Q1- A 1.0 cm wide diffraction grating has 1000 slits. It is illuminated by light of wavelength 550 nm. What are the angles of the first two diffraction maxima?

In a diffraction grating if d is the spacing between two ruling (opaque lines = slits) and l is the wavelength of the light used, then the angle θ of the m[th] order maximum is given by

$$\sin\theta = \frac{m\lambda}{d}$$

Thus $$\sin\theta_1 = \frac{1*550*10^{-9}}{(0.01/1000)} = \frac{550*10^{-9}}{1*10^{-5}} = 0.055$$

Or $\theta_1 = 3.153^0$

And similarly for second maximum

$$\sin\theta_2 = \frac{2*550*10^{-9}}{(0.01/1000)} = \frac{2*550*10^{-9}}{1*10^{-5}} = 0.11$$

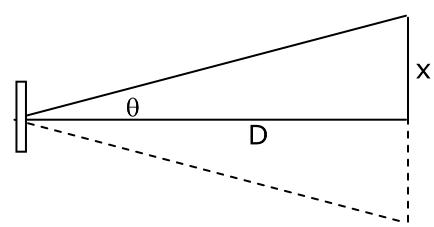
Or $\theta_2 = 6.315^0$

Q2- A helium-neon laser of wavelength 633 nm illuminates a diffraction grating. The distance between the two first order bright fringes is 32 cm on a screen 2.0 m behind the grating. What is the spacing between slits of the grating?

The angle of deviation θ of the first order maximum is given by

$$\sin\theta = \frac{\lambda}{d}$$

The distance x of this maximum from the central maximum is given by



$$x/D = \tan\theta = \frac{\sin\theta}{\sqrt{1-\sin^2\theta}} = \frac{\lambda/d}{\sqrt{1-(\lambda/d)^2}} = \frac{\lambda}{\sqrt{d^2-\lambda^2}}$$

Squaring this equation we have

$$d^2 - \lambda^2 = \lambda^2 D^2 / x^2$$

Gives $$d^2 = \lambda^2\left(1 + \frac{D^2}{x^2}\right)$$

Now as the two first order maximums are formed on the either side of the central maximum the distance between the two will be 2*x and hence we have

x = 32/2 = 16 cm.

Substituting the values of the given quantities we have

$$d^2 = (633*10^{-9})^2 * \left(1 + \frac{2^2}{0.16^2}\right) = 4.00*10^{-13}*157.25 = 6.3*10^{-11}$$

Or d = $7.94*10^{-6}$ m $=7.94*10^{-3}$ mm

****