A slit of width 0.16 mm is illuminated by a light of wavelength 5600 A°. Find the half angular width of the central maximum.

Data :→ $a = 0.016$ cm, $\lambda = 5600 \times 10^{-8}$ cm, $n = 1$

Formula :→

$$\boxed{a \sin\theta = n\lambda}$$

$$a \sin\theta = \lambda \quad (\text{As } n = 1)$$

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

$$\theta = \sin^{-1}(\lambda/a)$$

$$\theta = \sin^{-1}\left(\frac{5600 \times 10^{-8}}{0.016}\right)$$

$$\boxed{\theta = 12'}$$

A slit of variable width is illuminated by red light of λ = 6500 A°. At what width of the slit, the first minimum will fall at θ = 30° ?

Data :→

$\lambda = 6500 \times 10^{-8}$ cm.

$\theta = 30^\circ$

$n = 1$

Formula :→

$\boxed{a\sin\theta = n\lambda}$

$a\sin\theta = \lambda$

$$a = \frac{\lambda}{a\sin\theta} = \frac{6500 \times 10^{-4}}{\sin 30}$$

$\boxed{a = 0.13 \times 10^{-3} \text{ cm.}}$

A light of wavelength 5×10^{-5} cm is incident normally on the plane transmission grating of width 3 cm and having 15000 lines. Find the angle of diffraction in the first order.

Data :→

$\lambda = 5 \times 10^{-5}$ cm

$(a+b) = \frac{3}{15000}$

$n = 1.$

Formula :→

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

Solution :→

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

$\theta = \sin^{-1}\left(\frac{\lambda}{a+b}\right) = \sin^{-1}\left(\frac{5\times10^{-5}}{3} \times 15000\right)$

$\theta = 14^\circ\, 29'$

A parallel beam of sodium light is allowed to be incident normally on a plane grating having 4250 lines per cm and a second order spectral line is observed to be deviated through 30°. Calculate the wavelength of the spectral line.

Data :-

$\theta = 30°.$

$a+b = \frac{1}{4250}$

$n = 2.$

Formula :-

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

Solution :-

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

but $n = 2$

$(a+b)\sin\theta = 2\lambda$

$\lambda = \frac{(a+b)\sin\theta}{2}$

Substituting

$\lambda = \frac{1}{4250} \times \frac{1}{2} \times \frac{1}{2}$

$\lambda = 5.880 \times 10^{-5}\ \text{cm}$

$$\boxed{\lambda = 5880\ \text{Å}.}$$

A grating has 6000 lines/cm. Find the angular separation of two yellow lines of mercury of wavelengths 5770 A° and 5791 A° in the second order.

Data :→ $a+b = \frac{1}{6000}$ cm.

$\lambda_1 = 5770 \times 10^{-8}$ cm

$\lambda_2 = 5791 \times 10^{-8}$ cm.

$n = 2$

Formula :→ $\boxed{(a+b)\sin\theta = n\lambda}$

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

For λ_1

$(a+b)\sin\theta_2 = n\lambda_1$

$\sin\theta_2 = \frac{n\lambda_1}{(a+b)} = 2\times 5770\times 10^{-8} \times 6000$

$\sin\theta_2 = 0.6924$

$\theta_2 = 43.82'$

& $\sin\theta_2 = \frac{n\lambda_2}{(a+b)} = 2\times 5791\times 10^{-8} \times 6000 = 0.6949 = 44.02^{0}$

$\boxed{\theta_1 - \theta_2 = 0.2^{\circ} \text{ or } 12'}$

What is the highest order spectrum that is visible with light of wavelength 6000 A° by means of a grating having 5000 lines per cm ?

Data :→ $\lambda = 6000\,\text{Å}$.

$N = 5000 \frac{\text{lines}}{\text{cm}}$,

$$a+b = \frac{1}{5000} \text{ cm.}$$

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

Solution :→ Take, $\sin\theta = 1.$

$$a+b = n\lambda$$

$$\frac{1}{5000} = n \times 6000 \times 10^{-8}$$

$$n = 3.3$$

The highest order is $n = 3.$

Monochromatic light from He-Ne laser source (λ=6328A°) is incident normally on a diffraction grating having 6000 lines/cm. find the angle at which one would observe second order maximum.

Data :→

$\lambda = 623.8\ nm. = 623.8 \times 10^{-7}\ cm.$

$N = 6000 \frac{lines}{cm}$

$(a+b) = \frac{1}{6000}\ cm.$

Formula :→ ① $\boxed{(a+b) = \frac{1}{N}\ cm.}$

② $\boxed{(a+b)\sin\theta = n\lambda.}$

Solution :→

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

for $n=1$, $\theta_1 = \sin^{-1}\left(\frac{1 \times 623.8 \times 10^{-7}}{1.66 \times 10^{-4}}\right) = \boxed{22.31^\circ.}$

for $n=2$, $\theta_2 = \sin^{-1}\left(\frac{2 \times 623.8 \times 10^{-7}}{1.66 \times 10^{-4}}\right) = \boxed{49.39^\circ}$

The angular separation of two stars is 1.5 seconds. Find the minimum aperture of a telescope objective, if the two stars are to be distinguished as separate, given $\lambda = 5700 A^o$.

$\boxed{\text{Data :}\rightarrow}$

$\lambda = 5700 \times 10^{-8}$ cm.

$d\theta = 1.5$ second.

$1.5 \text{ second} = \frac{1.5''}{3600} \times \frac{\pi}{180}$ radians.

$= 0.72 \times 10^{-5}$ radians.

$\boxed{\text{Formula :}\rightarrow}$ $\boxed{d\theta = 1.22 \frac{\lambda}{d}}$

$\boxed{\text{solution :}\rightarrow}$ $d\theta = 1.22 \frac{\lambda}{d}$

aperture, $d = 1.22 \frac{\lambda}{d}$

$d = 1.22 \frac{\lambda}{d\theta}$

Substituting $d = 1.22 \frac{\lambda}{d\theta}$

$d = \frac{1.22 \times 5700 \times 10^{-8}}{0.72 \times 10^{-5}}$

$\boxed{d = 9.65 \text{cm.}}$

The objective of a telescope has a dia... of 40 inches. Calculate the smallest angular separat... two stars that may be resolved by it. Mean waveleng... light $\lambda = 5600\ A^o$.

Data :→

$x = 40$ inches. $= 40 \times 2.54\,cm$.

$= 1.016\,m$

$\lambda = 5600 \times 10^{-10}\,m$.

formula :→

$$\boxed{d\theta = \frac{1.22\lambda}{d}}$$

solution :→

$$d\theta = \frac{1.22\lambda}{d}$$

$$= \frac{1.22 \times 5600 \times 10^{-10}}{1.016}$$

$$\boxed{d\theta = 6.724 \times 10^{-7}\ \text{radians.}}$$

$d\theta$ is the smallest Angular separation between the stars can be resolved by the telescope.