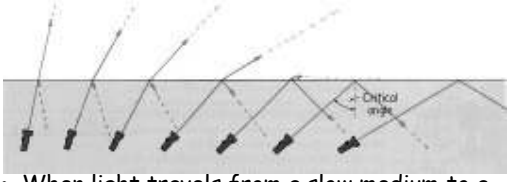
Refraction of Light –Part 2

Internal Reflection

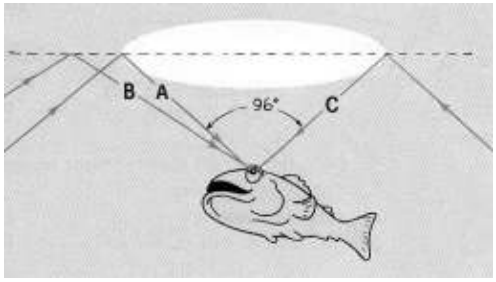


- When light travels from a slow medium to a fast medium, the angle of refraction is larger than the angle of incidence.
- When the angle of refraction should be 90° or greater, there is total internal reflection.
- The incident angle which predicts a 90° refraction angle is called the **critical angle**.
- Applet

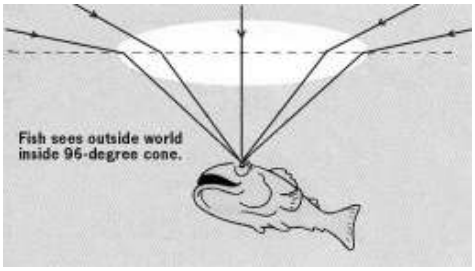
Critical Angle

- $n_1 \sin \theta_c = n_2 \sin 90^o$
- $n_1 \sin \theta_c = n_2$
- $\sin \theta_c = n_2 / n_1$
- $\theta_c = \sin^{-1}(n_2 / n_1)$
- For water: $\theta_c = 48^o$
- The higher the index of refraction the lower θ_c

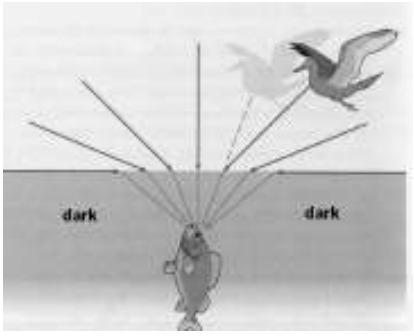
Fish Eye View



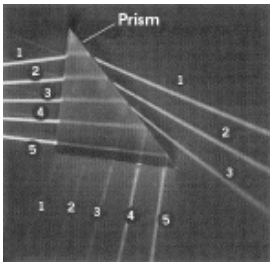
View of World Above
Applet



Bird & Fish

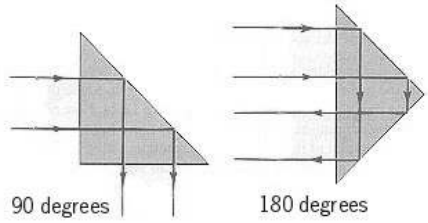


Internal Reflection

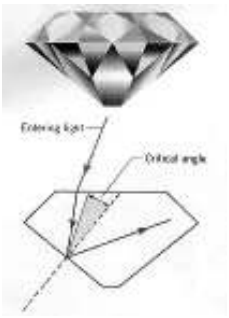


- All rays reflect internally, but the top three rays reflect only a small percentage internally; most energy leaves the prism.
- The fourth and fifth rays are reflected 100 % internally

Internal Reflection in Prisms

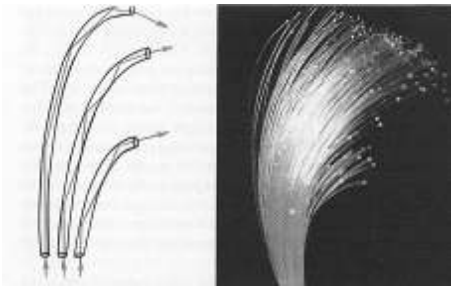


Internal Reflection in Diamond



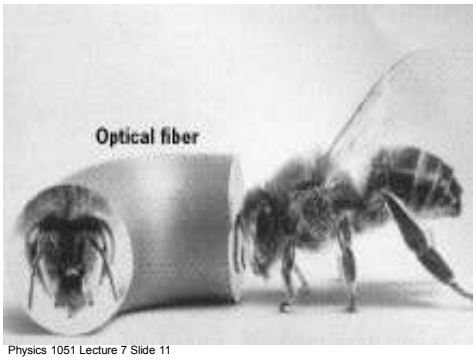
- The critical angle for diamond in air is 24.5 º.
- Any ray which strikes the inside surface at an angle greater than 24.5º will be totally internally reflected.

Fiber Optics



Physics 1051 Lecture 7 Slide 10

Fiber Optics



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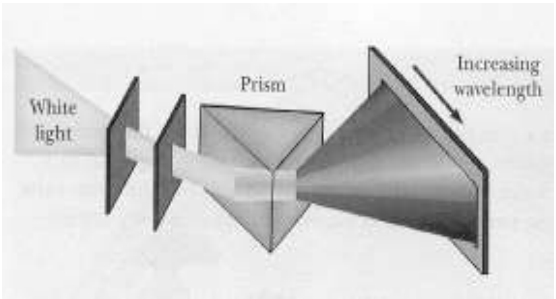
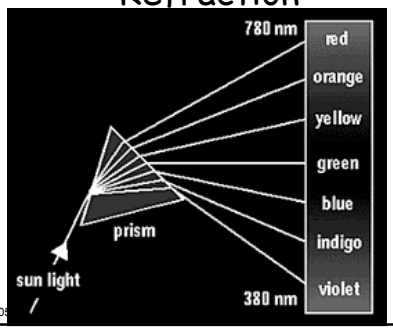
Dispersion
Blue Bends Best



Physics 1051 Lecture 7 Slide 12

Different Frequencies Different Indices of Refraction



Refractive Index Function of Wavelength

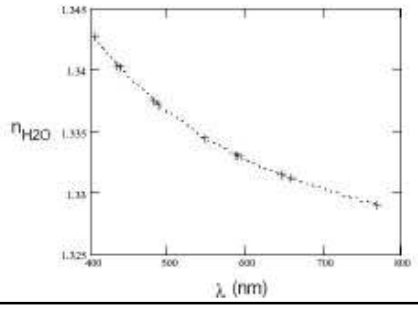
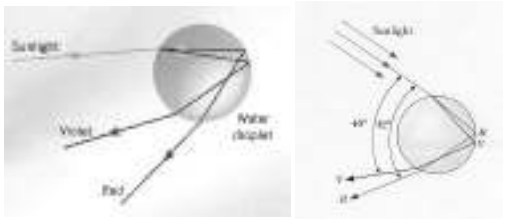


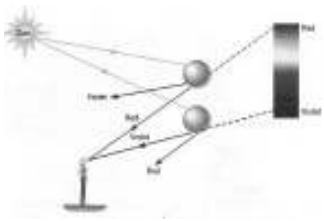
Table of Indices

Material	Blue (486.1 nm)	Yellow (589.3 nm)	Red (656.3 nm)
Crown Glass	1.524	1.517	1.515
Flint Glass	1.639	1.627	1.622
Water	1.337	1.333	1.331
Cargille Oil	1.53	1.52	1.516
Carbon Disulfide	1.652	1.628	1.618

Refraction & Reflection in a Raindrop

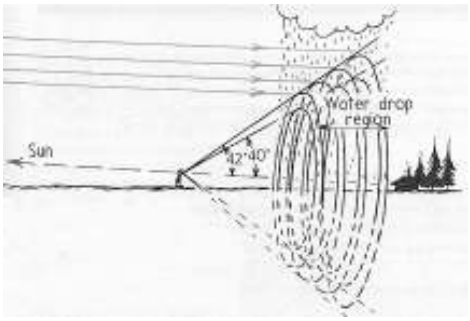


Rainbow Formation

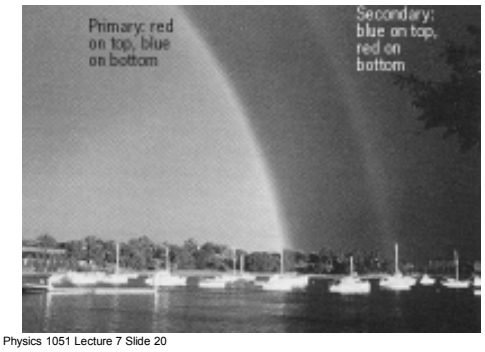


- An observer sees red light coming from droplets of water higher in the sky.
- Droplets of water lower in the sky send violet light to the eye.

Circular Rainbow



Double Rainbow Picture



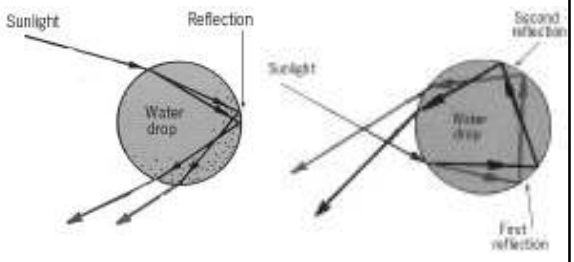
Double Rainbow Picture

Rainbow Arch

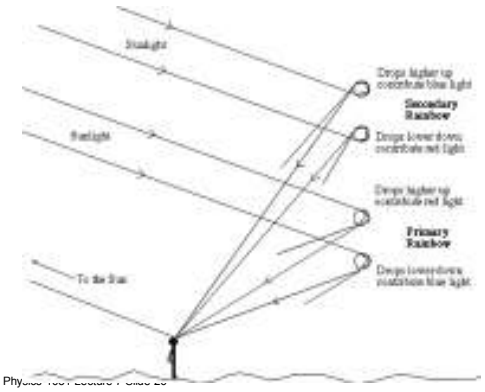
Rainbow Zoom

Double Rainbow

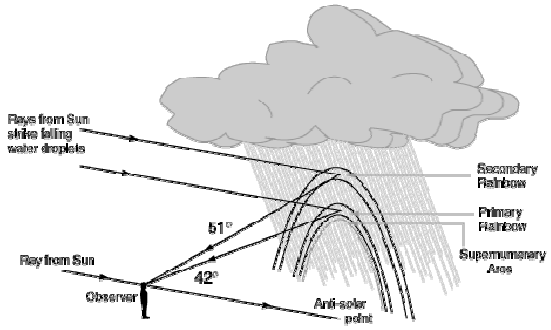
Double Rainbow Diagrams



Double Rainbow Diagram



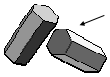
Many Raindrops Diagram



Alexander's Dark Band

- Sky is light inside primary rainbow
- Dark between primary and secondary bows
- Light beyond the secondary rainbow
- Dark region between is called Alexander's Dark Band

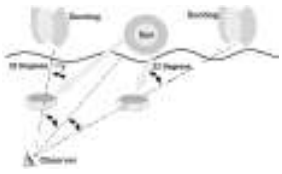
22^o Halo

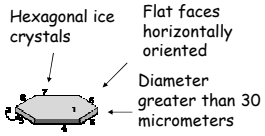


- A halo is a ring of light surrounding the sun or moon.
- Most halos appear as bright white rings but in some instances, the dispersion of light as it passes through ice crystals found in upper level cirrus clouds can cause a halo to have color.

Sundogs

- Sundogs or parhelia on right and left of sun





Sundog

Sundog

Sundog