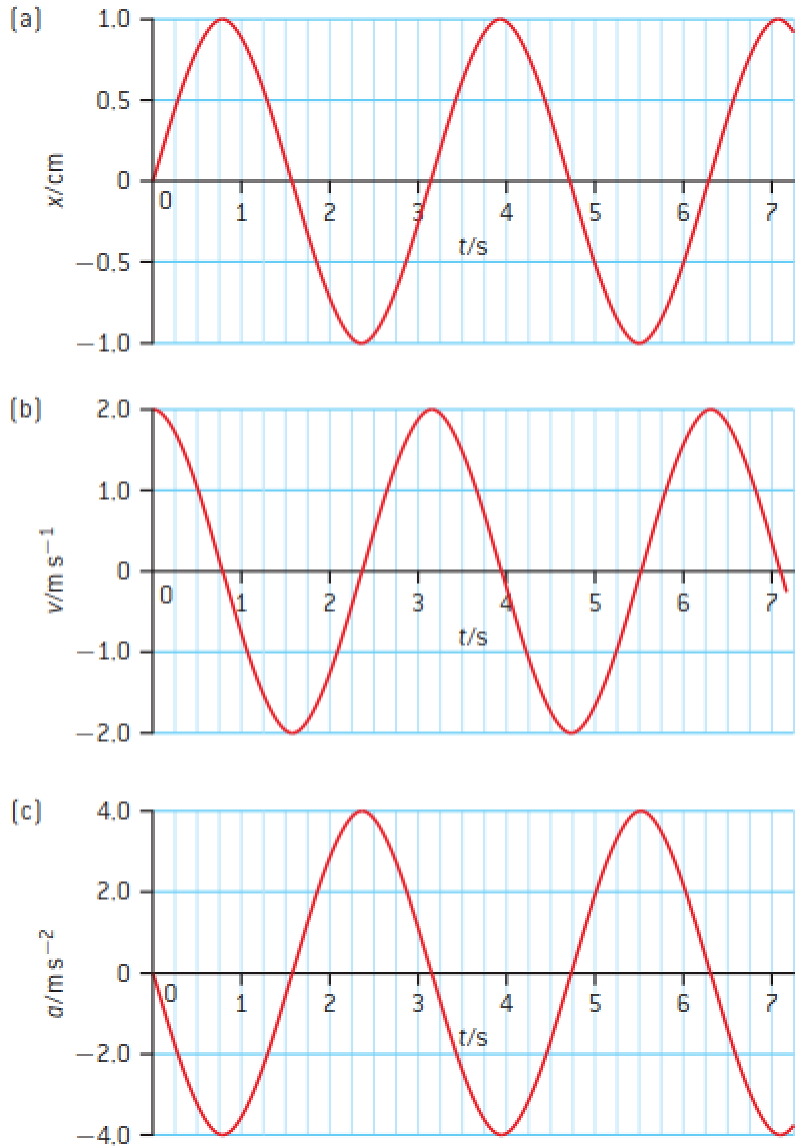
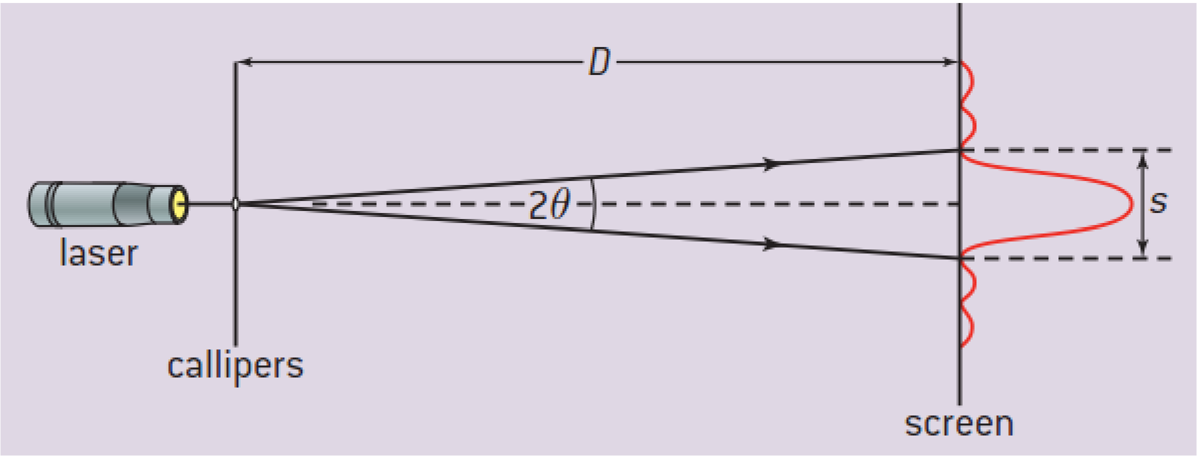


▲ Figure 8 The variation with time of displacement, velocity, and acceleration.

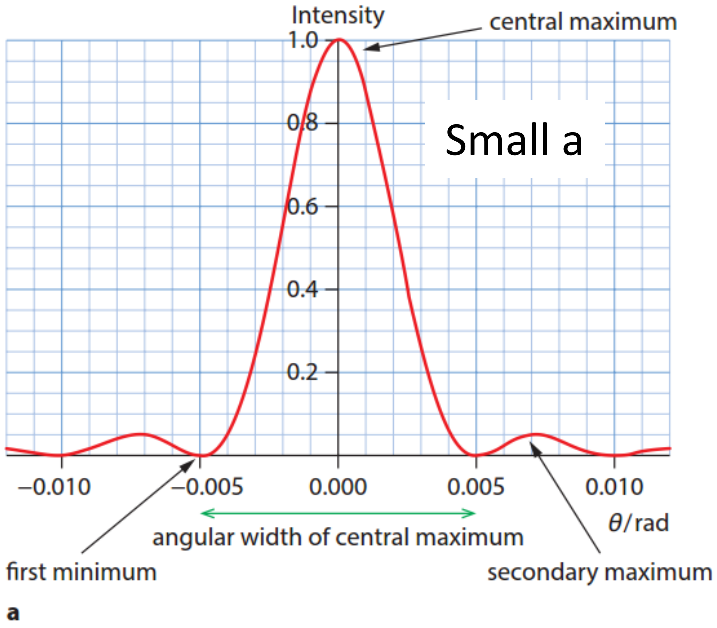
Single Slit Diffraction

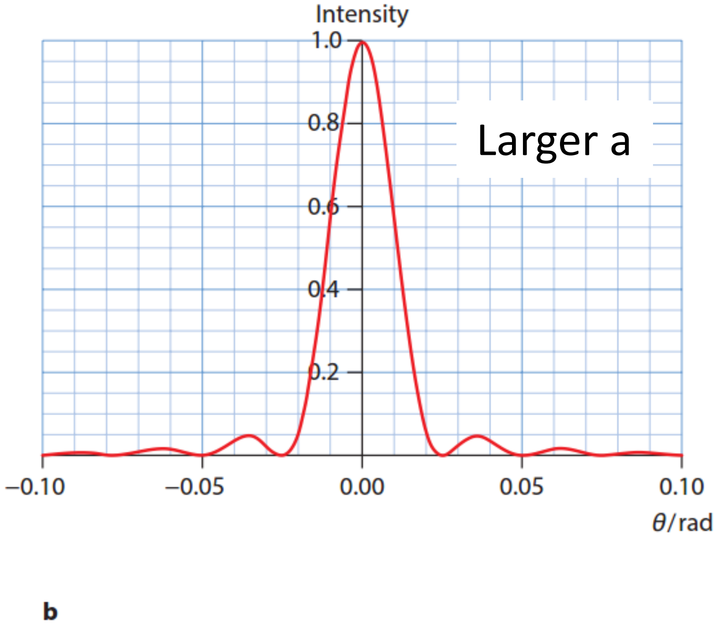
λ = wavelength
a = the width of the slit
θ = angle where the first minimum (zero occurs)

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



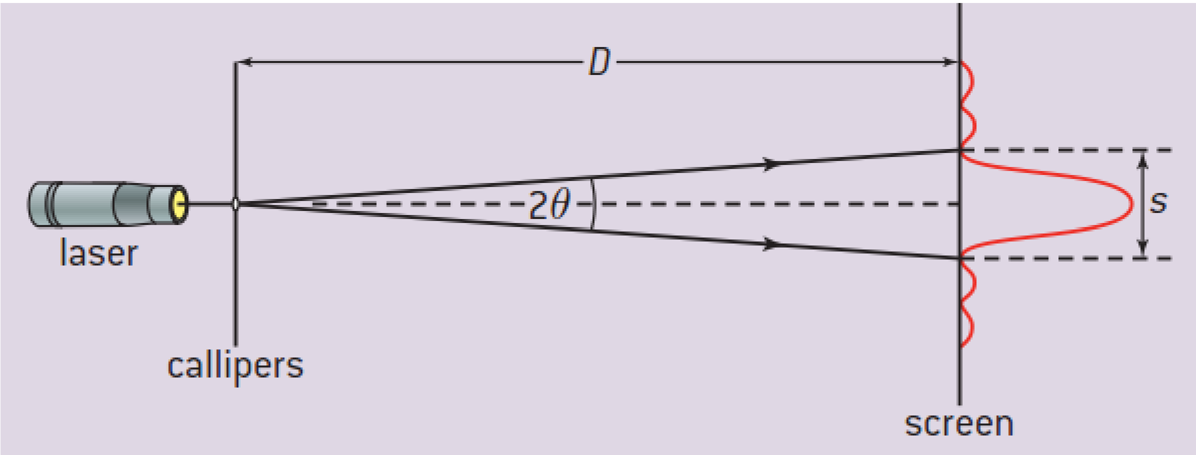
Decreasing a (denominator) increases the width of the of the central spot (diffraction)

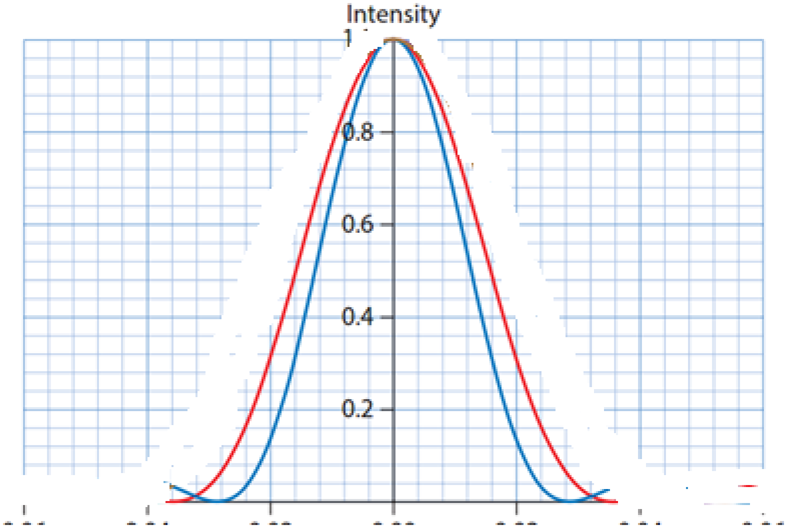




λ = wavelength
a = the width of the slit

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





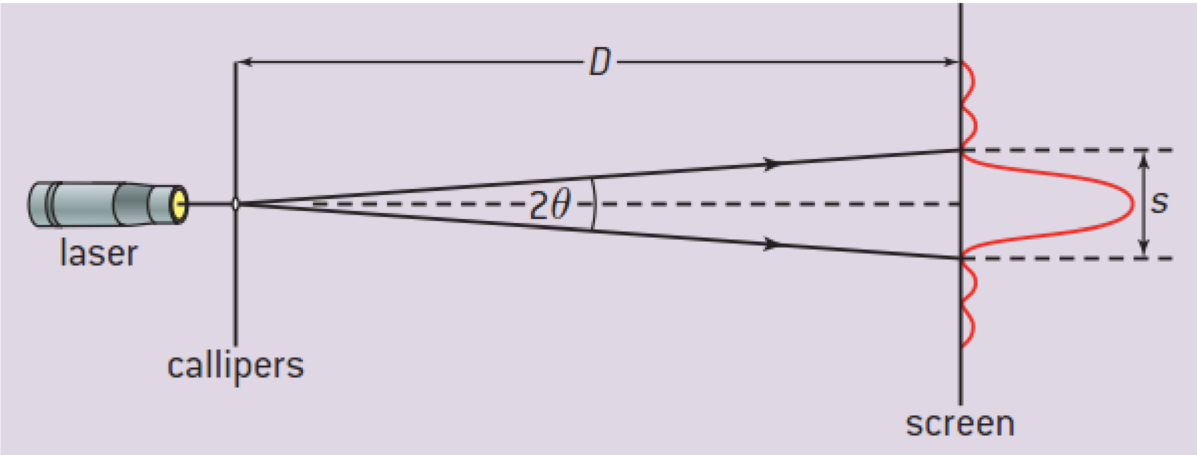
Increasing λ (numerator) increases the width of t
central spot (diffraction)

So notice RED is wider than BLUE

Notice the “width” of the bright spot is proportional to 2θ. This figure I took from you book, page 367, and settles the question I had if the want the width at the base like here, or in the half height. It is at the base so when asked you use 2θ.

So from this figure we see that when asked about widths and resolution use the following relation ship

$$\theta = \frac{s}{}$$



Notice the “width” of the bright spot is proportional to 2θ. This figure I took from you book, page 367, and settles the question I had if the want the width at the base like here, or in the half height. It is at the base so when asked you use 2θ.

So from this figure we see that when asked about widths and resolution use the following relation ship

$$\theta = \frac{s}{2D}$$

To find the number of primary maximum we use the following relations ships

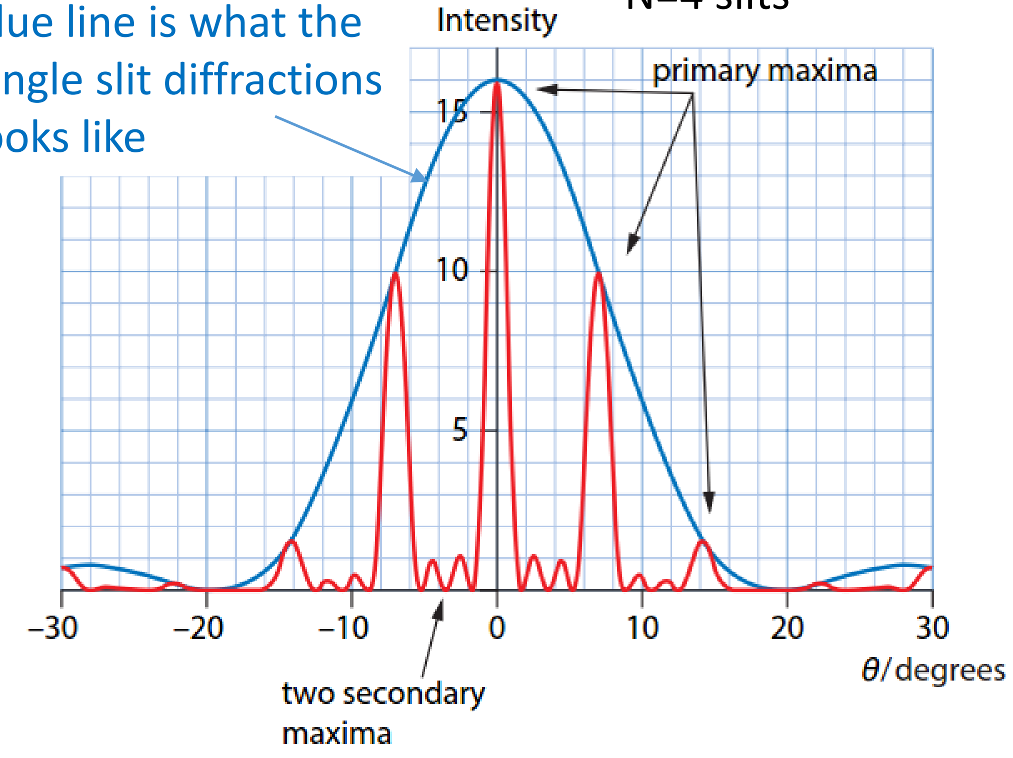
Multiple Slit Diffraction

In summary, if we increase the number of slits to N:

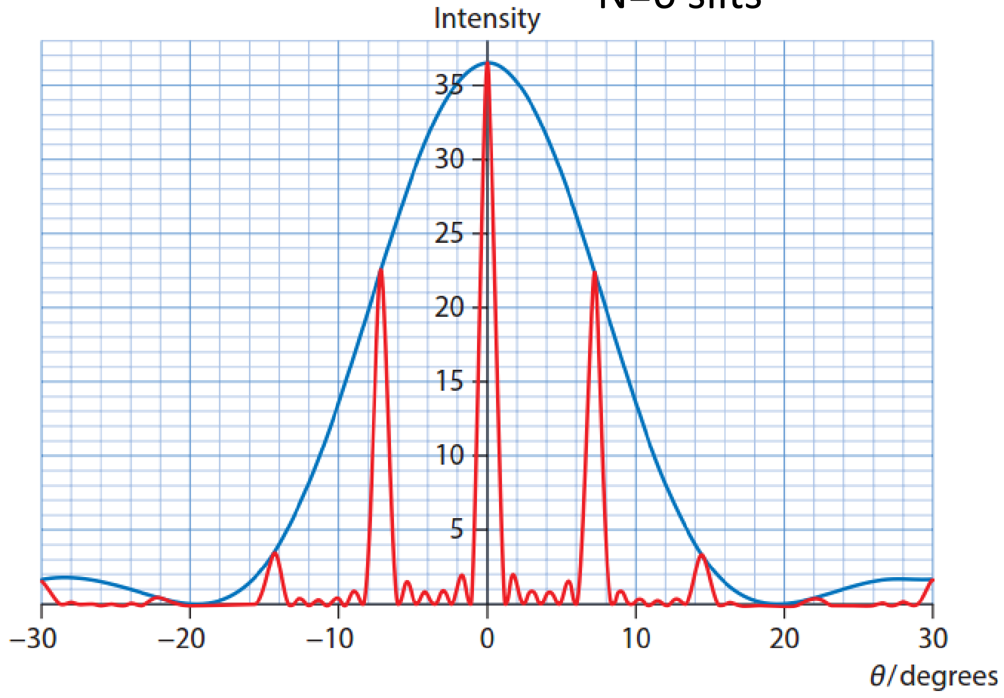
- The primary maxima will become thinner and sharper (the width is proportional to $\frac{1}{N}$)
- The $N-2$ secondary maxima will become unimportant
- The intensity of the central maximum is proportional to N^2.

Blue line is what the Single slit diffractions looks like

N=4 slits



N=6 slits



To find the number of primary maximum we use the following relations ships

First minimum condition for single slit of width a: $\sin\theta = \frac{\lambda}{a}$

For slits separated by d, the constructive interference occurs when $dsin\theta = m\lambda$ or $sin\theta = \frac{m\lambda}{d}$

Combining these two equations gives $\frac{m(max)\lambda}{d} = \frac{\lambda}{a}$

$$\boxed{m(max) = \frac{d}{a}}$$

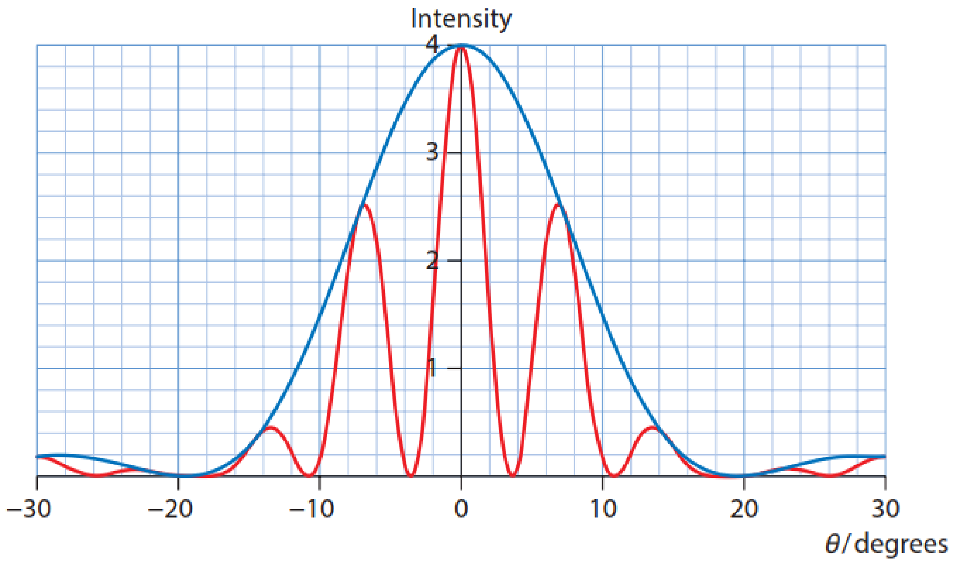


Figure 9.21 The two-slit interference intensity pattern for slits of width equal to three times the wavelength. The slit separation is eight times the wavelength.

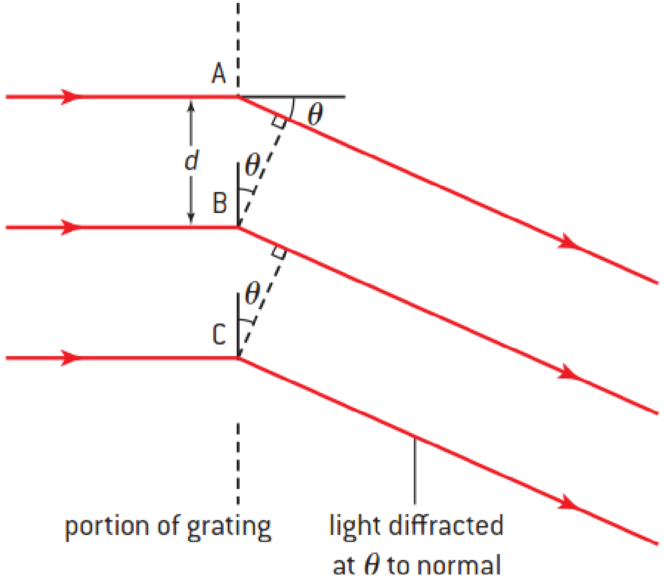
In this figure the width of the slit is $a = 3\lambda\ and\ d = 8\lambda$

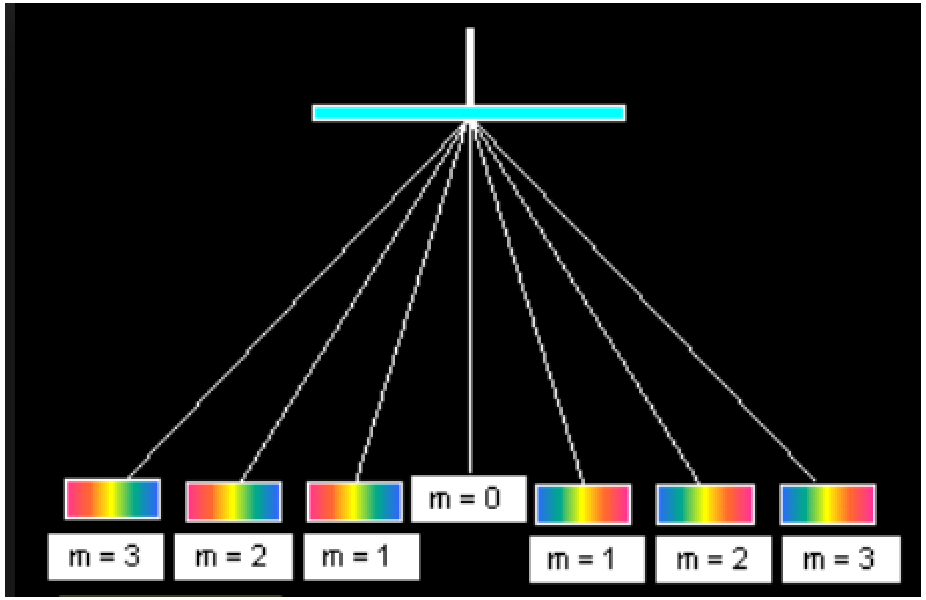
We thus expect that the primary $m(max) = \frac{8}{3}\ i.e,$ 2,this means we will have maxima at m=0, ±1±2, i.e., 5 primary maxima.

Diffraction Grating

$$d\sin(\theta) = m\lambda, \qquad m = 0,1,2,3$$

Where d is the separation between the slits, and m is the diffraction order.





Resolution of a grating:

The resolvance is also equal to Nm where N is the total number of slits illuminated by the incident beam and m is the order of the diffraction.

$$R = \frac{\lambda}{\Delta\lambda} = Nm$$

The larger the resolvance, the better a device can resolve.

Rayleigh criterion for resolving two objects

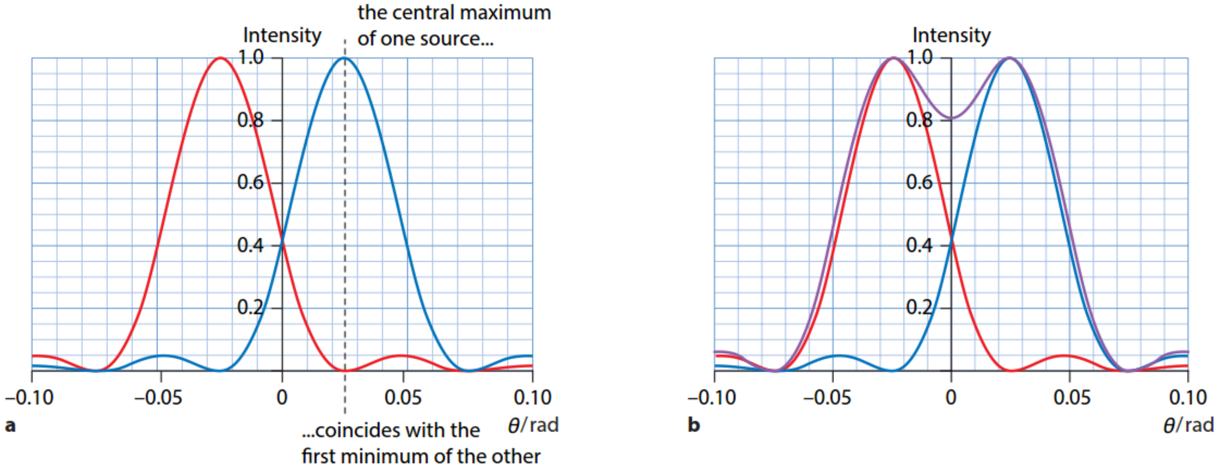


Figure 9.32 **a** The limiting case where resolution is thought to be just barely possible. The first minimum of one source coincides with the central maximum of the other. **b** The combined pattern for the two sources shows a small dip in the middle.

Figure **9.34** shows two objects separated by distance s. The two objects are a distance d from the observer. The angle that the separation of the objects subtends at the eye is called the **angular separation** θ_A of the two objects and is equal in radians to $\frac{s}{d}$.

Notice that the angle θ_A is also the angular separation of the central maxima of the diffraction patterns of the two sources. According to the Rayleigh criterion, resolution is just possible when this angular separation is equal to the angle of the first diffraction minimum: $\theta_D = \frac{\lambda}{b}$ (as we saw in Subtopic **9.2**).

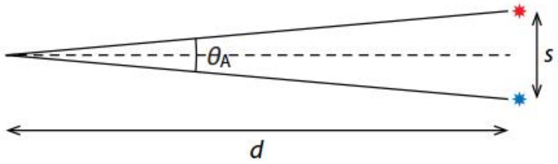


Figure 9.34 Two objects that are separated by a distance s are viewed by an observer a distance d away. The separation s subtends an angle θ_A at the eye of the observer.

For a **circular slit** things have to be modified somewhat and it can be shown that the angle of diffraction for a circular slit of diameter b is given by:

$$\theta_D = 1.22\frac{\lambda}{b}$$

So, for a circular slit, resolution is possible when:

$$\theta_A \geq \theta_D$$

$$\frac{s}{d} \geq 1.22\frac{\lambda}{b}$$

Doppler Formula

$$\frac{f_{observer}}{c \mp u_{observer}} = \frac{f_{source}}{c \pm u_{source}}$$

Observer towards the source: $u_{observer}$
Observer away from the source: $-u_{observer}$

Source towards the observer: $- u_{source}$
Source away from the observer: u_{source}

c = speed of the wave
$u_{observer}$ = speed of observer
u_{source} = speed of source
$f_{observer}$ = frequency of observer
f_{source} = frequency of source