Particle vs Wave

Particle

- discrete bundles
- travels in straight lines (Newtons 1st Law)

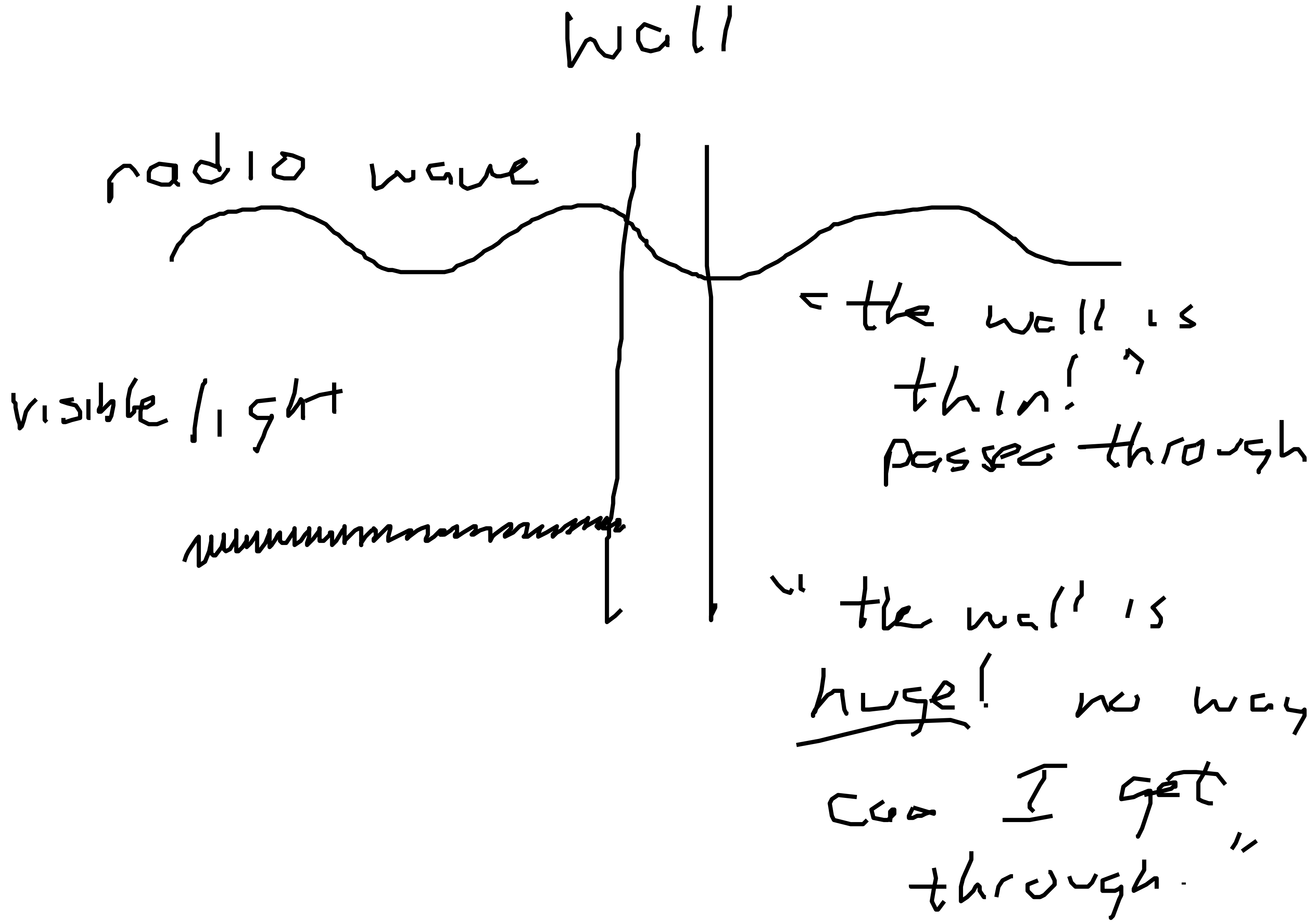
&

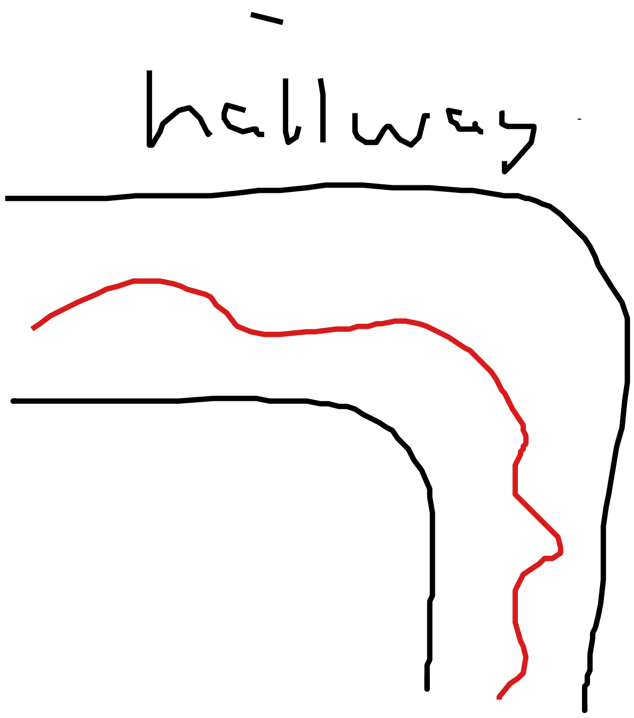
- collid with other

Wave

- spread out
- can go around corners (<u>diffraction</u>)
- can create destructive <u>interference</u>

The wavelength of a wave sets the scale of its interactions



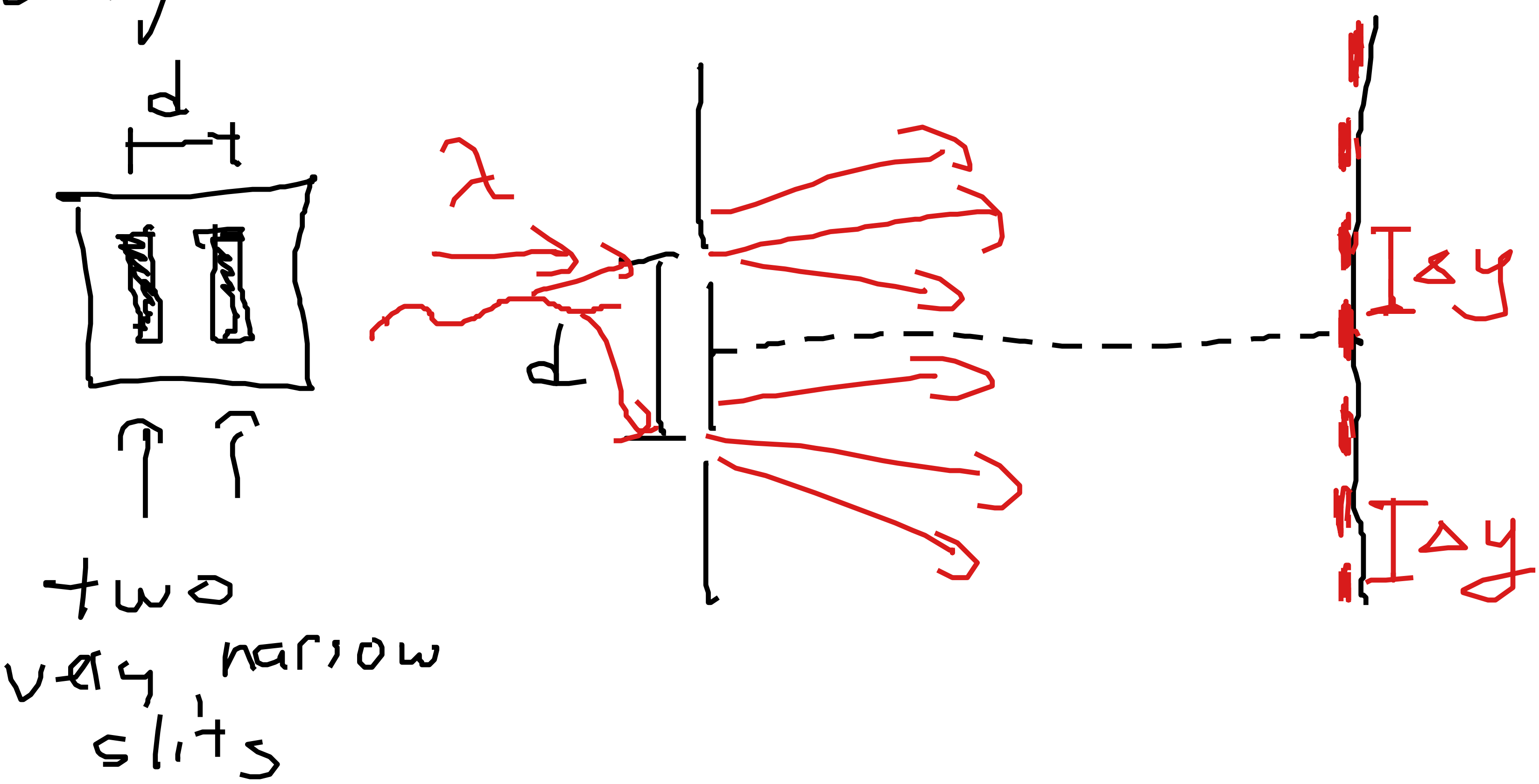


sound waves can go around corners b/c they have large λ

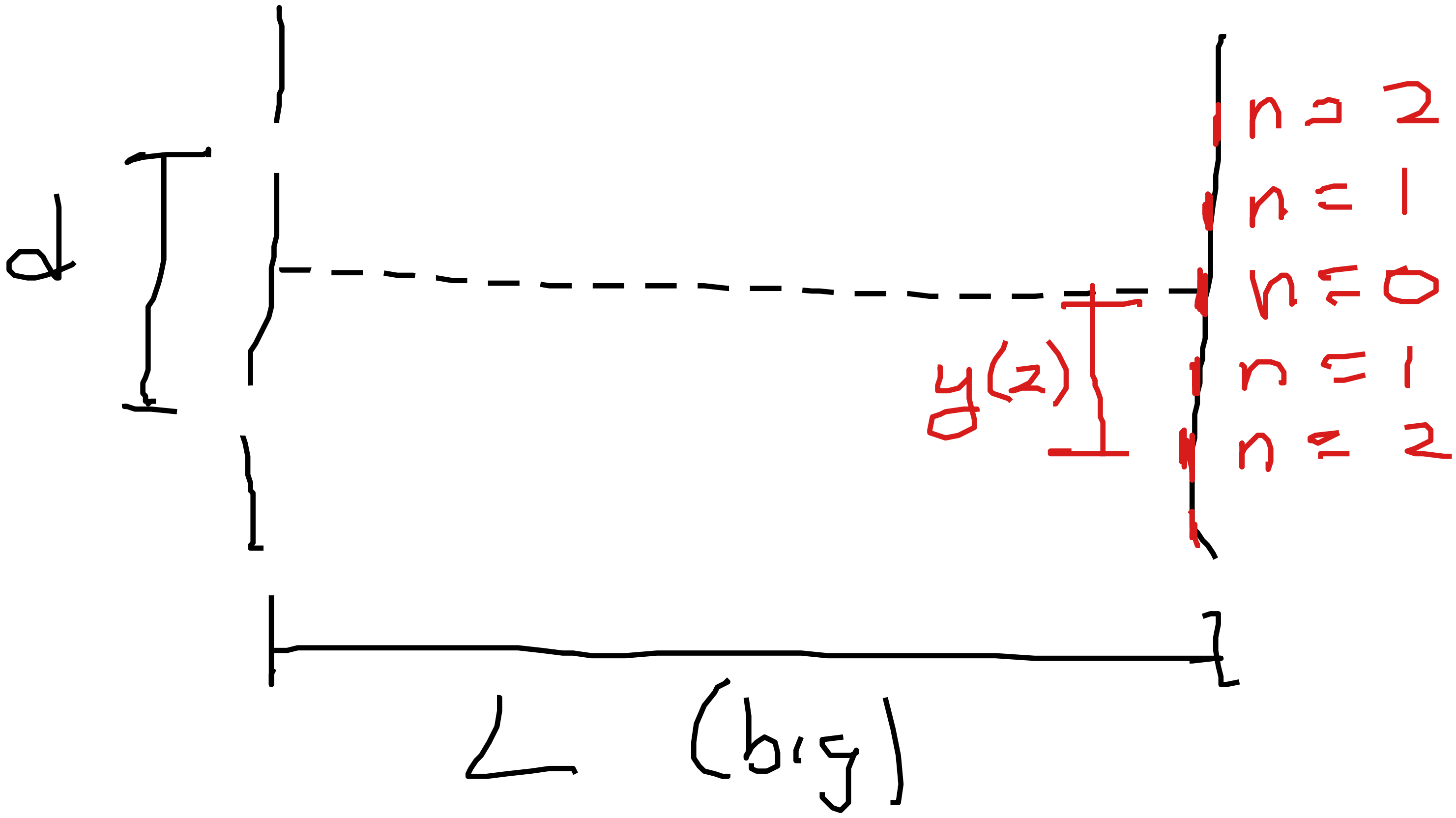
visible light has tiny λ (500nm) so the corner is way too big for it to go around.

Light **does** go around corners and does interfere, but only at very small scales

Young's Double-Slit Interference

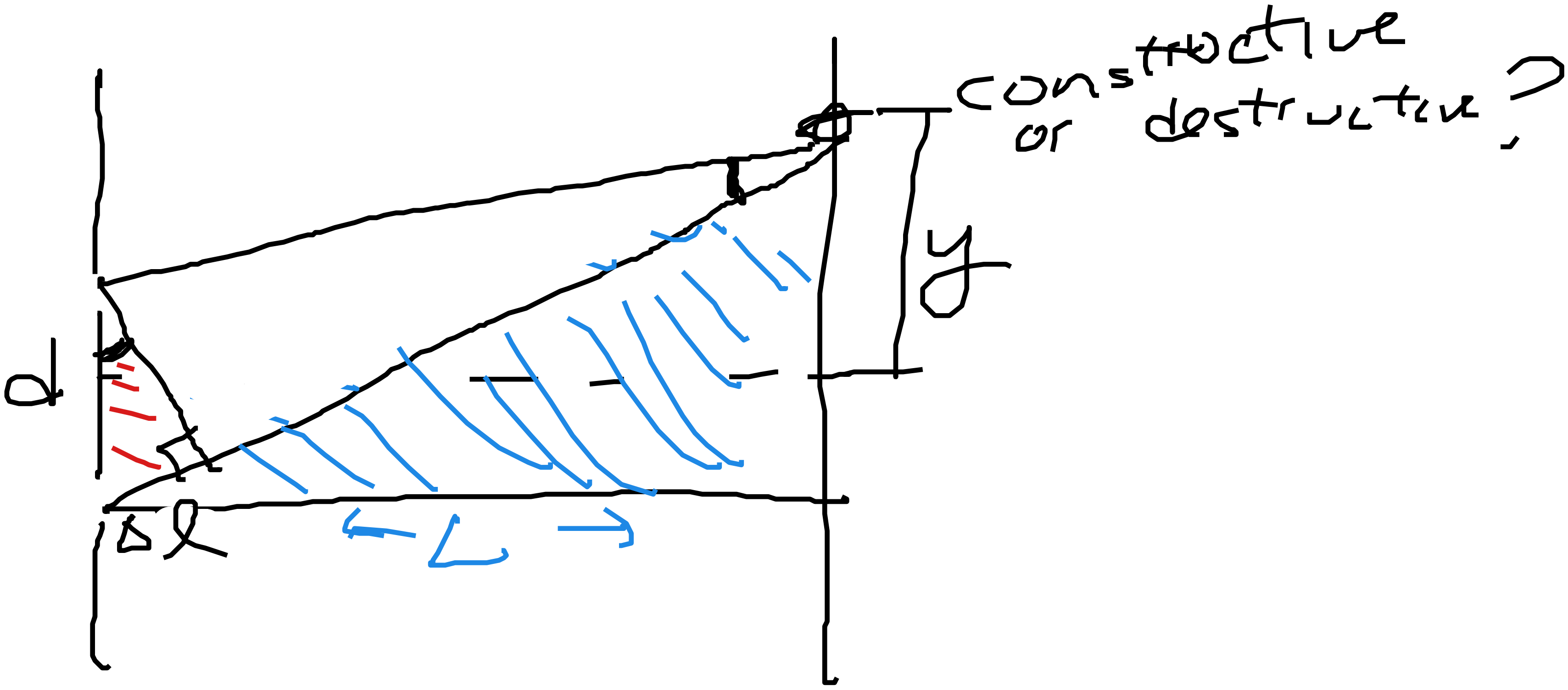


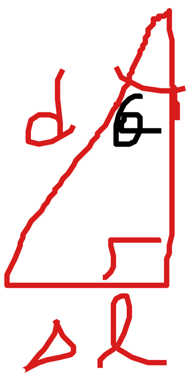
Waves through the slits must be in phase & single λ.

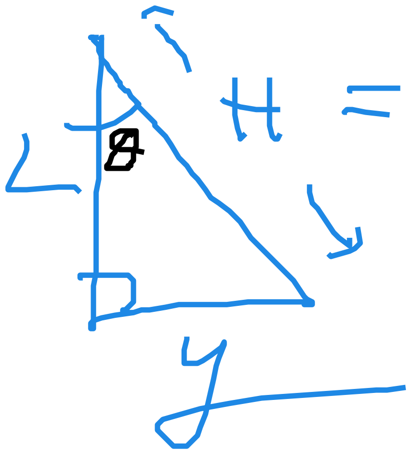


$$y(n) = \frac{n\lambda L}{d}$$

$$\Delta y = \frac{\lambda L}{d}$$







$$H = \sqrt{L^2 + y^2} \approx L$$

$$\frac{\Delta \ell}{d} = \frac{y}{H} \approx \frac{y}{L}$$

$$\rightarrow \Delta \ell = \frac{dy}{L}$$

Constructive interference

if

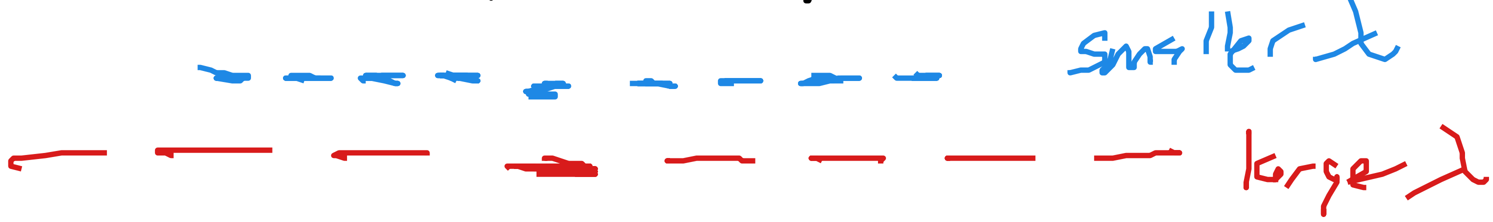
$$\frac{\Delta l}{\lambda} = n \quad \text{integer}$$

$$\frac{dy}{\lambda L} = n$$

$$y = \frac{n \lambda L}{d}$$

How spread out the pattern is (size of $y(n)$) depends on

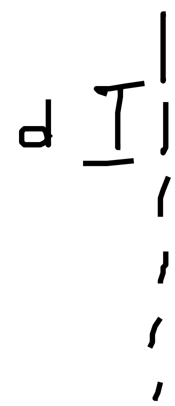
- L: bigger L, bigger y
- d: closer together the slits, the wider the pattern
- λ: smaller wavelength (towards purple), smaller pattern



If we use N slits instead of just 2, (N >> 2)

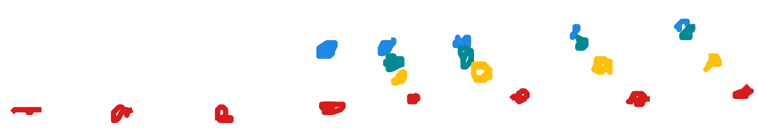
bright spots at

$$y(n) = \frac{n\lambda L}{d}$$



d: space in between neighboring slits

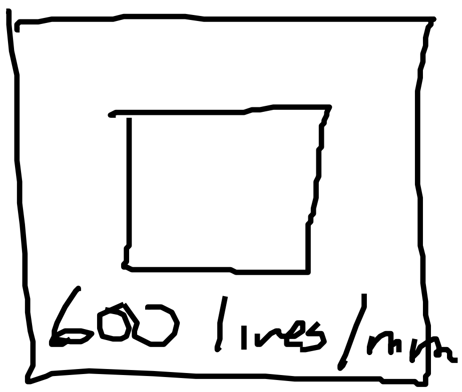
spacing is same, but bright spots get smaller & brighter



color doesn't overlap as much

diffraction grating

diffraction grating



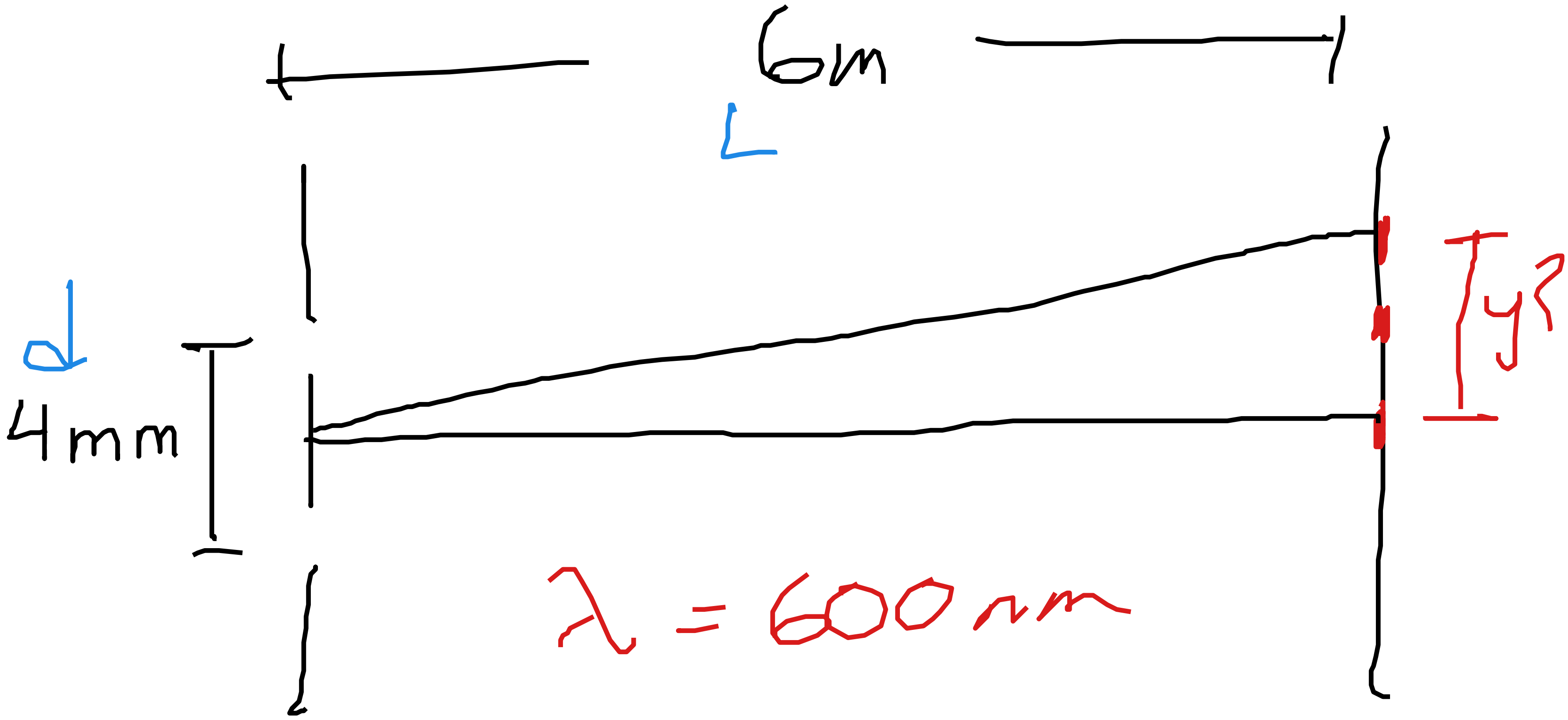
← $d = \frac{1\,mm}{600\,lines}$

$$d = \frac{meters}{line} = \frac{0.001\,m}{600\,lines}$$

$$= 1.67 \times 10^{-6} \frac{m}{line}$$

Used to study the spectrum of light from stars,

Used in spectroscopy in chemistry



$n = 2$

$y = $ NEED

$L = 6m$

$d = 4mm = 0.004m$

$\lambda = 600nm = 6 \times 10^{-7} m$

$$y = \frac{n\lambda L}{d} = \frac{2(6\times10^{-7})(6)}{0.004}$$

$$= 0.0018m = 1.8mm$$