5.

a)conditions for minima at the two wavelengths

$$a\sin\theta_a = m\lambda_a$$

$$a\sin\theta_b = n\lambda_b$$

$$\sin\theta_a = \theta_b \text{ when } m = 1 \text{ and } n = 2$$

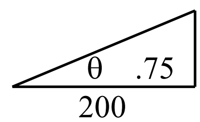
$$\lambda_a = 2\lambda_b$$

b) $\theta_a = \theta_b$ **implies** $n = 2m$

$\therefore$ **every other min @** λ_b **coincides with min for** λ_a

6.

$$\text{minima } a = \frac{m\lambda}{\sin\theta}$$



$$\sin\theta \approx \tan\theta \approx \frac{.75}{200}$$

$$a\left(\frac{.75}{200}\right) = 441 \times 10^{-9}\,\text{m}$$

$$a = .118\text{m}$$

15.

a) half width of central max

when $\frac{I_\theta}{I_{max}} = .5 = \frac{\sin^2\alpha}{\alpha^2}$

$\therefore \sin^2\alpha = .5\alpha^2 = \frac{\alpha^2}{2}$

b) $\left(\frac{\sin\alpha}{\alpha}\right)^2 = .5$

this formula can not be solved algebraically

$\therefore$ try an approx $\alpha = \frac{\pi}{2}$

$\left(\frac{\sin\frac{\pi}{2}}{\frac{\pi}{2}}\right)^2 = .405$ decrease α!

try $\alpha = 80^\circ$

$\left(\frac{\sin 80^\circ}{1.40}\right)^2 \approx .5 \quad 80^\circ \approx 1.40\text{radians}$

c) find θ using $\alpha = \frac{\pi a}{\lambda}\sin\theta$

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

$\sin\theta = \frac{\lambda}{a}\left(\frac{1.40}{\pi}\right) = \frac{\lambda}{a}(.445)$

remember $\Delta\theta$ would be twice this angle

$\Delta\theta = 2\sin^{-1}\left(.445 * \frac{\lambda}{a}\right)$

d) when $a = \lambda$

$\Delta\theta = 52.8^\circ$

when $a = 5\lambda$

$\Delta\theta = 10.2^\circ$

etc.

21.

θ = angle subtended @ observer by object

a = mirror diameter

d = distance to object

D = linear seperation

$$\sin\theta \approx \frac{D}{d}$$

Rayleigh criteria

$$a\sin\theta = 1.22\lambda$$

$$\therefore D = \frac{1.22\lambda d}{a}$$

$$a)D = 1.1\times 10^{4}\,\text{km, eye}$$
$$b)D = 11\text{km, mirror}$$

23.

b) in eye angle is θ'

$$\sin\left(\frac{1}{2}\theta\right) = n\sin\left(\frac{1}{2}\theta'\right)$$

$$\sin\theta' = 1.22\frac{\lambda/n}{a}$$

for small angles

$$r = \frac{d}{\theta} = \frac{d}{n\theta'} \qquad n\sin\theta' = n\theta' = \frac{n * 1.22\lambda/n}{a} = 1.22\frac{\lambda}{a}$$

$$\Rightarrow r = \frac{d}{1.22\lambda/a} = \frac{ad}{1.22\lambda} = \frac{1.4(0.005)}{1.22(550\times 10^{-10})} = 10.4\text{km}$$

$$a)\,\Theta_R = \frac{1.22\lambda}{d} = \frac{1.22(550\times 10^{-9}\,\text{m})}{5\times 10^{-3}\,\text{m}} = 1.34\times 10^{-4}\,\text{rad}$$

35.

want sixth min of interference

to coincide with first min of diff.

$m\lambda = d\sin\theta$

$n\lambda = a\sin\theta$

$\therefore \frac{d}{a} = \frac{m}{n} = M$

for eleven fringes

m = 6 and n = 1

$\therefore \frac{d}{a} = 6$

between first and second diff min

how many peaks are between 6&12? 5

43.

a)location of interference fringes

$d\sin\theta_i = m\lambda$

diffraction minima

$a\sin\theta_d = n\lambda$

d = 5a

m = 5

fringe falls at same position as n = 1 diff

inside central diff envelopes are = 1,2,3,4

fringes on each side of central(m = 0)fringe

$\therefore$ q in all

b)third fringe

$\sin\theta_i = \frac{3\lambda}{d} = \frac{3\lambda}{5a}$

$\frac{I}{I_m} = \left(\frac{\sin\alpha}{\lambda}\right)^2$

$\alpha = \frac{\pi a \sin\theta_d}{\lambda} = \frac{\pi a \sin\theta_i}{\lambda} = \frac{3\pi}{5}$

$\therefore \frac{I}{I_m} = .255$

45.

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

$$\text{needd} = \frac{.2\text{meters}}{6000} = 3.33\times10^{-5}$$

$$\sin\theta = \frac{(1)589\times10^{-9}}{3.33\times10^{-5}}$$

$$\theta_1 = 10^\circ$$

$$\text{b)for } m = 2, \Theta = 20.7^\circ$$

$$\text{for } m = 3, \Theta = 32.2^\circ \text{ etc}$$

46.

$$d = \frac{.001}{315} = 3.17\times10^{-6}$$

$$\sin\theta_{max} = 1.0 = \frac{5\lambda}{3.17\times10^{-6}}$$

$$\lambda < 635\text{nm}$$

58.

$$\Delta\lambda = \frac{500\text{nm}}{600(3)} = 27.7\text{pm}$$

61.

third order m = 3

R = 1000

#rulings

$$n = \frac{1000}{3} = 330$$

$$d\sin\theta = m\lambda$$

$$d = \frac{3(589\times10^{-9})}{\sin10^\circ} = 10175\times10^{-9}$$

$$d = 1\times10^4\text{nm}$$

$$1\times10^4\text{nm} = \frac{333}{1\text{cm}}$$

$$\frac{1000\text{nm}}{330} = 3.03\text{nm}$$