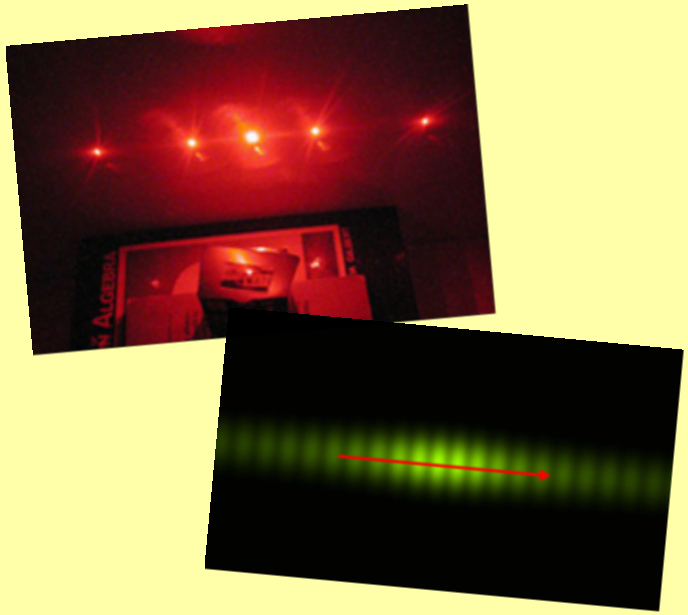
Double-Slit Interference



Objectives:

- Draw & label diagrams of double-slit interference
- Apply interference equations to double-slit and diffraction grating interference
- Decide when the small angle approximation can be used

Particle Nature	Wave Nature
- original Greek theory - supported by Newton (1687) - reflection & refraction	- proposed by Huygens (1678) - proved by interference (Thomas Young - 1801) - Doppler Effect observed (Fizeau - 1849) - EM nature proposed (James Maxwell - 1865) - EM nature produced (Heinrich Hertz - 1887)

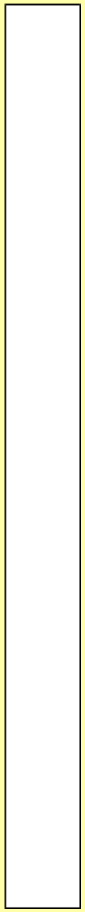
Young's Double Slit Interference:

- a light shines through 2 very small slits on to a screen . . .

What do you see?

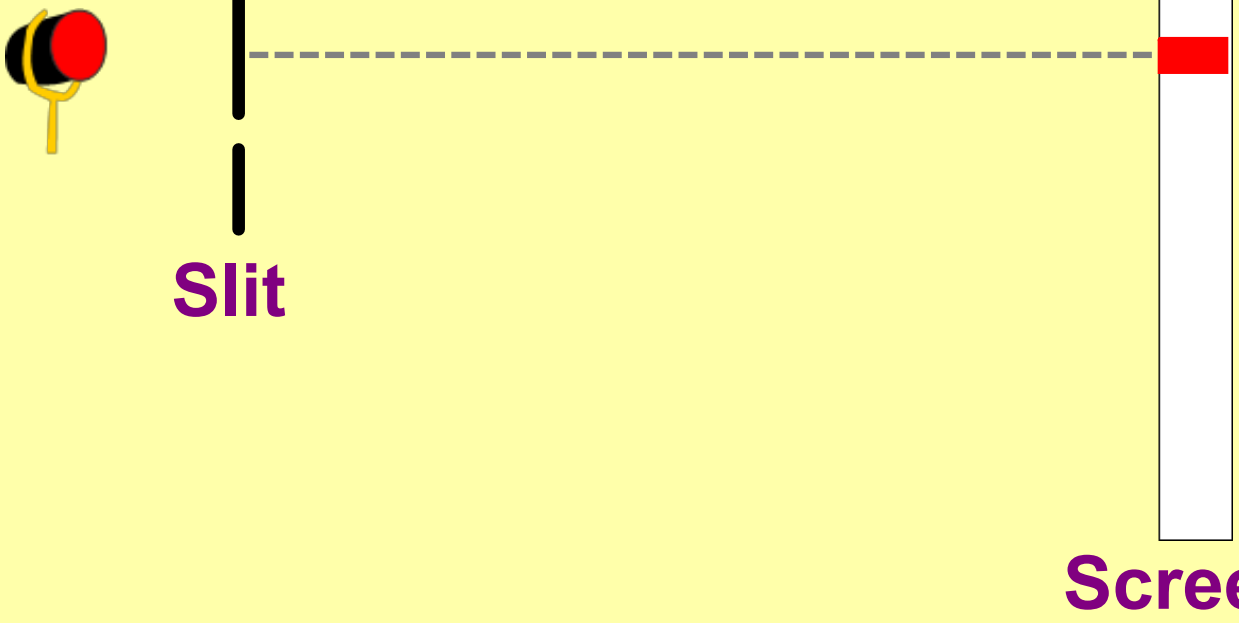
Young's Double Slit Interference:

Slit



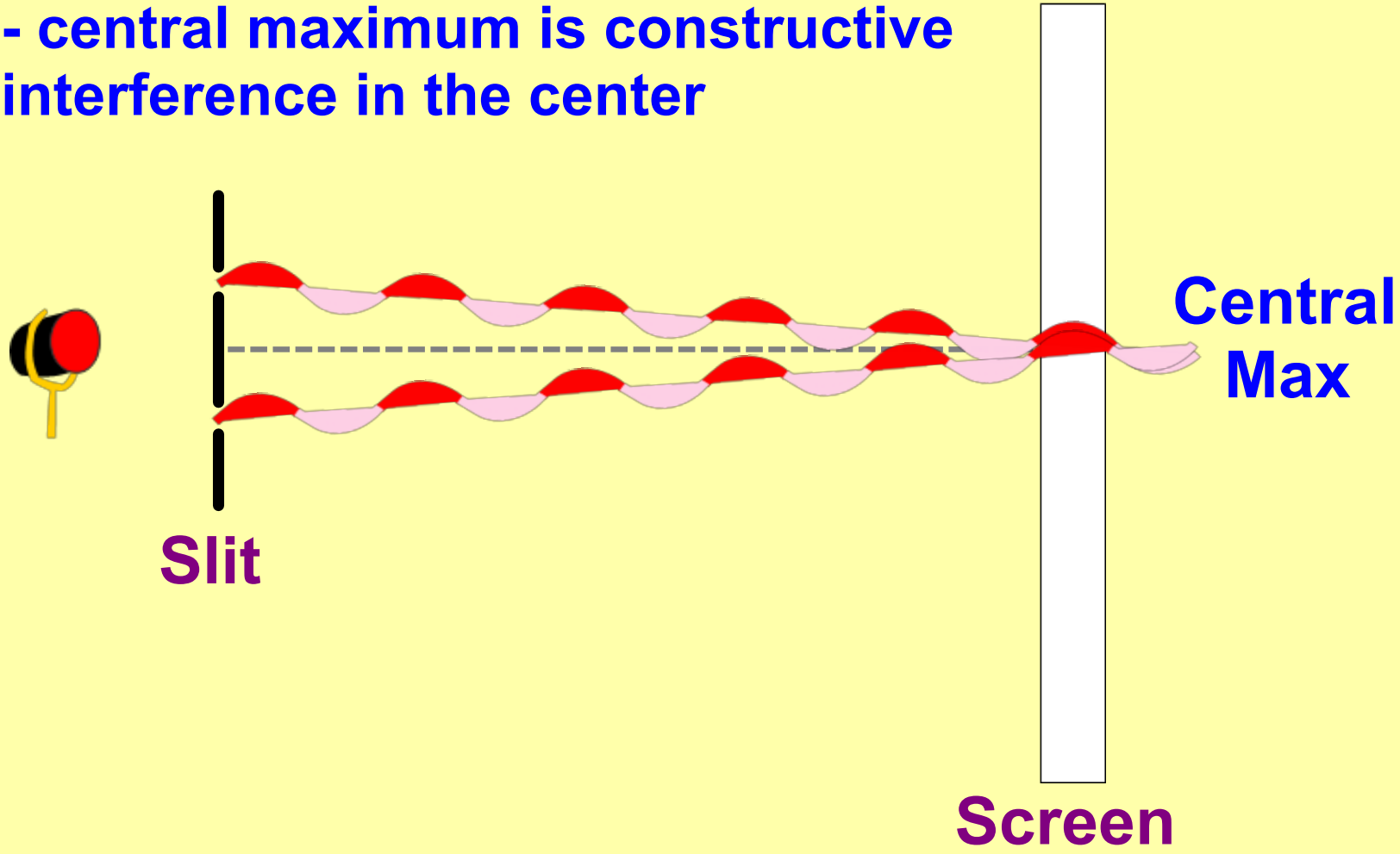
Screen

Young's Double Slit Interference:



Young's Double Slit Interference:

- central maximum is constructive interference in the center



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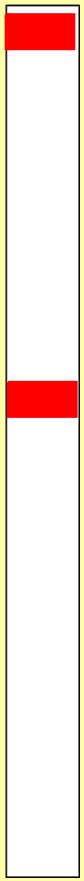


1st Order Fringe

Central Max

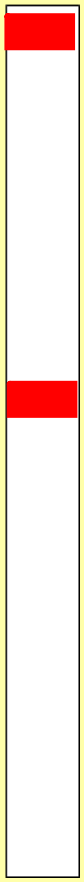
Screen

Young's Double Slit Interference:

λ = wavelength

λ

Slit



1st Order Fringe

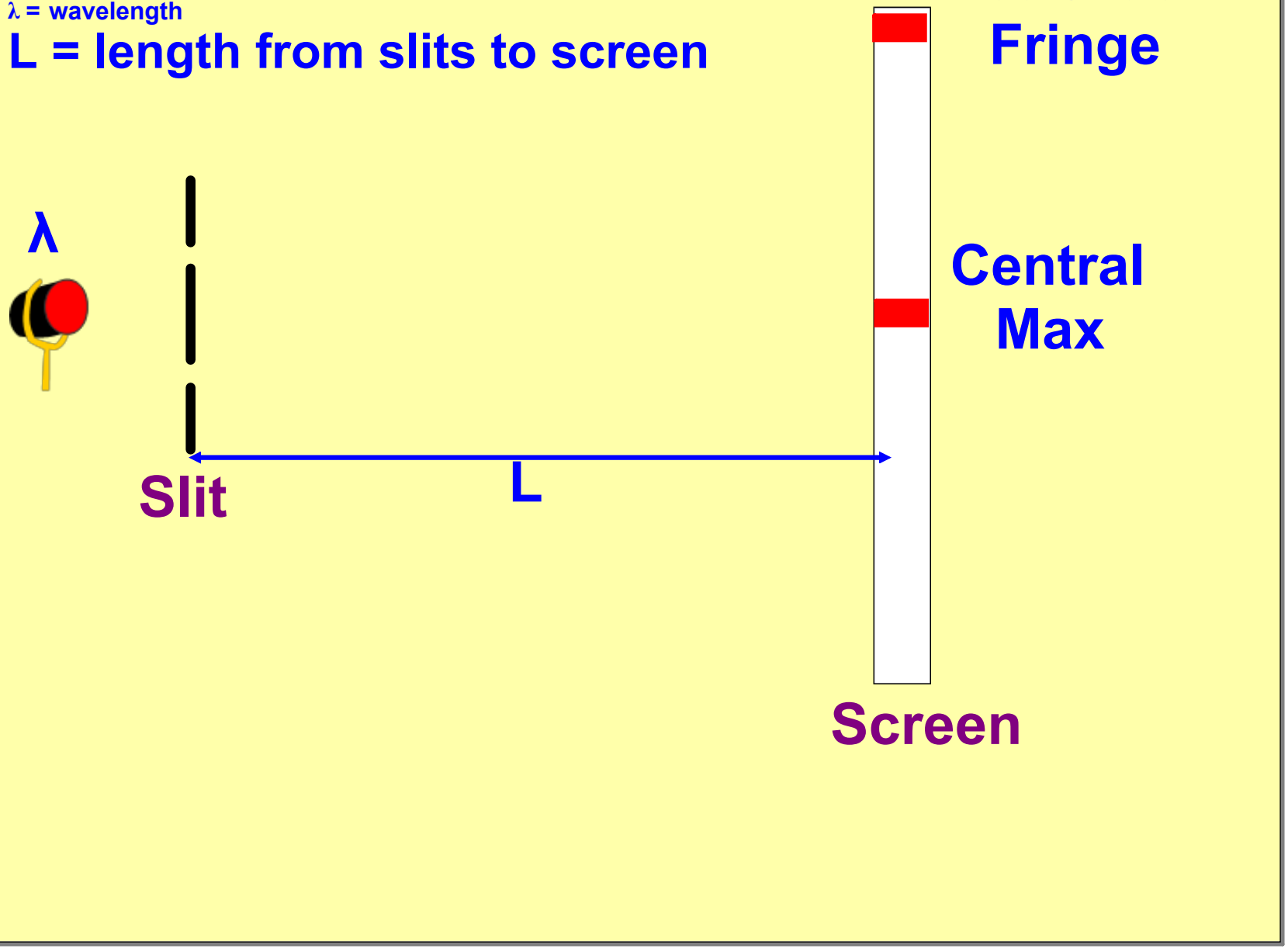
Central Max

Screen

Young's Double Slit Interference:

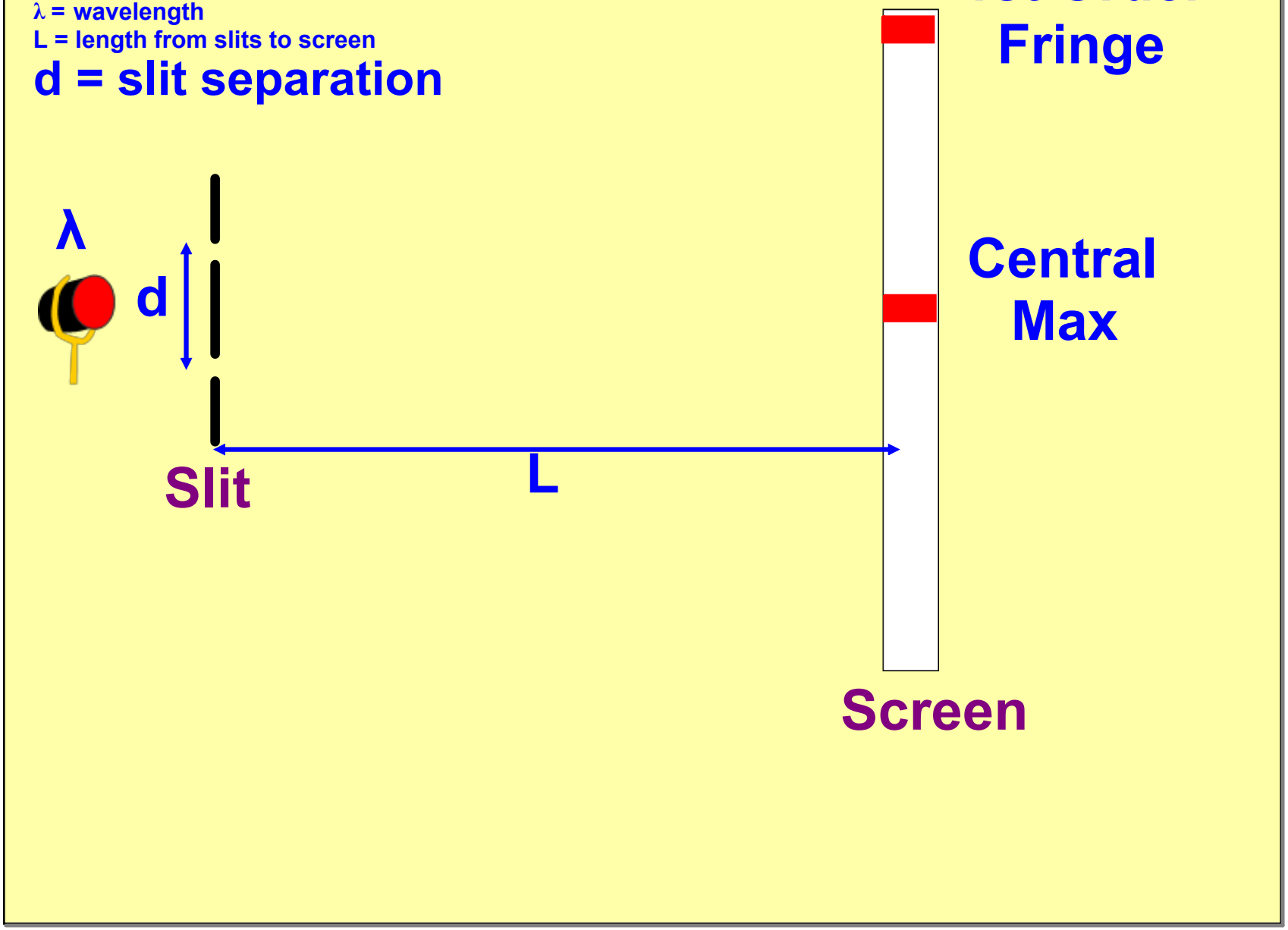
λ = wavelength

L = length from slits to screen



Young's Double Slit Interference:

λ = wavelength
L = length from slits to screen
d = slit separation



Young's Double Slit Interference:

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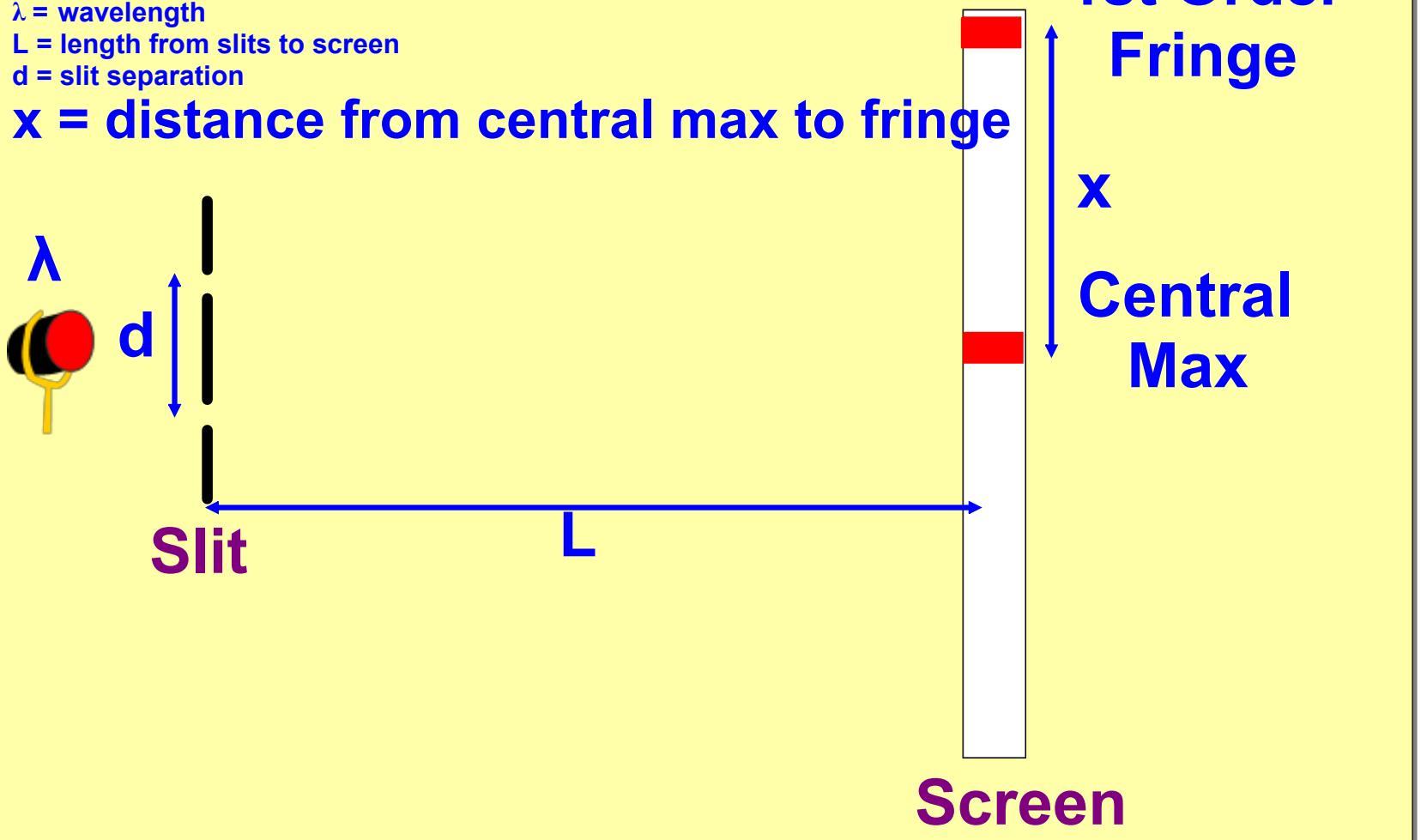
x = distance from central max to fringe

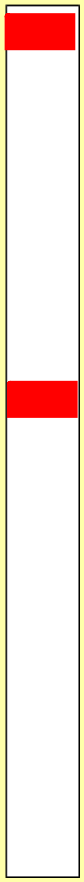


Young's Double Slit Interference:

- central maximum is constructive interference in the center

How do we get a 2nd place of constructive interference?

Slit



1st Order Fringe

Central Max

Screen

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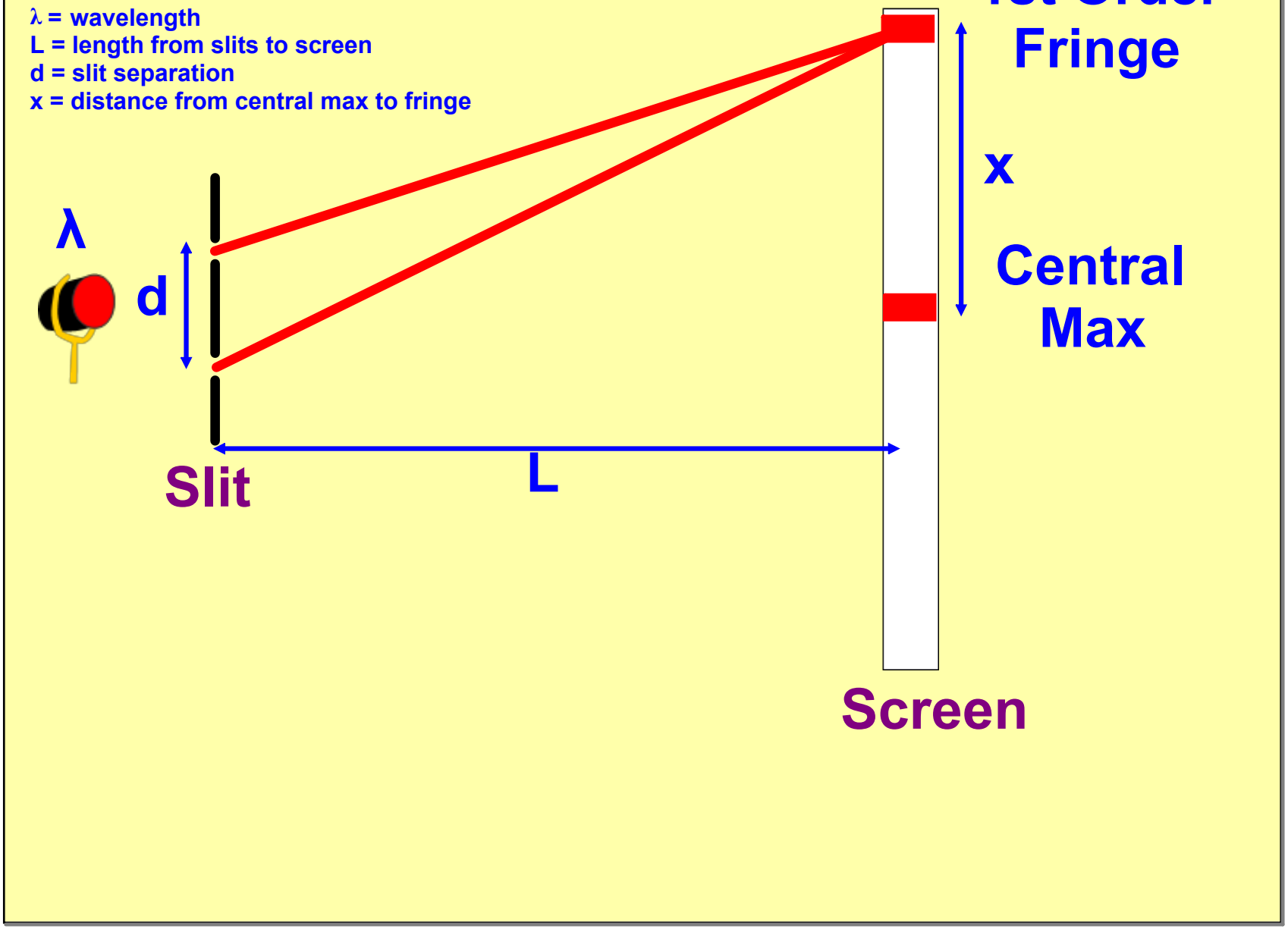

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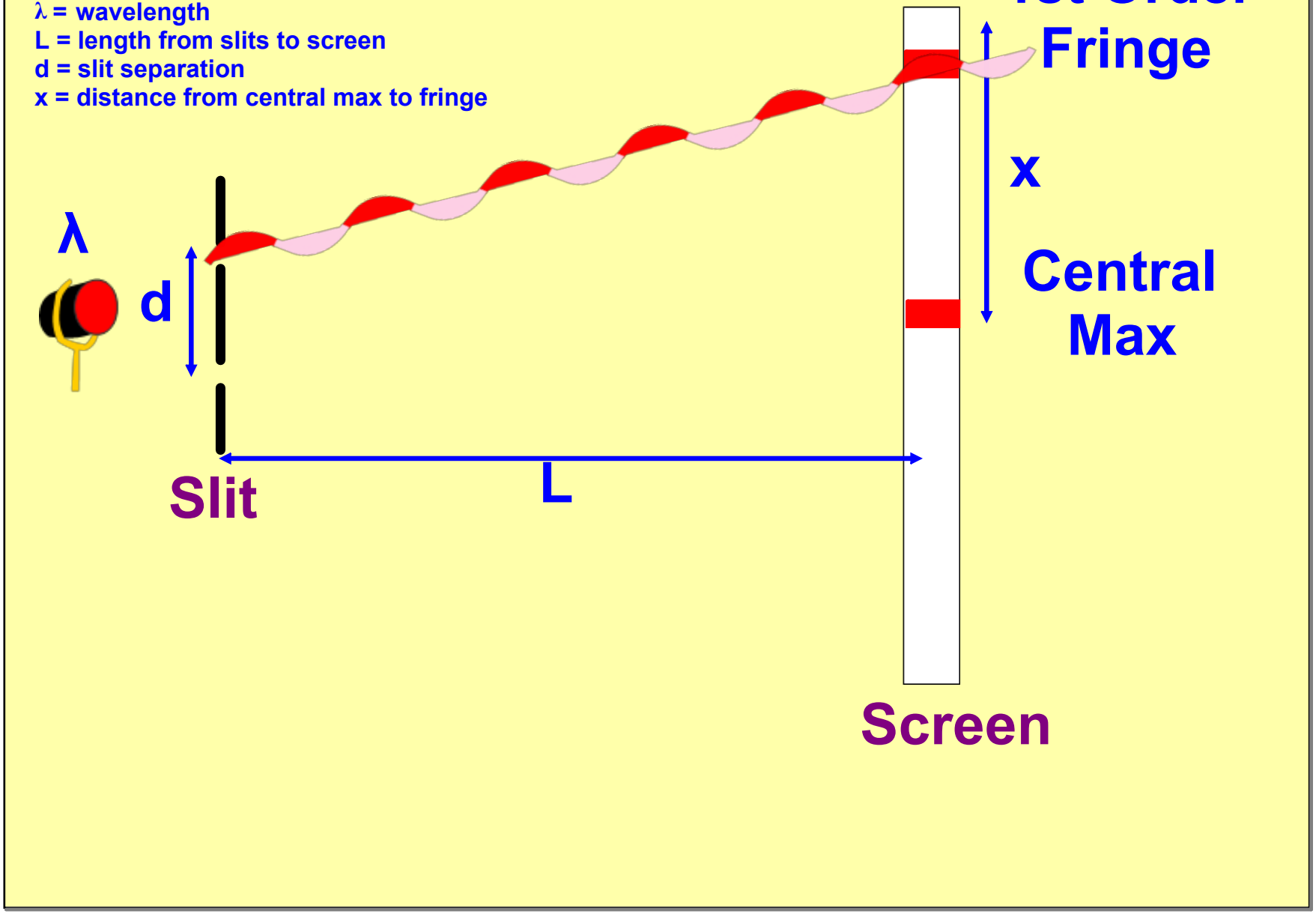

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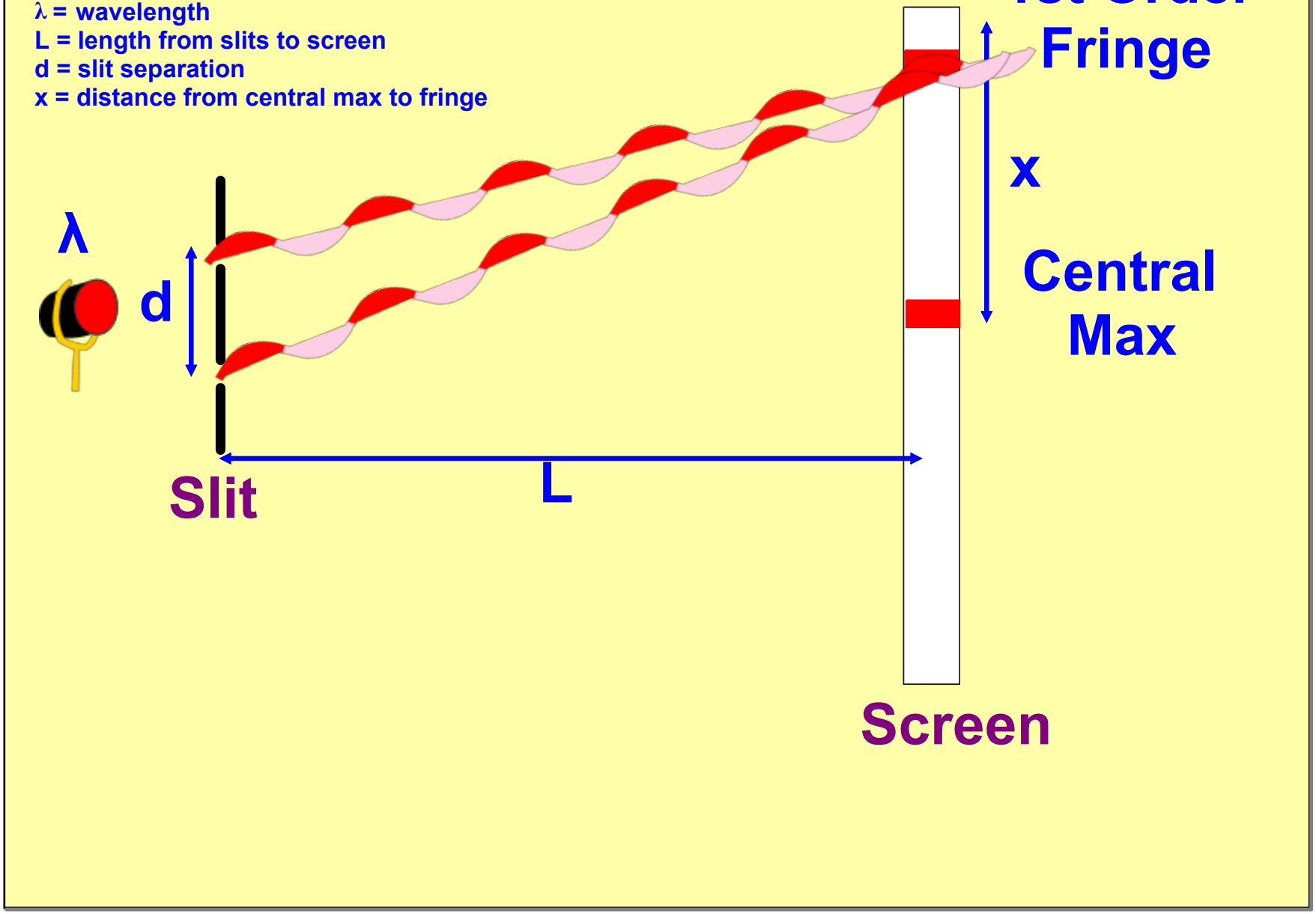

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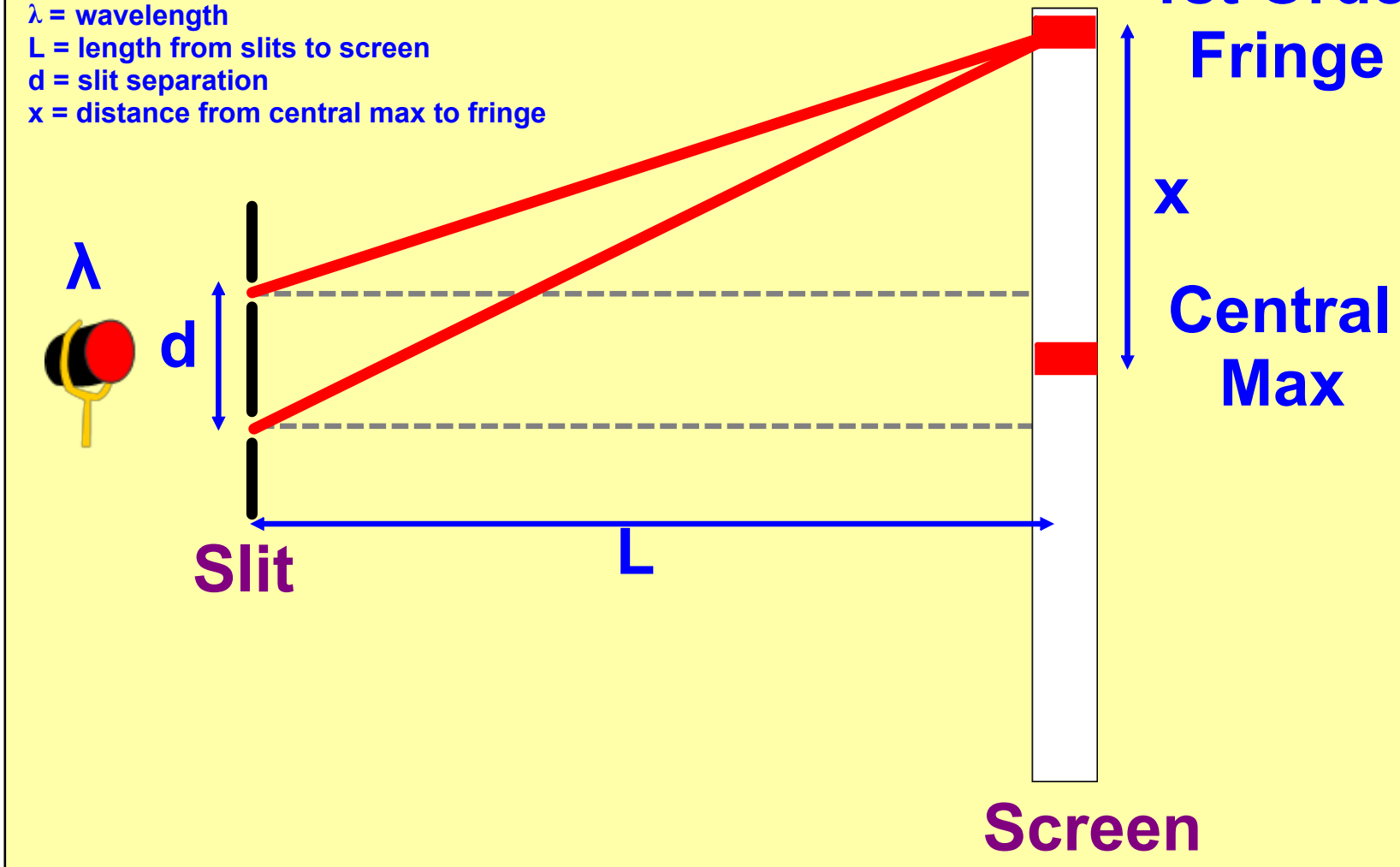

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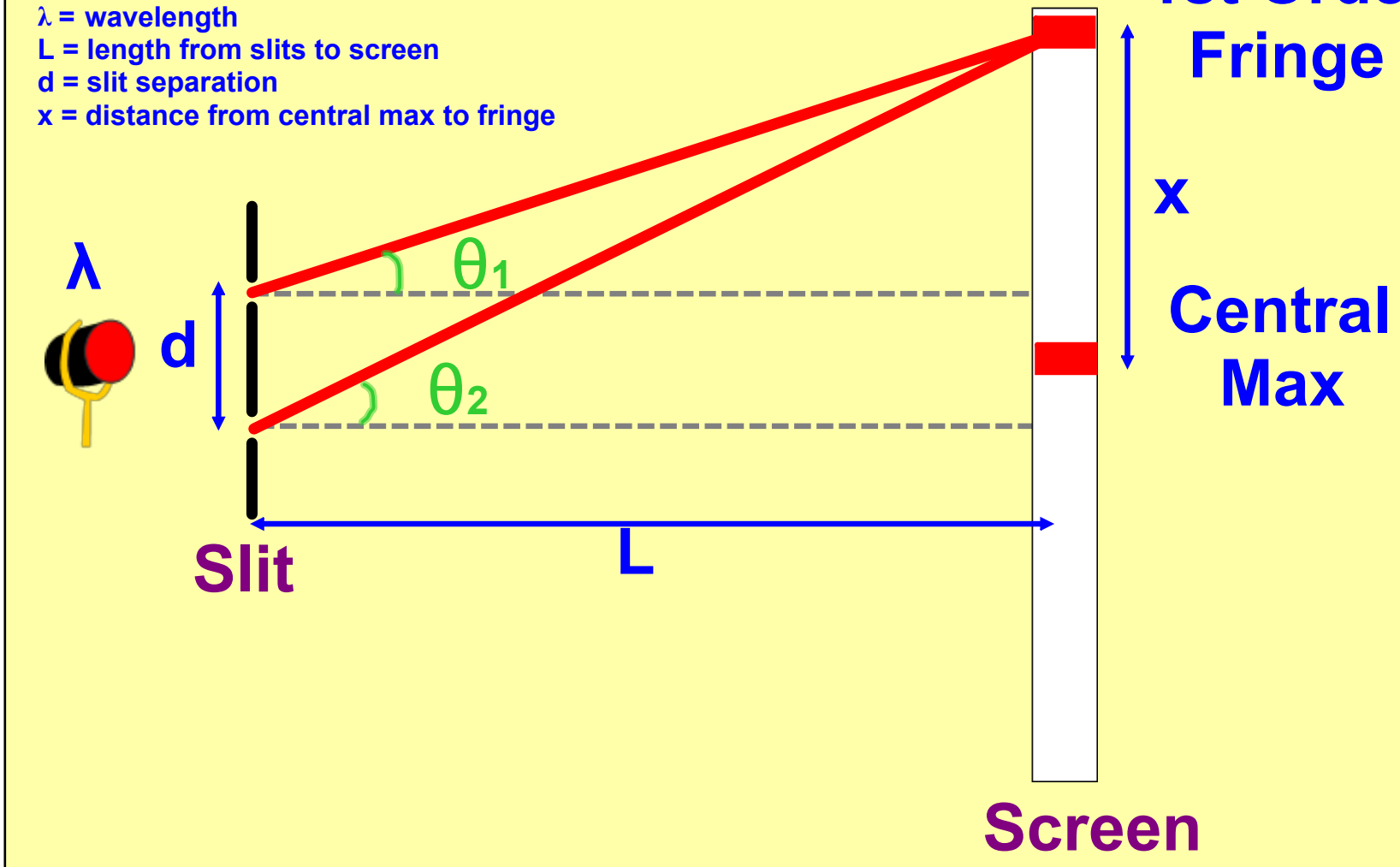

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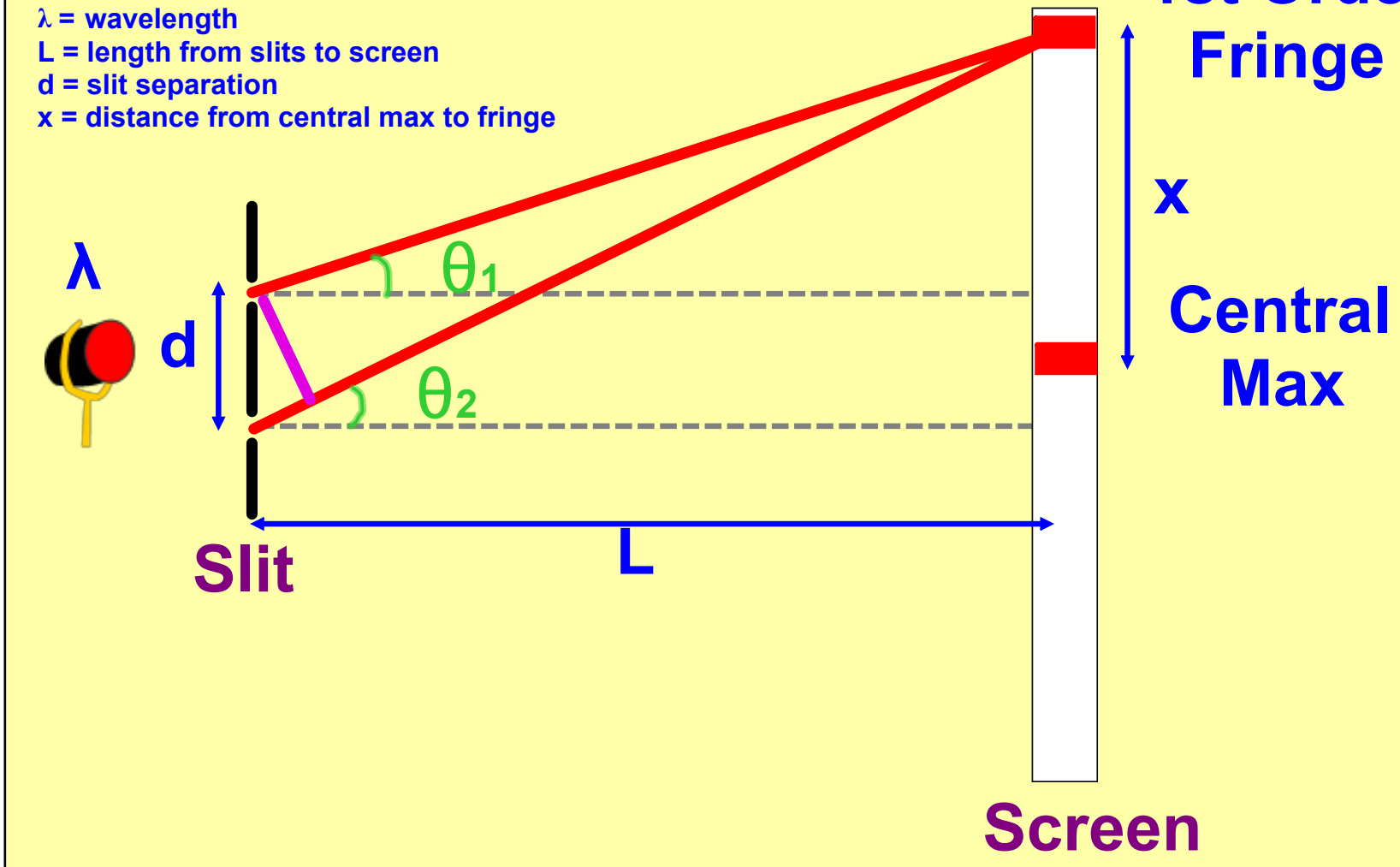

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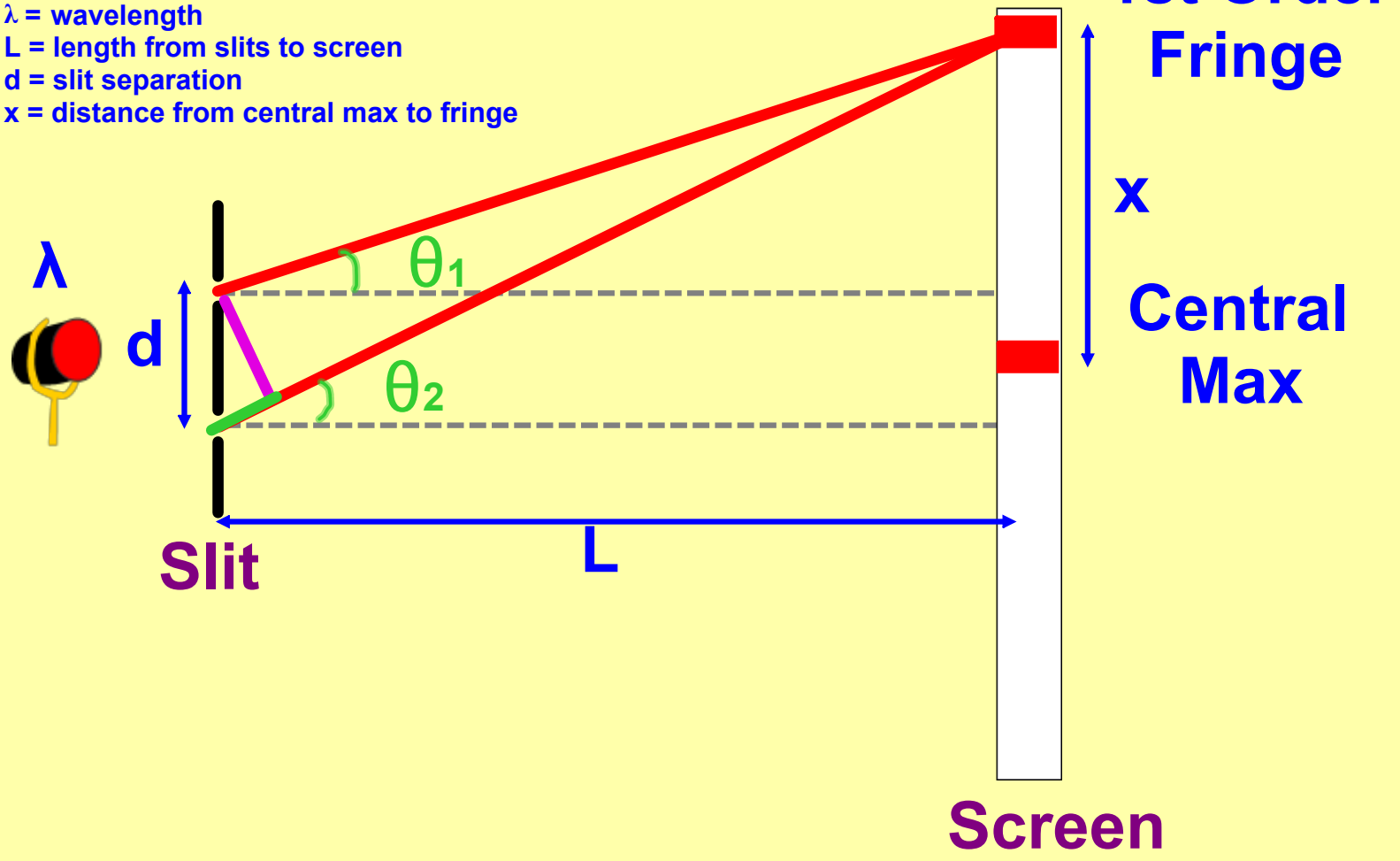

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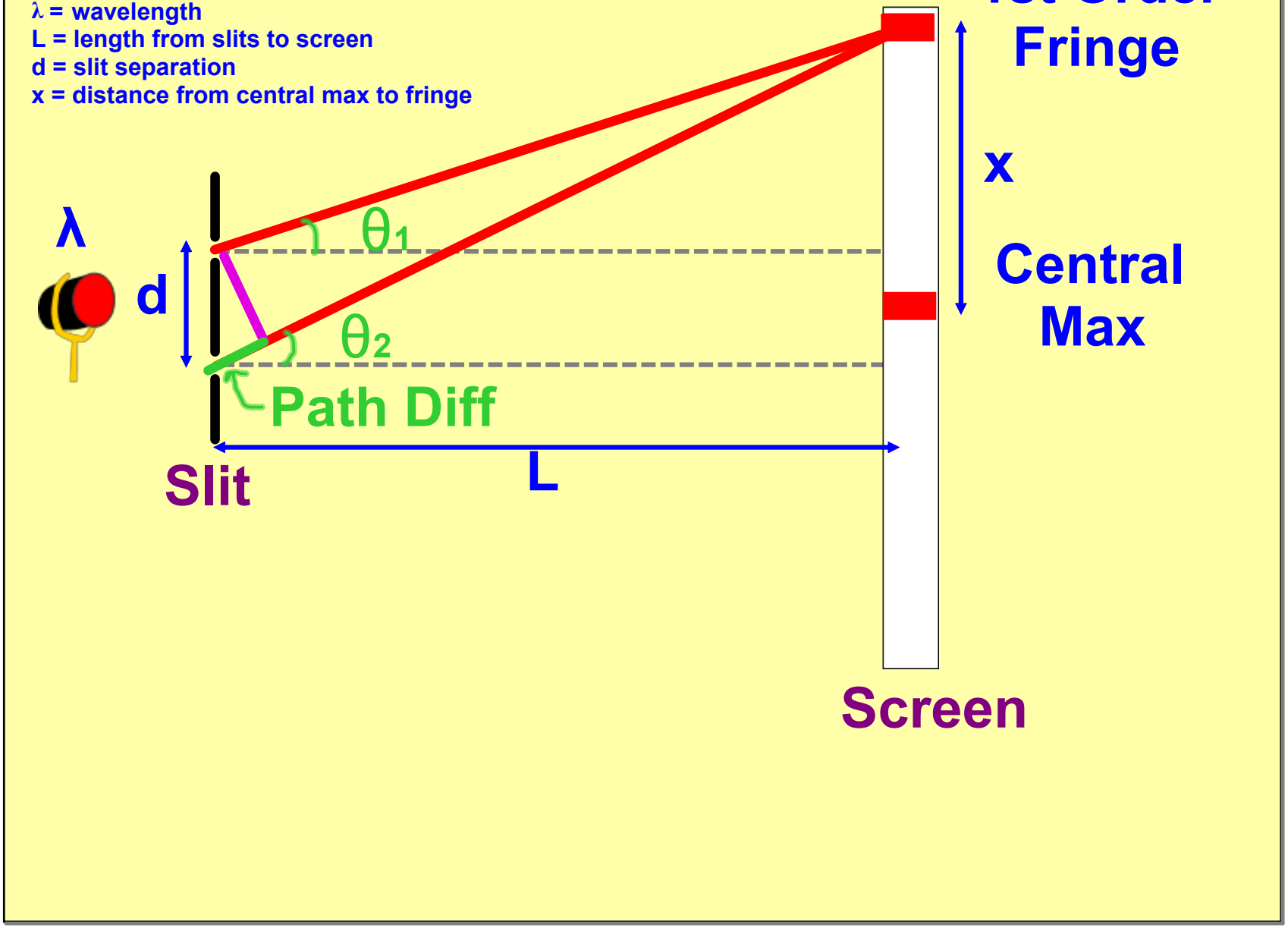

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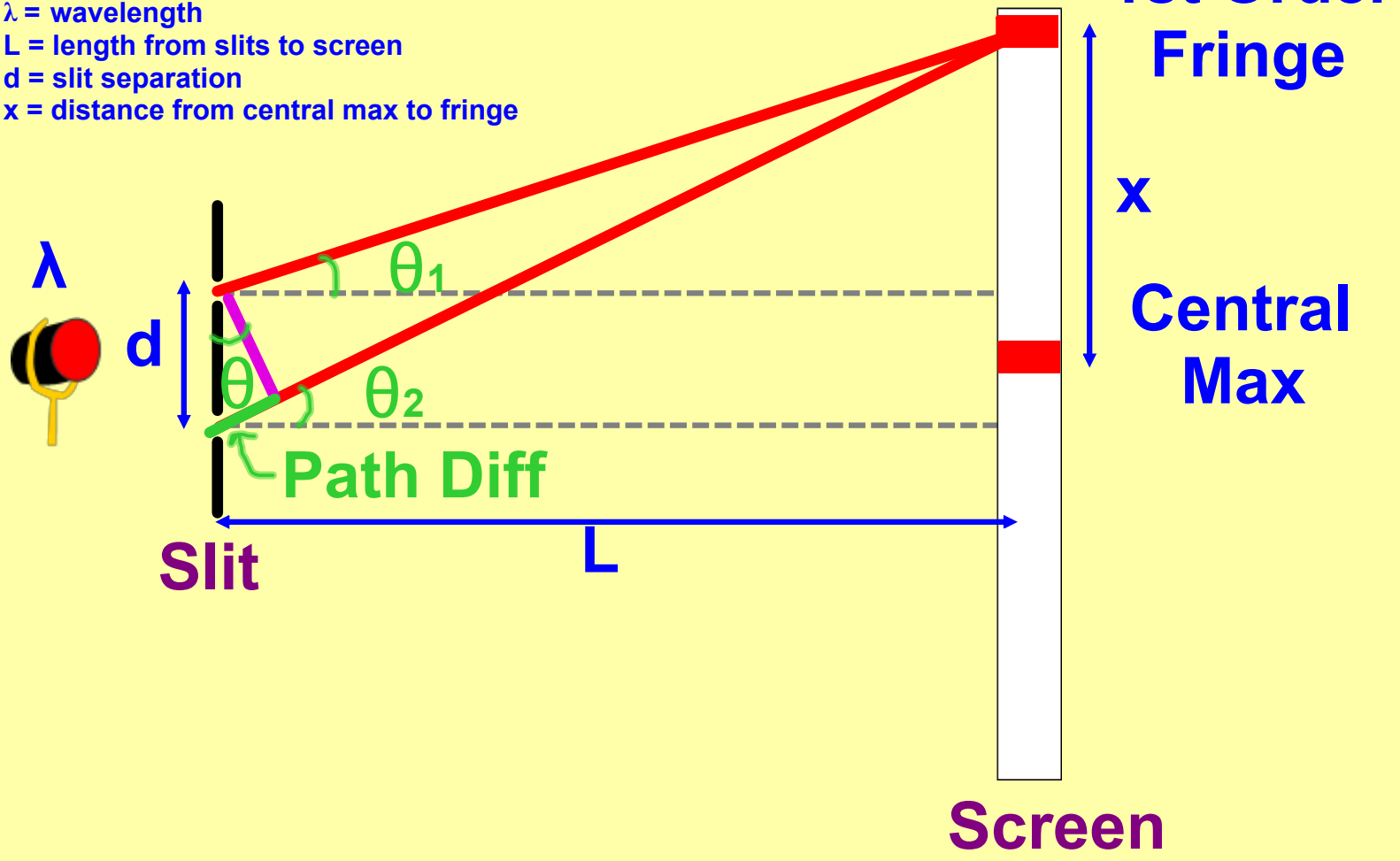

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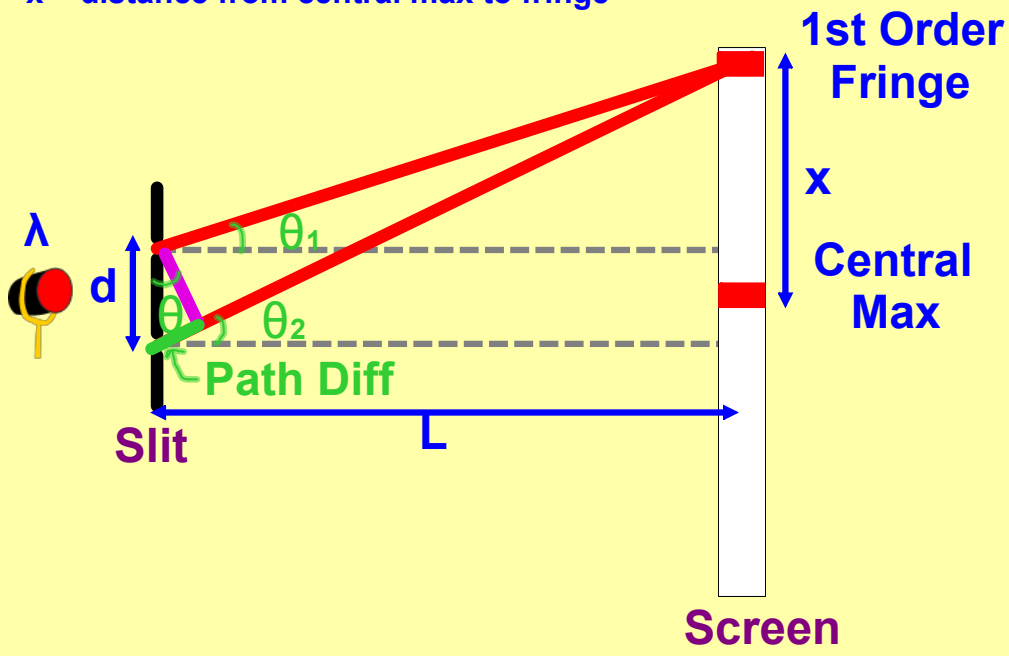

Equations:

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

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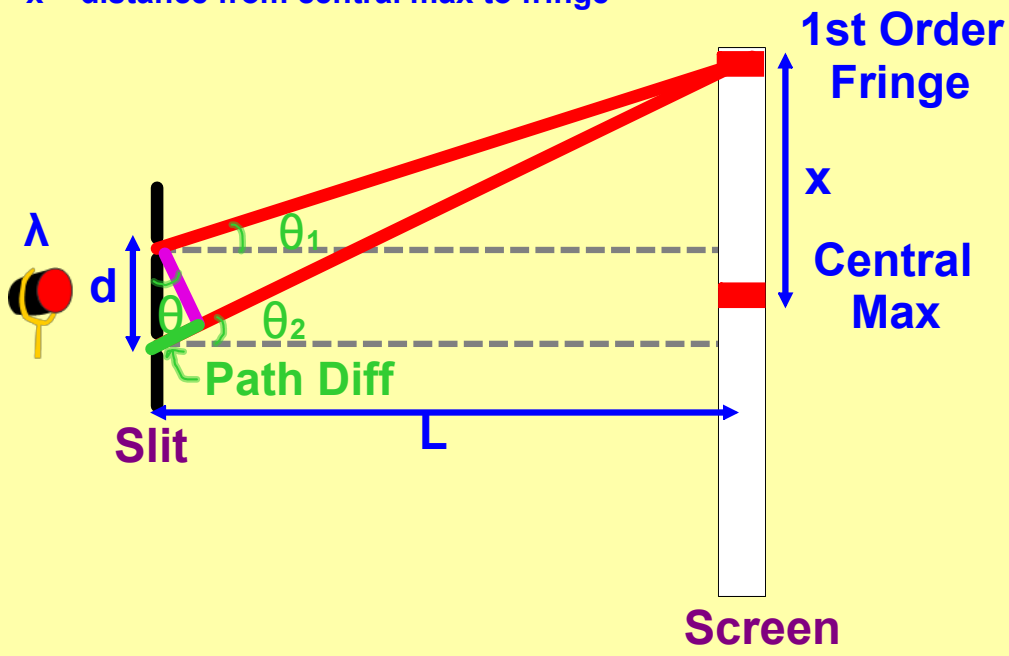

Equations:

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

m = 1, 2, 3 . . .
(constructive)

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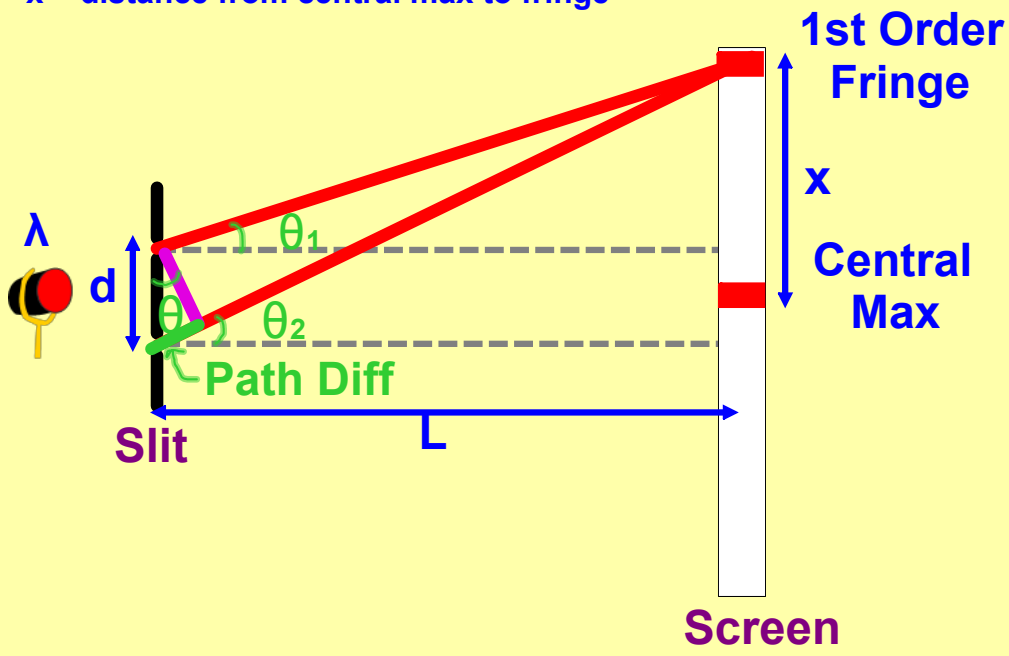

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m = ½, 1½, 2½ . . .
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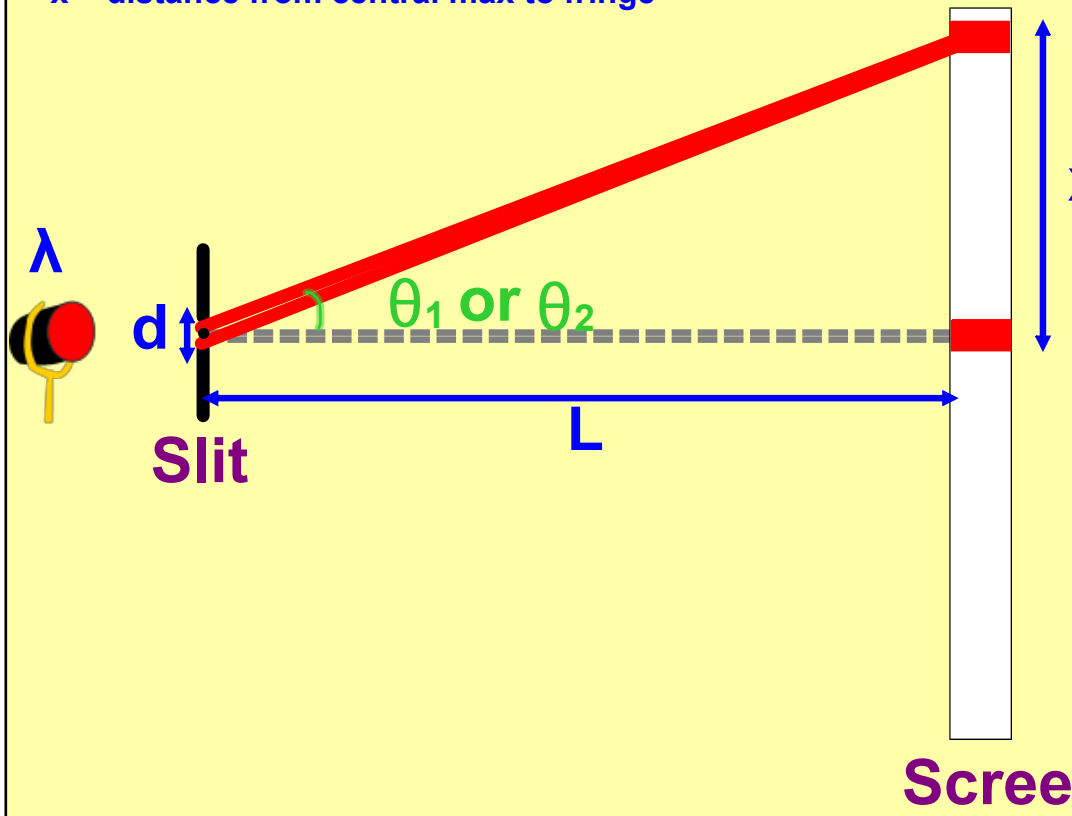

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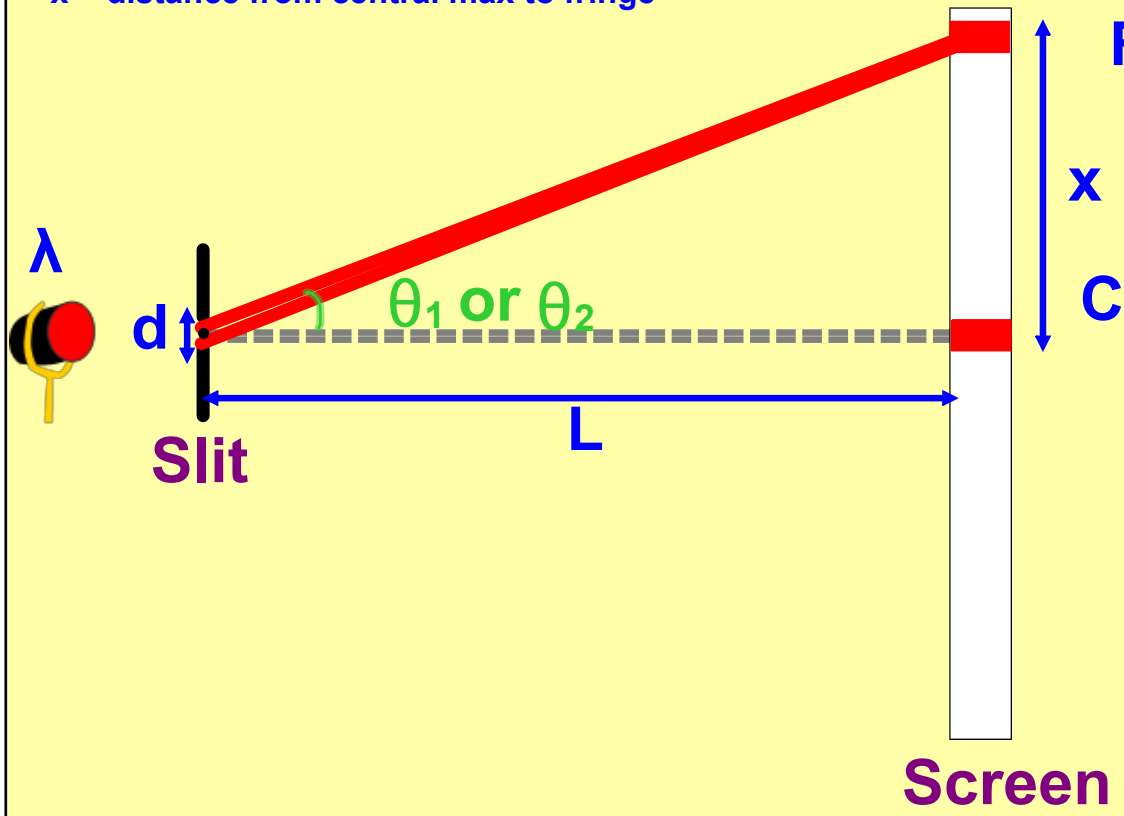

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$\tan\theta = \frac{x}{L}$

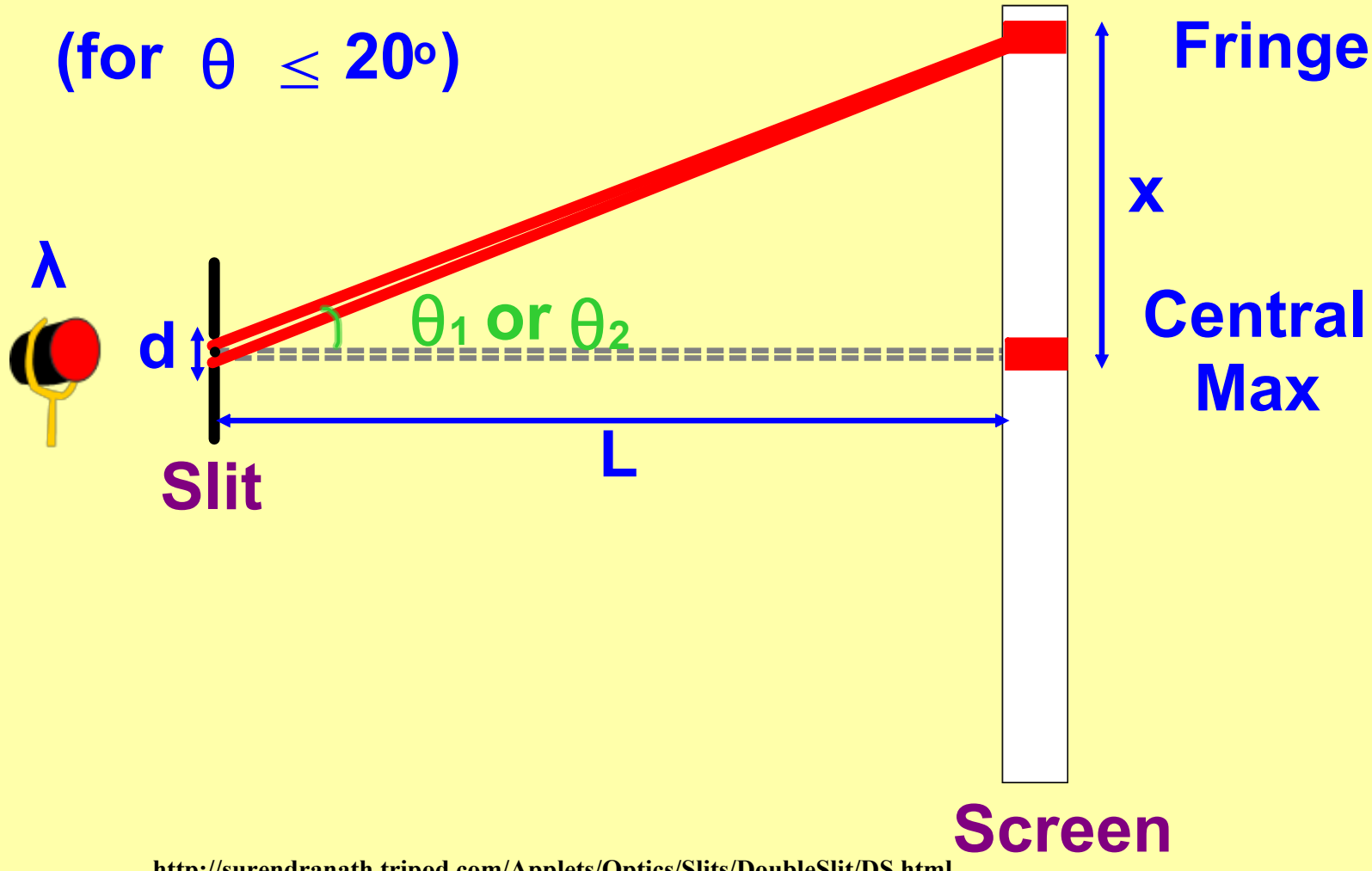
$x \approx \frac{m \lambda L}{d}$

(Small θ Approximation)

for $\theta \leq 20^{o}$

Small Angle Approximation:

(for $\theta \leq 20^{o}$)



http://surendranath.tripod.com/Applets/Optics/Slits/DoubleSlit/DS.html