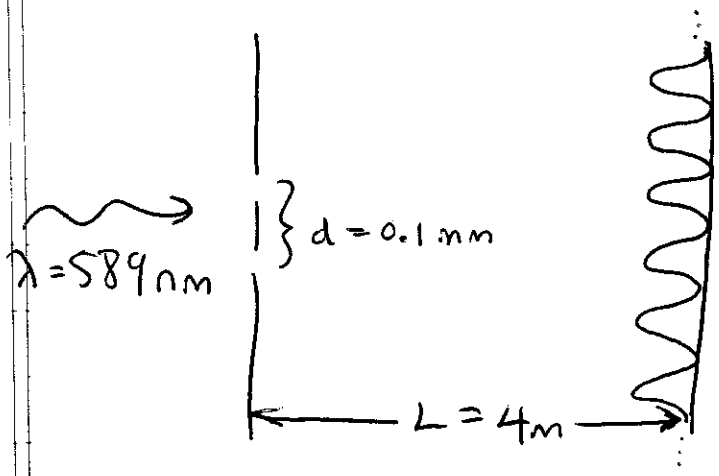
Chapter 24- Diffraction

(2)



$$y_{max} = m\frac{\lambda L}{d}$$

third order bright fringe ⇒

path length difference $= 3\lambda$

$= 3(589\ nm)$

$= \boxed{1767\ nm}$ //

third order dark fringe ⇒

path length difference $= (2+\frac{1}{2})\lambda$

$= \boxed{1472.5\ nm}$ //

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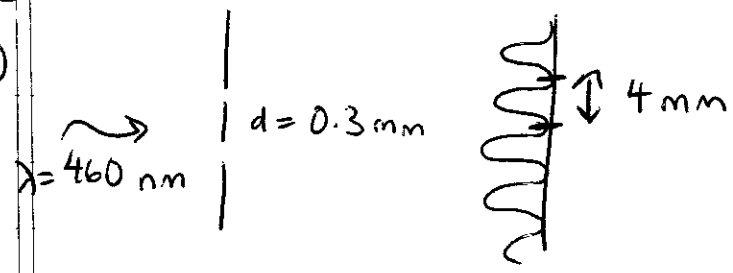
(4)



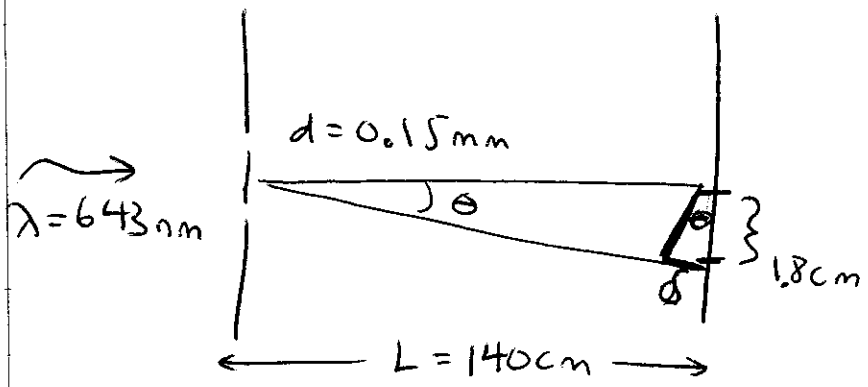
$$y_{min}^{(1)} = (\tfrac{1}{2})\frac{\lambda L}{d}$$

$$y_{min}^{(2)} = (\tfrac{3}{2})\frac{\lambda L}{d}$$

$$\Rightarrow \Delta y = (1)\frac{\lambda L}{D} = 4mm$$

$$L = \frac{D\,\Delta y}{\lambda} = \boxed{2.61\ m}$$ //

(10)



$\tan\theta = \frac{y}{L} \Rightarrow \theta = \arctan\left(\frac{y}{L}\right) = 0.74^\circ$

$\delta = d\sin\theta = 1.93\times10^{-3}$ mm //

$\frac{\delta}{\lambda} = 3$ //

path length $= 3\lambda \Rightarrow$ integer $* \lambda \Rightarrow$ constuctive interfernce

$\Rightarrow$ maximum //

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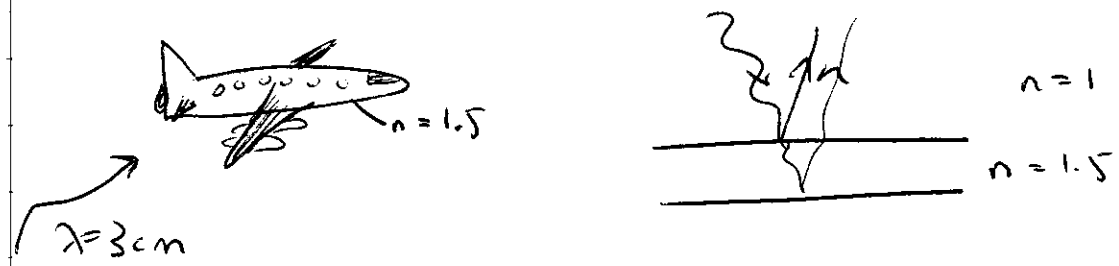
(19)



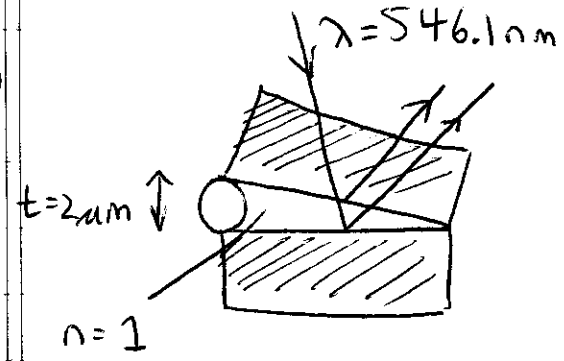
require destructive interference between 2 reflected waves

$2nt = (n + \frac{1}{2})\lambda$, want $n = 0$ to have smallest layer

$2nt = \frac{1}{2}\lambda$

$t = \frac{1}{4n}\lambda = \boxed{0.5\text{ cm}}$ //

(22)



destructive interference $\Rightarrow$ $2nt = m\lambda$

$\Rightarrow m = \frac{2t}{n\lambda}$ at thickest part

$= 7.32$

$\Rightarrow$ we have 7th order, but not 8th order dark fringe

so $m = 0, 1, \ldots, 7$

$\Rightarrow$ <u>8</u> dark fringes

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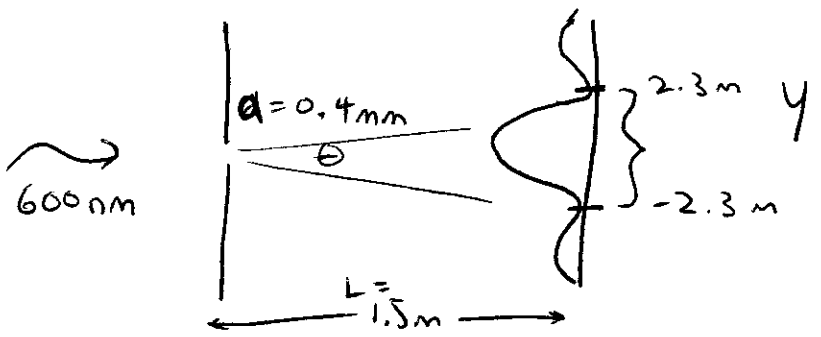
(30)

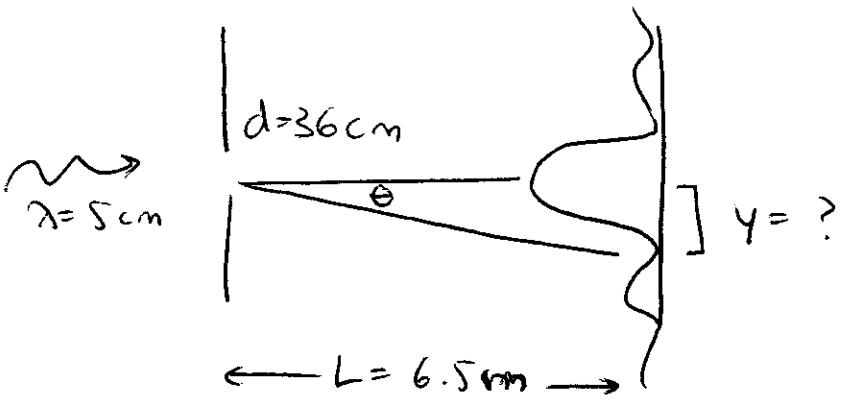


$\sin\theta_{dark} \simeq \frac{y_{dark}}{L} = \frac{m\lambda}{a}$

$y_{dark} = \pm\frac{L\lambda}{a} = \pm 2.25mm$

$\Rightarrow$ width of central maximum = <u>4.5mm</u>

(32)



$$d \sin\theta_{min} = m\lambda$$

approximately, $\frac{dy_{min}}{L} = m\lambda$

$$\Rightarrow y_{min} = \frac{m\lambda L}{d}, \text{ for } m = 1$$

$$= 10.3 \text{ cm} //$$

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(36) diffraction grating → 600 lines/mm $\Rightarrow d = \frac{1}{600}$ mm

in visible spectrum, largest $\lambda \approx 700$m

largest m coorespands to $\sin\theta = 1$

$$d \cancel{\sin\theta}^{1} = m\lambda \Rightarrow m = \frac{d}{\lambda} = 2.38$$

$\Rightarrow$ see 2 complete orders

for first order, $\Delta\theta$ for $\lambda = 400 \rightarrow 700$ nm

$$\Delta\theta = \theta_{700} - \theta_{400} = \arcsin\left(\frac{\lambda_{700}}{d}\right) - \arcsin\left(\frac{\lambda_{400}}{d}\right) = \boxed{10.9^\circ} //$$

(40) 2000 lines/cm $\Rightarrow$ $d = \frac{1}{2000}$ cm

$\lambda_{red} = 640$ nm

$d \sin\theta = m\lambda$ (m = 1)

$\theta = \arcsin\left[\frac{\lambda}{d}\right] = 7.35°$