Numericals

1) A plane differaction grating has the value of grating 15×10^{-4} cm. Calc position of 3rd principal max. for the light of $\lambda = 2.4\times10^{-4}$ cm

$(a+b) = d = 15\times10^{-4}$ cm

$n = 3 \quad \lambda = 2.4\times10^{-4} \quad \theta_3 = ?$

$(a+b)\sin\theta_n = n\lambda$

$\sin\theta_3 = \dfrac{3.\lambda}{a+b} = \dfrac{3\times2.4\times10^{-4}}{15\times10^{-4}\text{ cm}}$

$\theta_3 = \sin^{-1}(0.48)$

$\theta_3 = 28.68^{\circ}$

2) A grating has 15 cm of the surface ruled with 6000 lines per cm What is the RP of the grating in 1st order.

$L = 15$ cm $\quad$ ~~n = 60~~ $n = 1$

no of lines per cm 6000

$RP = nN$

$N \geqslant 6000 \times L =$

3] Calc the possible number of orders of spectra with a plane transmission grating having 18000 lines/inch when light of wavelength 4500Å is used.

$n = ?$ $N = 18000$ lines/in

$$= \frac{18000 \text{ lines}}{2.54}$$

$$\lambda = 4500Å = 4500 \times 10^{-8} \text{ cm}$$

By grating eq^n $(a+b)\sin\theta = n\lambda$

$$n = \frac{(a+b)\sin\theta}{\lambda}$$

$$a+b = 1/N$$

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

The max value for $\theta = 90°$; $\therefore \sin\theta = 1$.

$$\therefore n \leq \frac{1}{N\lambda}$$

$$n \leq \frac{2.54}{18000 \times 4500 \times 10^{-8}}$$

$$n \leq 3.135$$

$$\therefore \boxed{n \leq 3}$$

4] A transmission grating has 8000 rulings/cm. The 1st order principle max due to a monochromatic ~~sorce~~ source of light occurs at an angle of 30°. Determine λ of the light.

$N = 8000$ lines/cm $n = 1$ $\theta = 30$

$\lambda = ?$

$(a+b)\sin\theta = n\lambda$

$$\lambda = \frac{(a+b)\sin\theta}{n} = (a+b)\cdot\sin\theta$$

$$\lambda = \frac{1}{N}\sin\theta = \frac{\sin 30}{8000}$$

$\lambda = 6.25\times10^{-5}$ cm

$\lambda = 625$ nm

5] The Na yellow doubleslit has a λ of 589 nm & 589.6 nm. What should be the resolving power of the grating to resolve these lines?

RP of grating

$$RP = \frac{\lambda}{d\lambda} = \frac{\left(\frac{\lambda_1+\lambda_2}{2}\right)}{(\lambda_2-\lambda_1)}$$

$$= \frac{(589+589.6)\times10^{-9}}{(589.6-589)\times10^{-9}}$$

$=$

6] A plane transmission grating has 40000 lines in all with grating const 12.5×10^{-5} cm. Calc. the max resolving power for which it can be used in the range of $\lambda = 500$ nm

~~total lines over grating = 12.5×10^{-5} cm~~

total lines over grating

$= 40000$

$(a+b) = 12.5 \times 10^{-5}$ cm

$RP = nN = 2 \times 40000$

$= 80000$

$(a+b)\sin\theta = n\lambda$

$n = \dfrac{(a+b)\sin\theta}{\lambda}$

$n \leq \dfrac{(a+b)\sin\theta}{\lambda}$

$n \leq \dfrac{(a+b)}{\lambda} = \dfrac{12.5 \times 10^{-5}}{500 \times 10^{-9}} = 2$

$\therefore RP = nN = 2 \times 40000$

$= 80.000$

Applications of Michelson's interferometer

1) To determine wavelength of incident light

The monochromatic source of light whose wavelength is to be determined is kept at the position of the source 'S'. Let d_1 be the (distance) reading of micrometer for position of M_1 mirror. Now the position of M_1 is changed so that reading of the micrometer shows 'd_2'. At the same time no. of fringes disappearing at