Phys 100 Assignment #9.

1. The spiral galaxy in the Andromeda constellation is about 2×10^{19} Km away. How many light years is this?

$$1 \text{ light year} = \left(\frac{3 \times 10^8 \text{ m}}{\text{s}}\right)\left(\frac{3600 \text{ s}}{1 \text{ hr}}\right)\left(\frac{24 \text{ hr}}{1 \text{ day}}\right)\left(\frac{365 \text{ days}}{1 \text{ year}}\right)$$

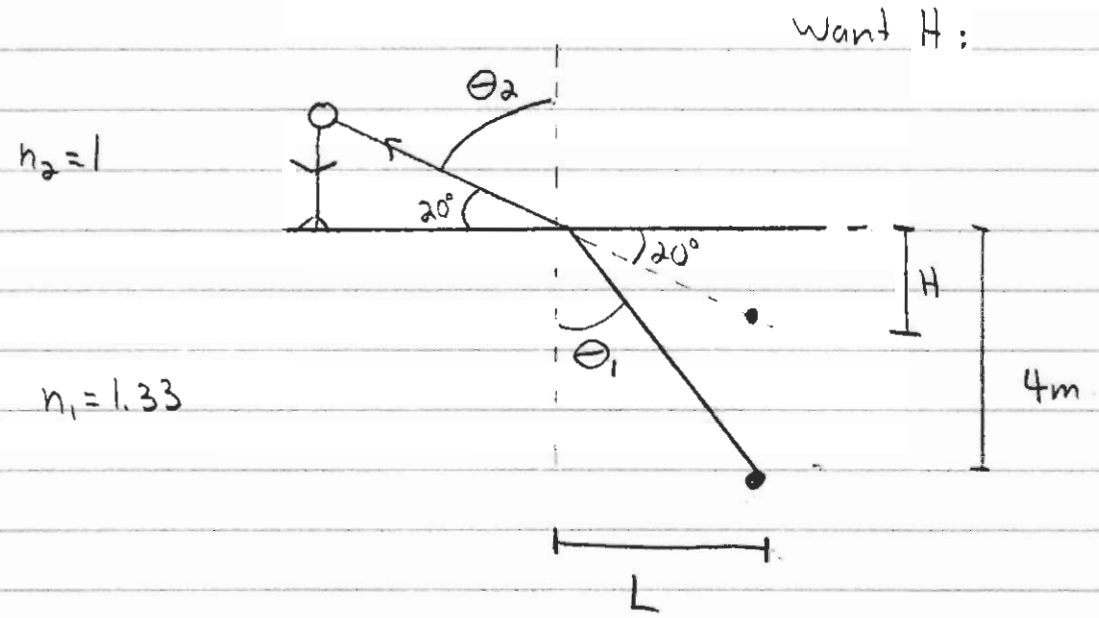
$$= 9.5 \times 10^{15} \text{ m}$$

$$\#\text{ of light years} = \frac{\text{total distance}}{\text{distance of 1 light year}}$$

$$= \frac{2 \times 10^{22} \text{ m}}{9.5 \times 10^{15} \text{ m}}$$

$$\#\text{ of light years} = 2.1 \times 10^6$$

2.



step i) obtaining θ_2.

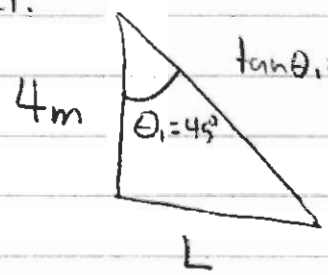
- using the fact that the normal is perpendicular to the surface.

$90 = \theta_2 + 20 \quad \therefore \quad \theta_2 = 70°$

step ii) obtaining θ_1 using snell's law.

$$n_1 \sin\theta_1 = n_2 \sin\theta_2$$
$$1.33 \sin\theta_1 = \sin 70$$
$$\theta_1 = 45°$$

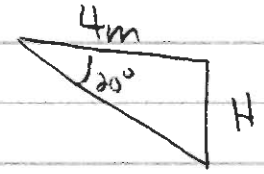
step iii) determining L, the horizontal distance from the coin to the refraction normal.



$\tan\theta_1 = \tan 45 = \frac{L}{4m}$

$L = 4m$

step iii) Finding H, apparent depth of pool.



$\tan 20° = \frac{H}{4m}$

$H = 4 \tan 20°$

$H = 1.45m$

The apparent depth of the pool is 1.45 m

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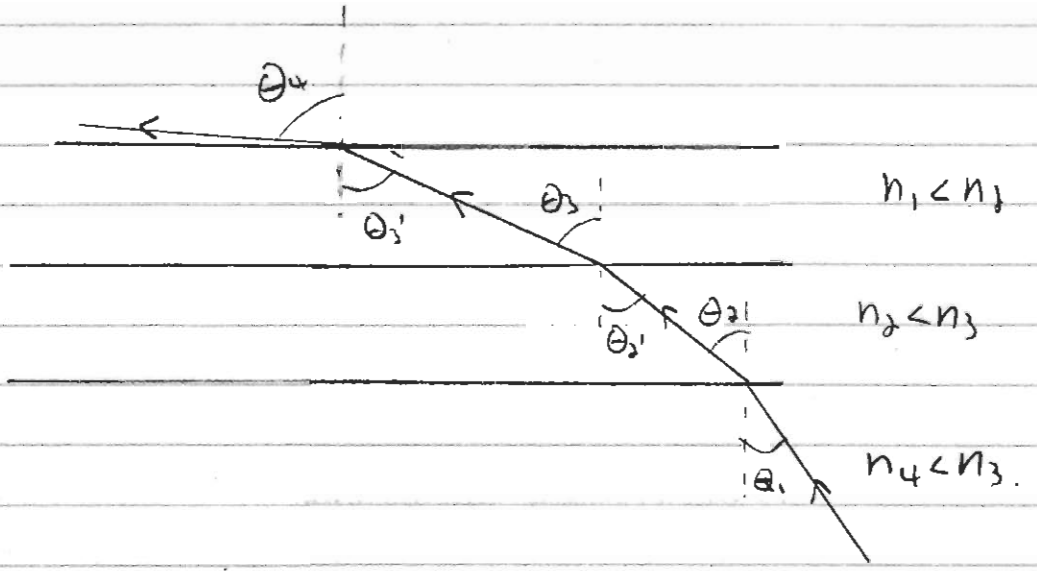
Similar to Mirage example done in class.

Assume 3 surfaces

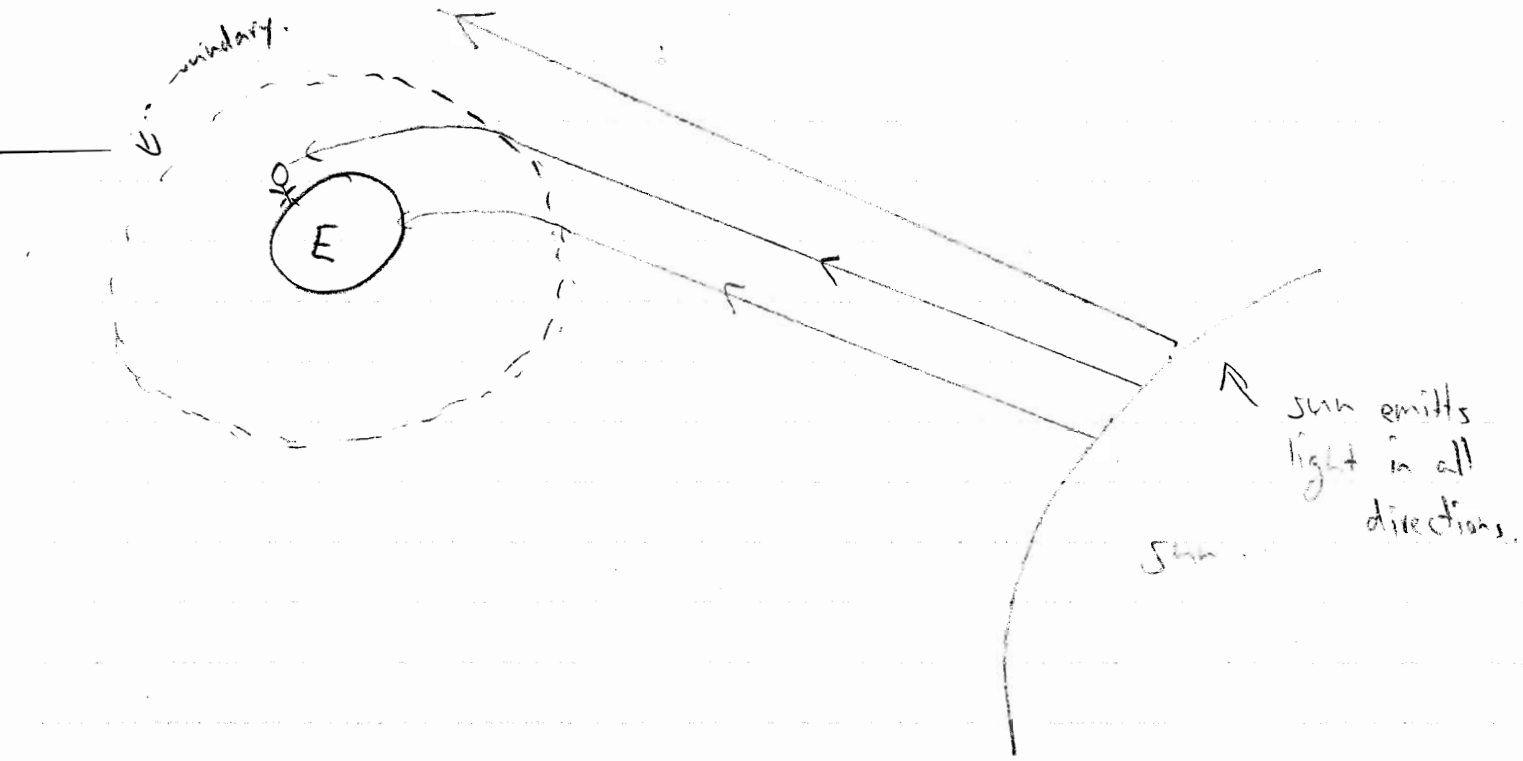


As the above diagram shows, light bends away from the normal if the n on the refracted side is smaller than the n on the incident side. One can see this from Snell's law.

$$n_1 \sin\theta_1 = n_2 \sin\theta_2 \qquad n_1 > n_2 \;\therefore\; \theta_2 > \theta_1$$

This bending is why light rays can be seen after the sun is set

SEE Diagram on next page.



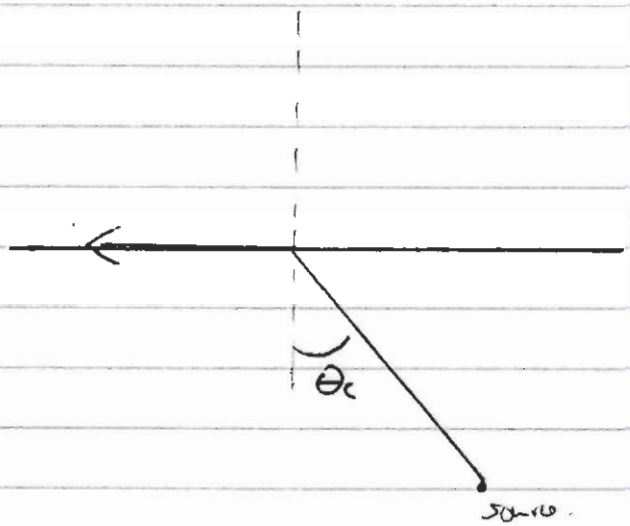
Why is the sun flat?

There is a great explanation @.

http://www.atoptics.co.uk/atoptics/sunflat.htm

4.

Note, reflected ray not drawn.



The critical angle occurs when $\theta_2 = 90°$, NO Refraction.

$$n_1 \sin\theta_1 = n_2 \sin\theta_2$$
$$1.5 \sin\theta_c = 1.33$$
$$\theta_c = \sin^{-1}\left(\frac{1.33}{1.5}\right)$$

$$\boxed{\theta_c = 62.5°}$$