46-3

$a \sin\theta = m\lambda$ gives MINIMA in single-slit diffraction

2^{nd} minimum $\Rightarrow m = 2$

from geometry $\sin\theta = \dfrac{y}{D}$ y = position on screen, D = slit to screen distance

a) $\sin\theta = \dfrac{1.62\text{ cm}}{2.16\text{ m}} \Rightarrow \theta = 0.43$

b) $a = \dfrac{m\lambda}{\sin\theta} = \dfrac{2\lambda}{y}D = 1.18 \times 10^{-4}\text{ m}$

46-7

$2y = 5.20\text{ mm} \Rightarrow y = 2.60\text{ mm}$
$D = 82.3\text{ cm}$
$\lambda = 546\text{ nm}$

$a \sin\theta = m\lambda$

$a = \dfrac{m\lambda}{\sin\theta} = \dfrac{m\lambda D}{y} = \dfrac{(1)(546\text{ nm})(82.3\text{ cm})}{(2.60\text{ mm})}$

$= 1.73 \times 10^{-4}\text{ m}$

46-11 a) $\sin\theta = \dfrac{1.13\text{ cm}}{3.48\text{ m}} \Rightarrow \theta = 3.25 \times 10^{-3}\text{ rad}$

b) $\alpha = \dfrac{\phi}{2} = \dfrac{\pi a}{\lambda}\sin\theta = 0.478\text{ rad}$

c) $I_\theta = I_m \dfrac{\sin^2\alpha}{\alpha^2} = 0.91$

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4c - 12

Doubling the width effectively doubles the number of secondary sources along the slit. The light from all of these sources is <u>in phase</u> at the center of the pattern

∴ the amplitude <u>doubles</u> and therefore the intensity increases by a factor of four

however, the width of the central maximum decreases by a factor of 2 $y = (m\lambda D/a)$ so the total energy in the central max has only increased by a factor of 2, as expected

4c - 35

a) the first minimum associated w/ diffraction through each individual slit is at $\theta = 5°$.

$$a\sin\theta = m\lambda \Rightarrow a = \frac{(1)(440\,nm)}{(\sin 5°)} = 5.05\times10^{-6}\,m$$

b) the first min. associated w/ double slit interference is at $0.625°$

$$d\sin\theta = (m+\tfrac{1}{2})\lambda \Rightarrow d = \frac{\lambda}{2\sin\theta} = 2.0\times10^{-5}\,m$$

any

47-1

a) 6140 rulings in 21.5 mm $\Rightarrow d_{adj} = 3.5\times10^{-6}$ m

b) $d\sin\theta = m\lambda \Rightarrow \theta = \sin^{-1}\left(\frac{m\lambda}{d}\right)$

$= 9.7°, 19.7°, 30.3°, 42.3°, 57.3°,$

47-9 a) $I = \frac{I_m}{9}(1 + 4\cos\phi + 4\cos^2\phi)$

$I = I_m$ at $\phi = 0$ & 2π

$I = 0$ at $\phi = \frac{2\pi}{3}$ & $\frac{4\pi}{3}$

from: $1 + 4\cos\phi + 4\cos^2\phi = 0$

$\cos\phi = \frac{-4 \pm \sqrt{16-16}}{8}$

$\phi = \cos^{-1}\left(\frac{-1}{2}\right)$

$= 120°, 240°$

b) $\frac{dI}{d\phi} = \frac{I_m}{9}(-4\sin\phi - 8\cos\phi\sin\phi)$

extrema occur where $\frac{dI}{d\phi} = 0$

$= -\frac{4I_m}{9}\sin\phi(1 + 2\cos\phi)$

$\Rightarrow 1 + 2\cos\phi = 0$ OR $\sin\phi = 0$

$\downarrow$ minima as above

$\Rightarrow \phi = 0, \pi, 2\pi$

0 & 2π are the PRINCIPAL

c) $I(\phi = \pi) = \frac{I_m}{9}$

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47-12

200 rulings/mm $\Rightarrow d = 5 \times 10^{-6}$ m

$d \sin\theta = m\lambda$

$\lambda = \frac{d \sin\theta}{m}$ $m = 1, 2, 3, \ldots$

$= 2347$ nm, 1174 nm, 782 nm, 586 nm,
469 nm, 391 nm

these are in the visible range