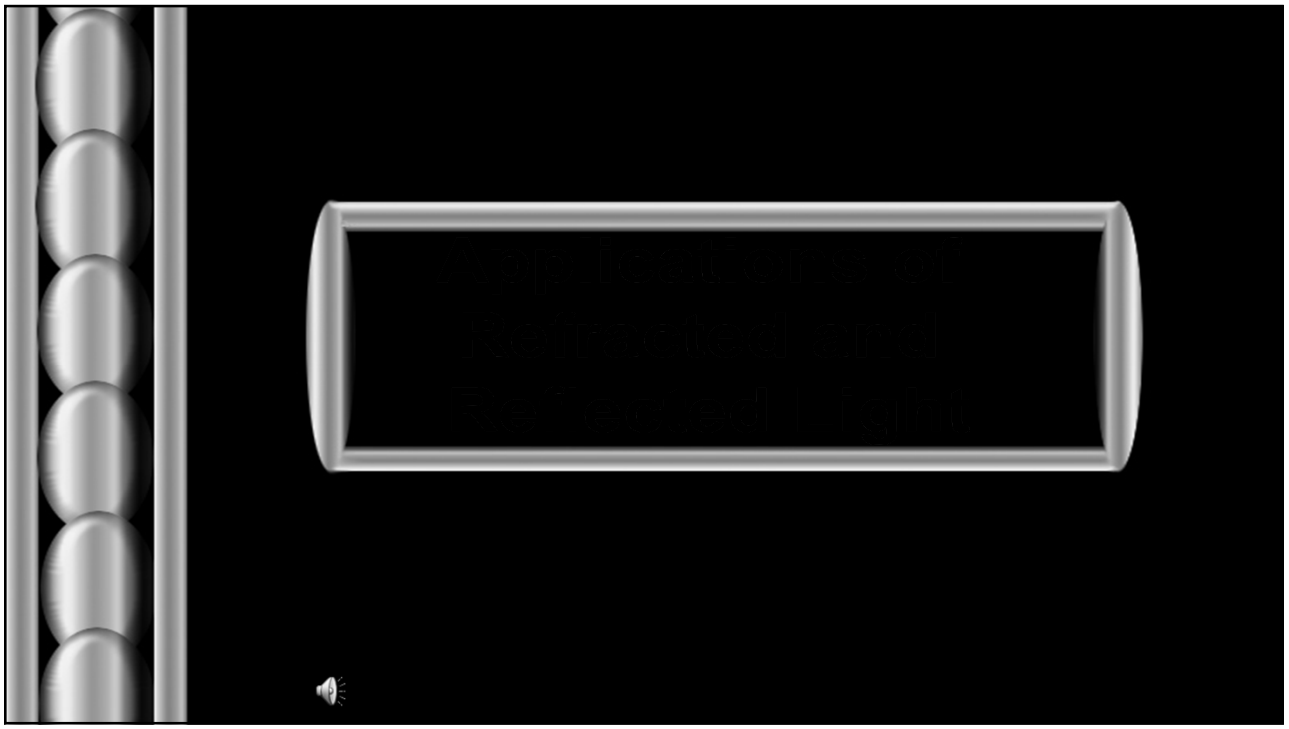
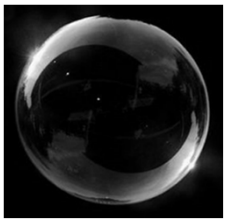


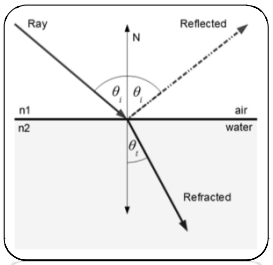
1

If an object is transparent, how to we know it is there?

- Colors
  - If seen at the right angle, a transparent object can also have colors running through it (ex: bubbles)



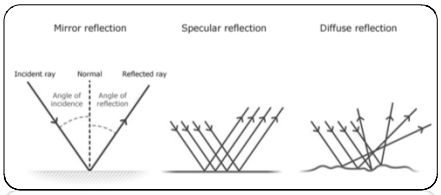
- Refraction
  - Objects appear distorted
- Reflection
  - We see our reflection on the surface of the object



2

Reflection

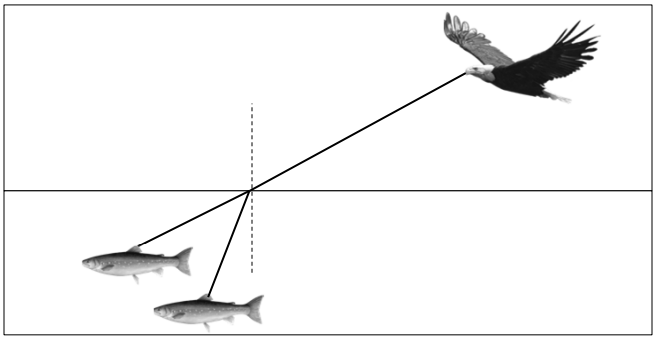
- Law of Reflection
  - The angle of incidence = the angle of reflection
- Types
  - Regular or Specular (smooth surface)
  - Diffuse (rough surface)



3

Effects of Refraction

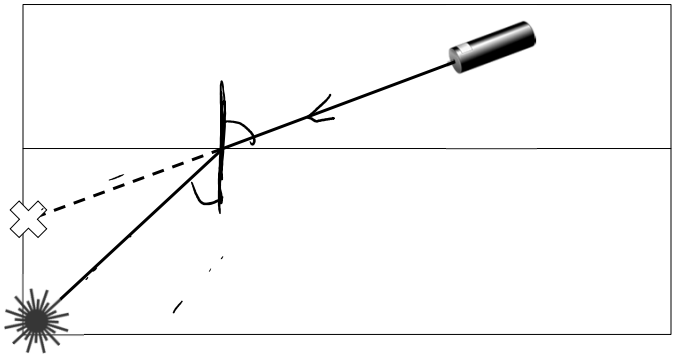
- Light coming from the fish bends away from the normal as it goes from water to air.
- Where does the eagle THINK the fish is?



4

Effects of Refraction

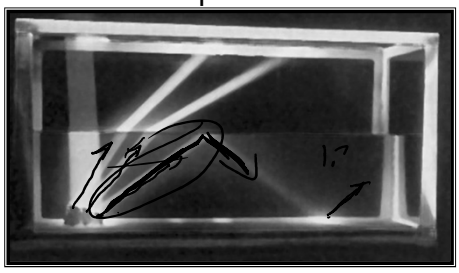
- You want to shine a laser in the corner of the fish tank. Where should you aim the laser?



5

Total Internal Reflection

- The complete reflection of light at the boundary of two transparent media; the effect occurs when the angle exceeds the critical angle.
- Only occurs when light is traveling from a more optically dense medium to less optically dense medium.
- Theory behind fiber optics



6

Critical Angle

- The minimum angle of incidence for which total internal reflection occurs.

$$\sin\theta_c = \frac{n_r}{n_i}$$

← SMALLER

↖ LARGER

- This only occurs when the index of refraction for the first medium is greater than the index of refraction of the second medium

7

Example Problem

- Find the critical angle for a water-air boundary if the index of refraction of water is 1.33.

FROM TO ✓ $n = 1.0003$

$$\sin\theta_c = \frac{n_r}{n_i}$$

$$\sin\theta_c = \frac{1.0003}{1.33}$$

$$\sin\theta_c = .752$$

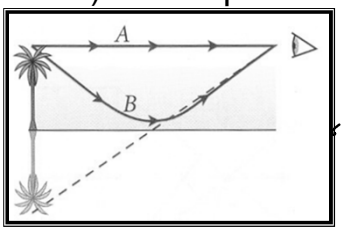
$$\theta_c = \sin^{-1}(.752) = 48.8^0$$

Answer: 48.8^0

8

Refraction and Mirages

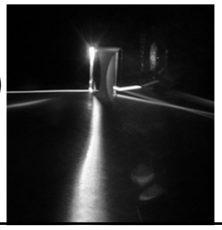
- A mirage can be observed when the ground is so hot that the air directly above is warmer than the air at higher elevations.
- This causes the air to have different densities and therefore different indices of refraction.
- The light refracts (bends) back up towards the eye.



9

Dispersion

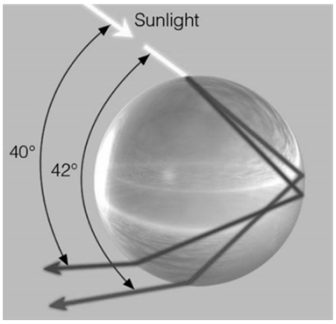
- The process of separating polychromatic (consisting of more than one color) light into its component wavelengths through refraction.
- The amount of dispersion depends on the index of refraction.
- The index of refraction decreases with increasing wavelength.
- Shorter wavelengths (violet) bend more than longer (red) wavelengths.



10

Rainbows

- How do rainbows form?
  - Light refraction
  - Total internal reflection
  - Causes a 2 degree difference in the location of red and violet



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