Explanation of diffraction for a light wave

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Diffraction pattern for light based on interference:

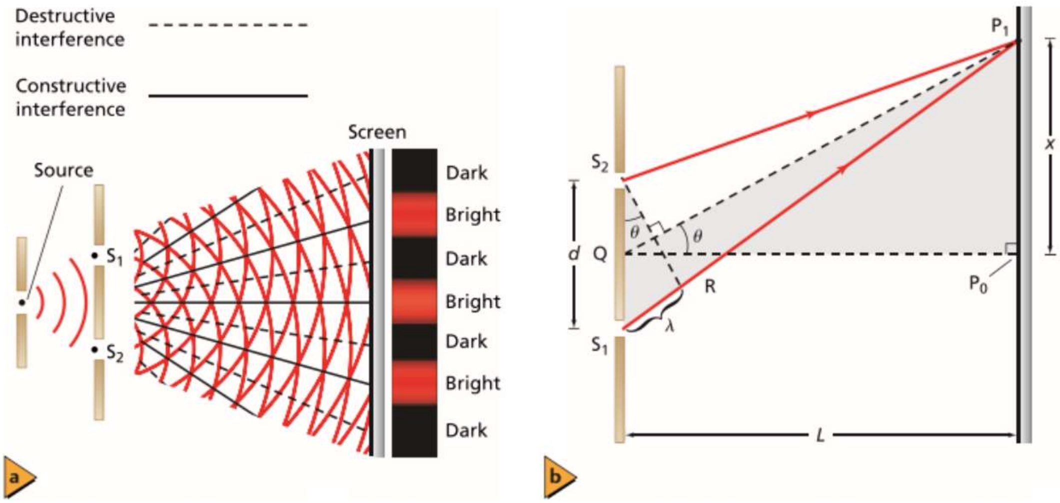

Figure 19-5 The interference of monochromatic light that passes through the double slit produces bright and dark bands on a screen **(a).** This diagram **(b)** represents an analysis of the first bright band. The distance from the slits to the screen, L, is about 10^5 times longer than the separation, d, between the two slits. (Illustrations not to scale)

There are two triangles shaded in the figure. The larger triangle is a right triangle, so $\tan\theta = x/L$. In the smaller triangle RS_1S_2, the side S_1R is the length difference of the two light paths, which is one wavelength. There are now two simplifications that make the problem easier to solve.

1. If L is much larger than d, then line segments S_1P_1 and S_2P_1 are nearly parallel to each other and to line segment QP_1, and triangle RS_1S_2 is very nearly a right triangle. Thus, $\sin\theta \approx \lambda/d$.
2. If the angle θ is small, then $\sin\theta$ is very nearly equal to $\tan\theta$.

With the above simplifications, the relationships $\tan\theta = x/L$, $\sin\theta \approx \lambda/d$, and $\sin\theta \approx \tan\theta$ combine to form the equation $x/L = \lambda/d$. Solving for λ gives the following.

Wavelength from Double-Slit Experiment $\lambda = \frac{xd}{L}$

The wavelength of light, as measured by a double slit, is equal to the distance on the screen from the central bright band to the first bright band, multiplied by the distance between the slits, divided by the distance to the screen.