Problem 5. Diffraction grating *(7 points)*

The experiment is rather straightforward, except that the grating pitch is smaller than the wavelength. Therefore, for a perpendicularly falling laser beam, first main maximum cannot be observed. In order to observe that maximum, the laser beam needs to be inclined. The easiest way is to determine angle by which the first main maximum is observed at the direction, directly opposite to the laser beam. Then the optical path difference between the rays originating from two neighbouring stripes is found as $\Delta l = 2d \sin\alpha = \lambda$, so that $d = \frac{1}{2}\frac{\lambda}{\sin\alpha}$, where α is such an angle between the laser beam and grating surface normal for which the first main maximum is observed at the direction, directly opposite to the laser beam. $\sin\alpha = a/c$ can be calculated from geometrical measurements of the sides a and c of a right triangle. For the uncertainty, $\frac{\Delta\lambda}{\lambda} = \frac{\Delta a}{a} + \frac{\Delta c}{c}$. Measurements yield $d \approx (320 \pm 4)\,\mathrm{nm}$.