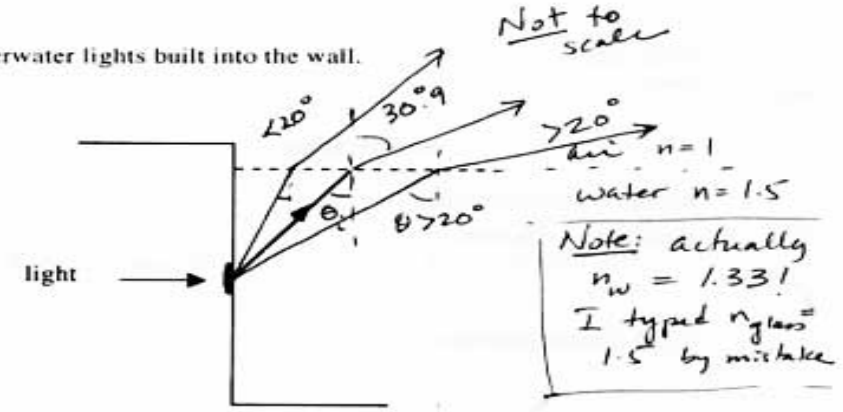
2. "Your" swimming pool has underwater lights built into the wall.



(a) Label the angle of incidence, θ_i, for the ray shown on the diagram.

(b) For the ray shown ($\theta_i = 20.0°$), calculate the refracted angle.

[value using n = 1.33 $\theta_r = 27.06°$]

$$n_1 \sin\theta_1 = n_2 \sin\theta_2$$

$$1.5 \sin 20° = 1 \sin\theta_r$$

$$\sin\theta_r = 1.5 \sin 20° = 0.513 \longrightarrow \theta_r = 30.87°$$

(c) Draw the refracted ray on the diagram.

(d) Now draw a ray (starting at the light and ending in the air) for an incident angle < 20.0° **AND** for for an incident angle > 20.0°.

(e) What is the refracted angle when the incident angle is equal to the critical angle – give a value – don't say it doesn't exist.

$90°$

(f) Calculate the critical angle for light which begins underwater ($n_w = 1.50$) and ends in air ($n_a = 1.00$).

$$n_1 \sin\theta_1 = n_2 \sin\theta_2$$

$$1.5 \sin\theta_c = 1 \sin 90°$$

$$\sin\theta_c = \frac{1}{1.5}$$

$$\theta_c = 41.8°$$

[using 1.33 = n $\theta_c = 48.8°$]