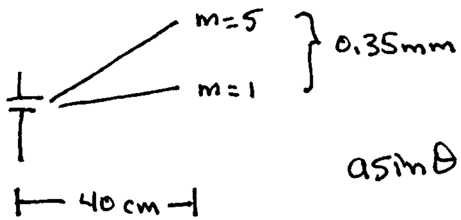
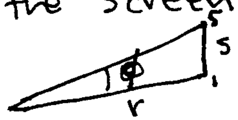
36-1



$a\sin\theta = m\lambda$

$\lambda = 550nm$

Notice that the separation between diffraction zeroes is small compared to the distance between the slit and the screen.



Consider this a pie wedge

$s = r\phi$

$(0.35\times10^{-3}) = 0.40\ \phi$

$\phi = 8.75\times10^{-4}$ radians

a) 1st Diffract Zero

$a\sin\theta_1 = 1\lambda$

5th Diffract Zero

$a\sin\theta_5 = 5\lambda$

use small angle approximation

$a\,\theta_1 = 1\lambda$

$a\,\theta_5 = 5\lambda$

Take difference

$a\theta_5 - a\theta_1 = 5\lambda - 1\lambda$

$a(\theta_5 - \theta_1) = 4\lambda$

$a(8.75\times10^{-4}) = 4(550\,nm)$

$a = 2.51\times10^{6}\,nm = 2.51\times10^{6}\ 10^{-9}\,m$

$= 2.51\times10^{-3}\,m$

$= 2.51\,mm$

b) Calculate θ_1

$a\sin\theta_1 = 1\lambda$

$(2.51\times10^{-3})\sin\theta_1 = 1(550\times10^{-9}\,m)$

$\theta_1 = 3.8\times10^{-6}$ degrees

36-4

was $\lambda \sim 50\,cm$

now $\lambda \sim 10\,mm$

a) Diffaction is most apparent when the wavelengths are comparable to the sizes of objects. 10mm is much smaller than the characteristic size of building obstructions, so we would expect diffraction effects to be not so apparent.

b) Use single slit formula

$a\sin\theta = m\lambda$

5m, 1

If $\lambda = 50cm$

$5\sin\theta = 1(0.50\,m)$

$\theta \simeq 5.74^\circ$

$2\theta \simeq 11.5^\circ$

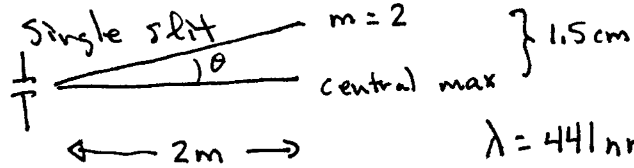
If $\lambda = 10mm$

$5\sin\theta = 1(0.010\,m)$

$\theta \simeq 0.11^\circ$

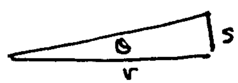
$2\theta \simeq 0.22^\circ$

36-6 Single slit



$\lambda = 441\,nm$

Estimate θ for $m = 2$



$s = r\theta_2$

$(0.015\,m) = (2\,m)\,\theta_2$

$\theta_2 = 0.0075$ rad

Width of slit

$a \sin\theta = m\lambda$

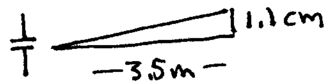
$a \sin\theta = 2\lambda$

$a \sin(0.0075\,rad) = 2\,(441 \times 10^{-9}\,m)$

$a = 1.18 \times 10^{-4}$ m

$= 0.118$ mm

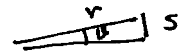
36-13 Single slit



$\lambda = 538\,nm$

$a = 0.025\,mm$

a) Estimate θ for this location



$s = r\theta$

$(0.011) = 3.5\,\theta$

$\theta = 3.14 \times 10^{-3}$ rad

b) α The book defines α as:

$\alpha = \frac{1}{2}\phi = \frac{\pi a}{\lambda}\sin\theta$ pg 997

$= \frac{\pi(0.025 \times 10^{-3})}{538 \times 10^{-9}} \sin(3.14 \times 10^{-3}\,rad)$

$= 4.59 \times 10^{-1}$

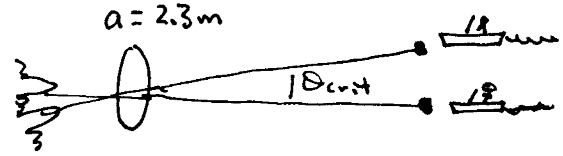
c) Intensity ratio from book

$\frac{I(\theta)}{I_m} = \left(\frac{\sin\alpha}{\alpha}\right)^2$ pg 999

$= 0.93$

36-20

$a = 2.3\,m$



$\lambda = 1.6\,cm$

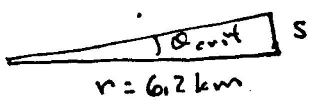
Circular aperature

$$a \sin\theta_{crit} \simeq 1.22\,\lambda$$

$$2.3 \sin\theta_{crit} \simeq 1.22\,(0.016)$$

$$\theta_{crit} \simeq 8.49\times10^{-3}\ rad$$

Then



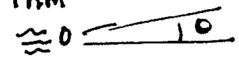
$$s = r\,\theta$$

$$= (6200\,m)(8.49\times10^{-3}\,rad)$$

$$= 52.6\,m$$

36-33

$\lambda = 1.4\,nm$



$a = 0.2\,mm$

Circular aperature

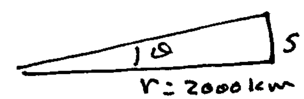
$$a \sin\theta_{crit} = 1.22\,\lambda$$

~~$(0.2mm) \sin\theta_{crit} = 1.22\,\lambda$~~

$$(0.2\times10^{-3}) \sin\theta_{crit} = 1.22\,(1.4\times10^{-9})$$

$$\theta_{crit} = 8.54\times10^{-6}\ rad$$

Diameter of beam 2000 km away



$$s = r\,\theta$$

$$= (2000\times10^{3})(8.54\times10^{-6}\,rad)$$

$$= 17.1\,m$$

The reduction factor will be the ratio of areas

$$\frac{A_{far}}{A_{close}} = \frac{\pi r_{far}^2}{\pi r_{close}^2} \propto \left(\frac{d_{far}}{d_{close}}\right)^2$$

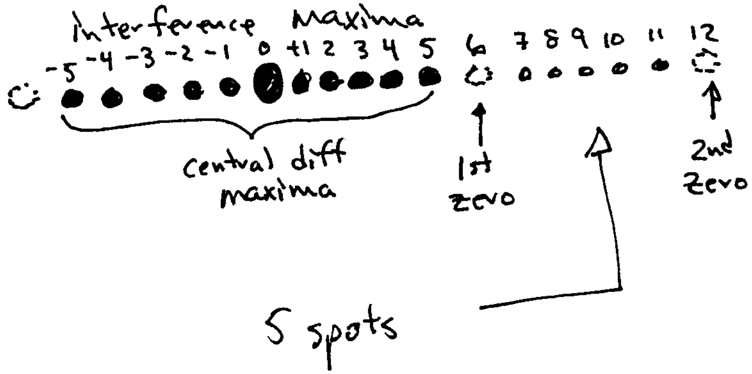
$$\sim \left(\frac{17.1}{0.2\times10^{-3}}\right)^2$$

$$\sim 7.3\times10^{9}$$

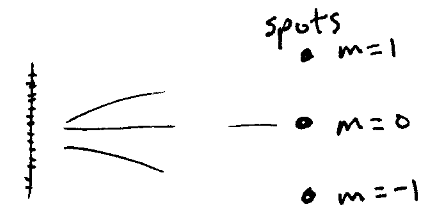
– a big reduction factor

36-35 Double Slit

Central diffraction envelope contains 11 interference maxima



36-44



The angle btw $m=+1$ and $m=-1$ is 26°

Therefore the angle of +1 is just

$$\frac{26^\circ}{2} = 13^\circ$$

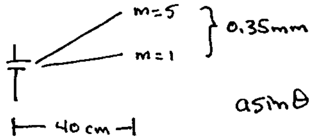
$$d\sin\theta = m\lambda$$

$$d\sin 13^\circ = 1(550\times10^{-9})$$

$$d = 2.44\times10^{-6}\ m$$

$$= 2.44\ \mu m$$

36-1



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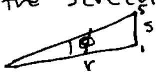

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5th Diffract Zero

$a\sin\theta_5 = 5\lambda$

use small angle approximation

$a\ \theta_1 = 1\lambda$ $\qquad$ $a\ \theta_5 = 5\lambda$

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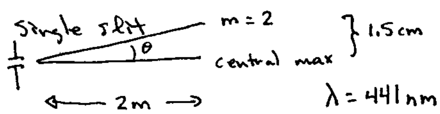
36-6



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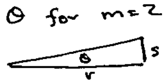

$s = r\theta_2$

$(0.015m) = (2m)\ \theta_2$

$\theta_2 = 0.0075$ rad

Width of slit

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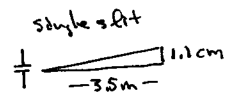
36-13



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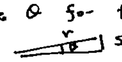

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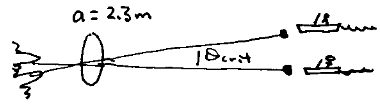
36-20



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Circular aperature

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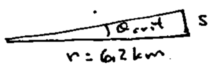

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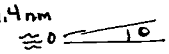
36-33 $\lambda = 1.4\,nm$



$a = 0.2\,mm$

Circular aperature

$$a \sin\theta_{crit} = 1.22\lambda$$
~~(0.2 mm) sin θcrit = 1.22 λ~~
$$(0.2\times10^{-3})\sin\theta_{crit} = 1.22(1.4\times10^{-9})$$
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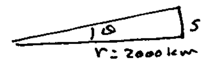
Diameter of beam 2000 km away



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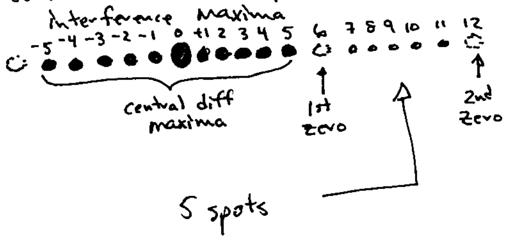
$$\sim \left(\frac{17.1\,m}{0.2\times10^{-3}}\right)^2$$
$$\sim 7.3\times10^{9}$$

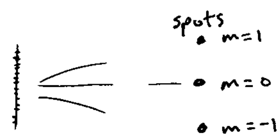
– a big reduction factor

36-35 Double Slit

Central diffraction envelope contains 11 interference maxima



36-44



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