1

$$\beta = 10\left(\left(\log_{10} I\right) + 12\right)$$

$$= 10\left(12 + \log_{10} I\right)$$

$$\log_{10}\left(5.3 \times 10^{-5}\right) = -4.28$$

$$\log_{10}\left(10^{-5}\right) = -5$$

1b) Twice as loud!

$$I \longrightarrow 2I$$

$$I = 1 \times 10^{-3}$$

$$\beta = 10(-3 + 12)$$
$$= 90 \, dB$$

twice as loud

$$I = 2 \times 10^{-3}$$

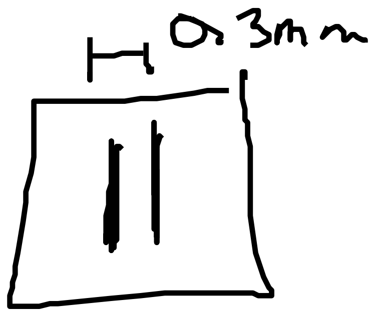
$$\beta = 10(\log_{10}(2 \times 10^{-3}) + 12)$$
$$= 10(-2.7 + 12)$$
$$= 93 \, dB,$$ not ~~180 dB~~

Twice as far away

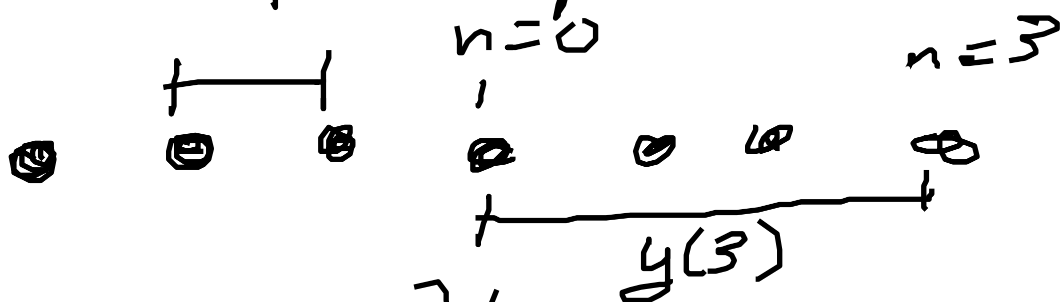
$$I \longrightarrow \frac{1}{4} I$$

---

2)



How far apart are the dots?



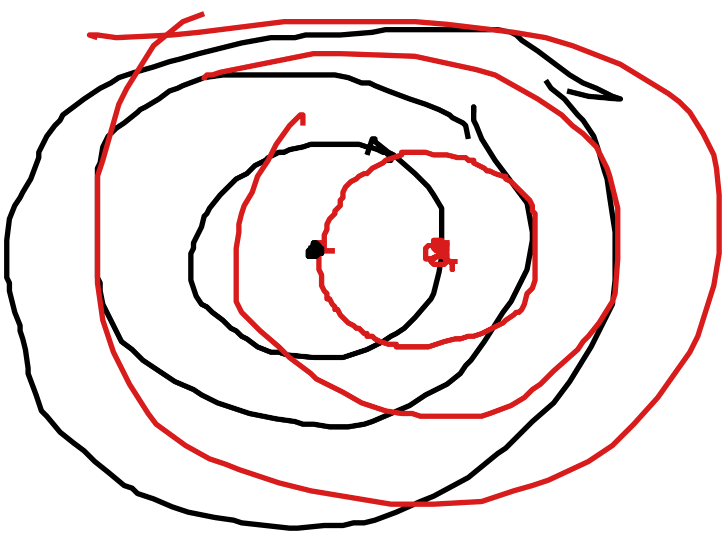
$$y(n) = \frac{n\lambda L}{d} \qquad \Delta y = \frac{\lambda L}{d}$$

$0.3\,\mathrm{mm} = 0.3 \times 10^{-3}\,\mathrm{m}$

~~Keep~~ L, d, y, & λ — all lengths, know what they mean

3) $1\,cm = 10^{-3}\,m$

4) Telescope can barely distinguish two stars that are 5×10^{-6} radians apart. What is the diameter of the telescope? ($\lambda = 500\,nm$)



Barely distinguish!

$$\theta_{min} = 1.22\frac{\lambda}{a}$$

a: width of aperture (diameter)

If the stars are both a distance L away,

minimum separation

$$S_{min} = L\theta_{min}$$

(works for any two objects a distance L away)

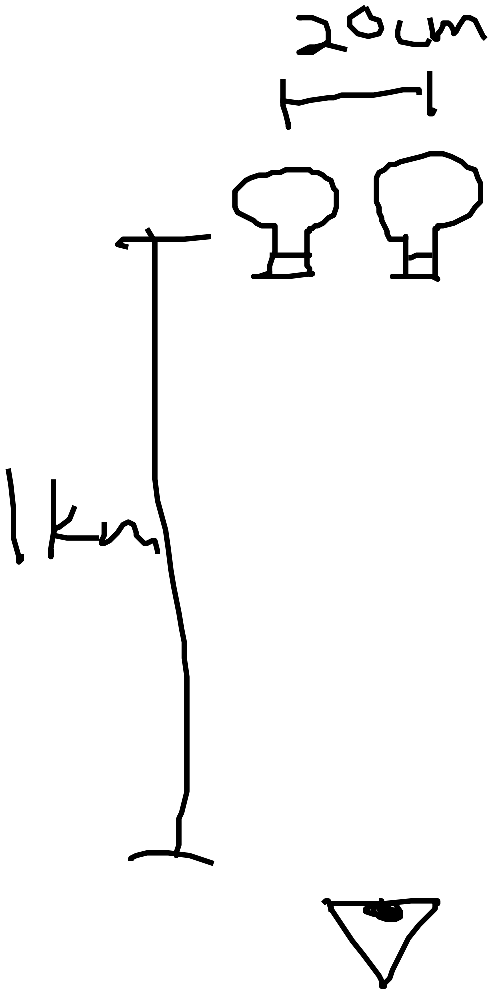
eg. our eyes $a = 6mm$ at night.

$$\theta_{min} = 1.22 \frac{(500\,nm)}{6\,mm} = 1.02 \times 10^{-4}\,rad$$

For a object 1 km away,

$$S_{min} = (10^3 m)(1.02 \times 10^{-4}\,rad) = 0.1\,m$$

10 cm.



I can distinguish these as 2 different lights (assuming perfect conditions)

I can't

To distinguish headlights

$s = 2m$

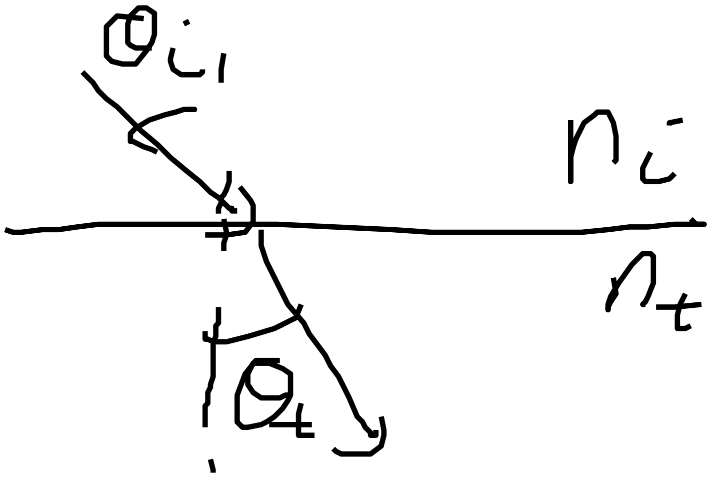
then we need

$$s_{min} = L\theta_{min} < s$$

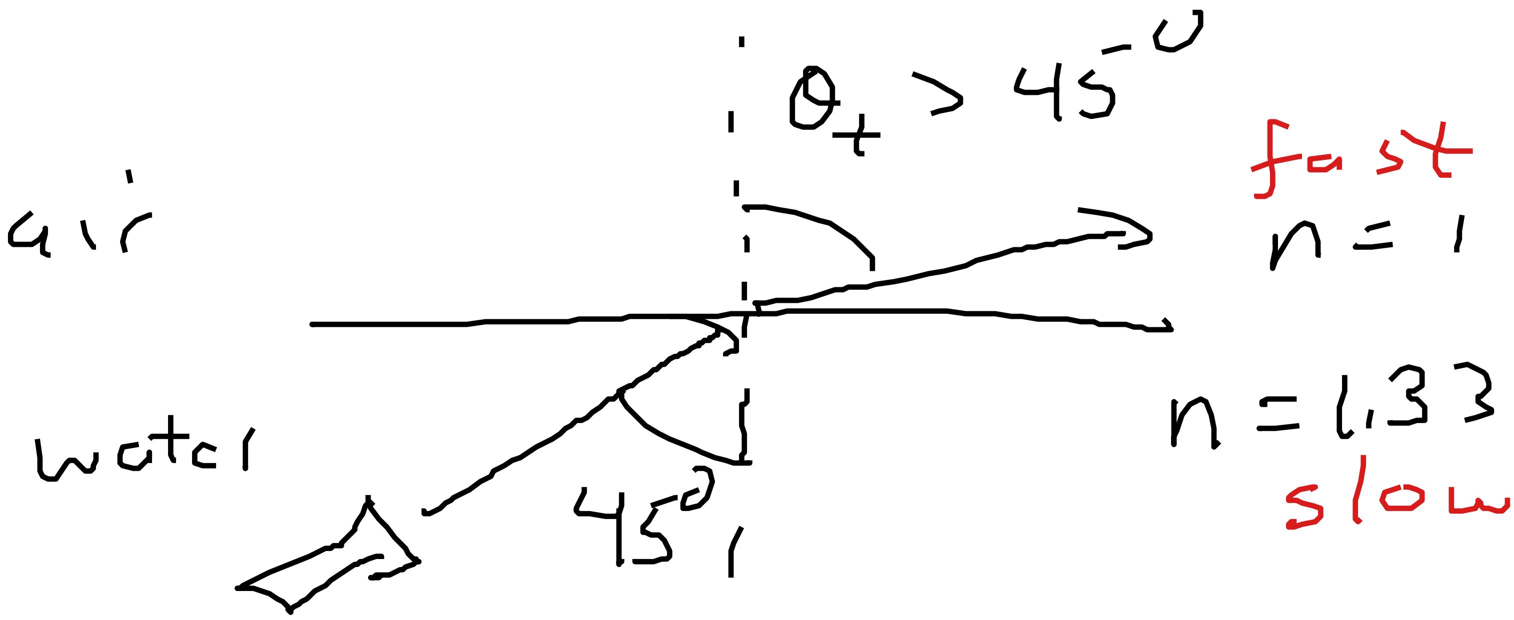
$$L < \frac{s}{\theta_{min}} = \frac{2}{102 \times 10^{-9}}$$

$$= 19.6\,km$$

Snell's Law



$$n_i \sin\theta_i = n_t \sin\theta_t$$



$$1.33 \sin 45^\circ = 1 \sin \theta_t$$

$$\sin \theta_t = 0.94$$

$$\theta_t = \sin^{-1} 0.94$$

$$= 70^\circ$$

What if θ_i were 50° instead of 45°?

$$1.33 \sin 50^\circ = \sin \theta_t$$

$$1.02 = \sin \theta_t$$

$$\theta_t = \sin^{-1} 1.02$$

↑ "Hey wait, sines can't be > 1"

If Snell's Law has no solution, then light doesn't transmit.

total reflection

$$n_i \sin\theta_i = n_t \sin\theta_t$$

$$\theta_t = \sin^{-1}\left(\frac{n_i}{n_t} \sin\theta_i\right)$$

< 1

if $\frac{n_i}{n_t} < 1$ then no problem.

$n_i < n_t$

light slows down

if $n_i < n_t$ $\qquad \frac{n_i}{n_t} > 1$

then $\frac{n_i}{n_t} \sin\theta_i$ might get bigger than 1 when light speeds up.

Total Internal Reflection

when $\frac{n_i}{n_t} \sin\theta_i > 1$

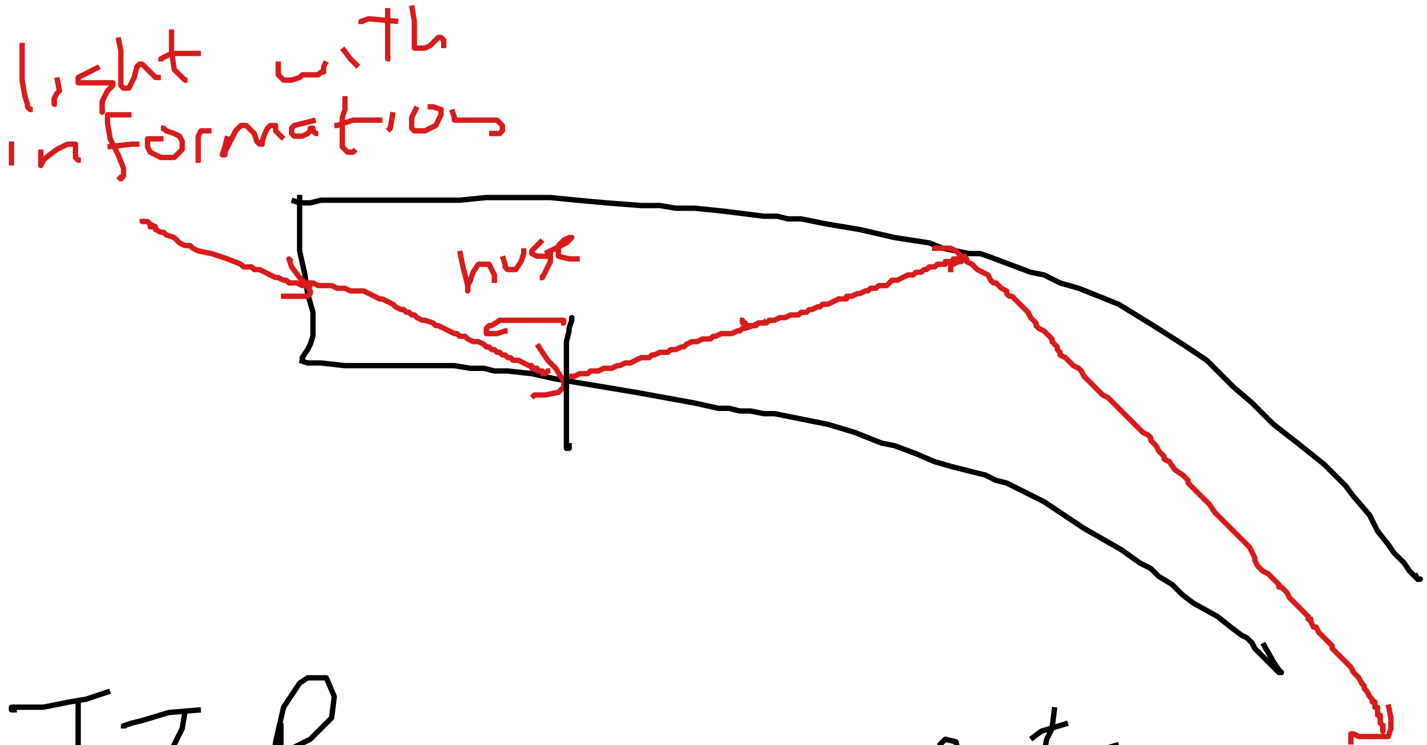
$$\rightarrow \sin\theta_i > \frac{n_t}{n_i}$$

$$\theta_i > \sin^{-1}\frac{n_t}{n_i}$$

critical angle

$$\theta_c = \sin^{-1}\frac{n_t}{n_i}$$

Fibes Optics



T.I.R. prevents the light from escaping