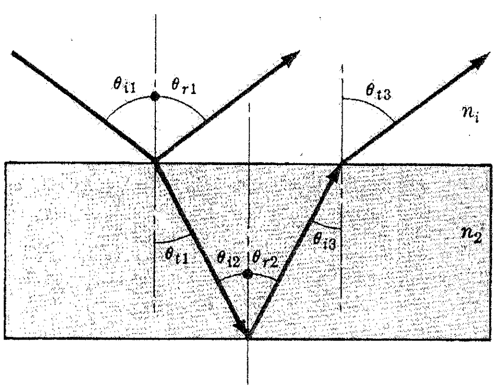
1) Imagine a source emitting 100 W of green light at a wavelength of 500 nm. (a) How many photons per second are emerging from the source? (b) If a telescope with an objective lens of 2 cm diameter is located 10 km from the source, how many photons per second will be detected by a CCD at the focus? Assume 100% efficiency for the components.

a) $N = \frac{100}{h\nu} = \frac{100\lambda}{hc} = \frac{100(500\times10^{-9})}{(6.6\times10^{-34})(3\times10^{8})} = 2.5\times10^{20}$ photons/sec

b) At $d = 10\text{km} = 10^{4}\text{m}$ the flux $= \frac{N}{4\pi d^2} = \frac{2.5\times10^{20}}{(12.57)(10^{8})} = 1.989\times10^{11}\ \frac{\text{photons}}{m^2\ \text{sec}}$

A 2cm diameter aperture has a surface area of: $\pi r^2 = (3.14)(0.01)^2 = 3.14\times10^{-4} m^2$

so it collects 6.25×10^{7} photons/sec



'art of the beam reflects off the top surface and part off the bottom surface, ıg back into the incident medium are parallel.

$\theta_{t1} = \theta_{i2}$ and $\theta_{r2} = \theta_{i3}$ (geometry)

$\theta_{i1} = \theta_{r1}$ and $\theta_{i2} = \theta_{r2}$ (law of reflection)

so $\theta_{t1} = \theta_{i3}$ (Snell's law)

$n_1 \sin\theta_{i1} = n_2 \sin\theta_{t1}$ and $n_2 \sin\theta_{i3} = n_1 \sin\theta_{t3}$

and so $n_1 \sin\theta_{i1} = n_1 \sin\theta_{t3}$

so $\theta_{i1} = \theta_{t3} = \theta_{r1}$

3) The sparkling appearance of gem-cut diamond arises from the total internal reflection. Light entering from above Is reflected back out toward the viewer, re-emerging through the top facets. Determine the critical angle (n = 2.147) and compare it to that of glass (n = 1.5).

diamond: $\sin\theta_c = n_{ti} = \frac{1}{2.147}$ so $\theta_c = 27.8^\circ$

glass: $\sin\theta_c = \frac{1}{1.5}$ so $\theta_c = 41.8^\circ$

4) Determine the critical angle for a water (n = 1.33) to glass (n = 1.50) interface.

$\sin\theta_c = n_{ti}$ so $\theta_c = \sin^{-1}\left(\frac{1.33}{1.50}\right) = 62.5^\circ$