\delta) \tag{3}$$

where δ is the star's declination. If you dot these two vectors to get the cosine between zenith and the star you get:

$$\cos z = \sin\delta\sin\varphi + \cos\delta\cos h\cos\varphi \tag{4}$$

Recall $\sec z = 1/\cos z$.