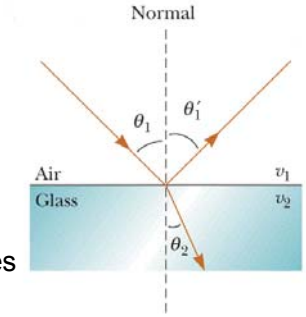
PHY138 – Waves, Lecture 7

Today's overview

- The Ray Model of Light
- Reflection
- Refraction
- Total Internal Reflection
- Medical Fibrescopes
- Apparent Depth



Reading Assignment

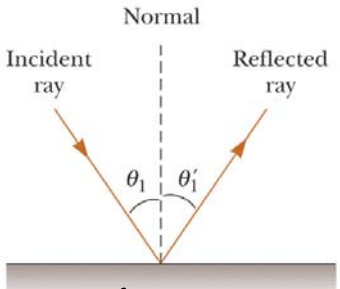
- This week's reading assignment from the text by Knight is: **Chapter 23**, Sections 23.1-23.7
- Test 2 will cover up to and including Section 23.7, Thin Lenses and Refraction Theory, plus lab materials from this semester.
- A masteringphysics Problem Set is due Friday by 5:00 PM.

  It is the *last* problem set of 2007.
- Suggested Chapter 23 Exercises and Problems for Practice: 11, 17, 19, 27, 39, 49, 73, 81

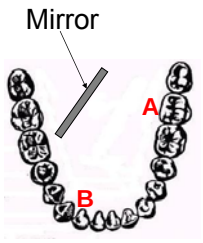
Wave Fronts and Rays

- Wave fronts connect points of equal phase on an extended wave.
- Rays show the propagation direction of waves, and are always perpendicular to wave fronts.
- Rays travel in straight lines
- At a boundary they can *reflect* (bounce off) and *refract* (penetrate) the different medium.
- Ray angles are measured relative to surface normal.

The Law of Reflection



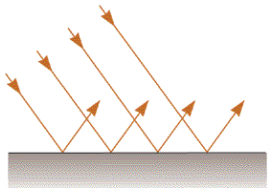
$$\theta_1' = \theta_1$$



A dentist uses a mirror to look at the back of a second molar (A). Next, she wishes to look at the back of a lateral incisor (B), which is 90° away. By what angle should she rotate her mirror?

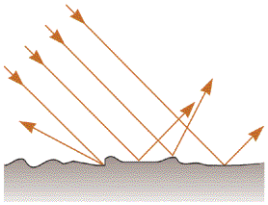
A. 90°
B. 45°
C. 180°

Specular vs. Diffuse Reflection



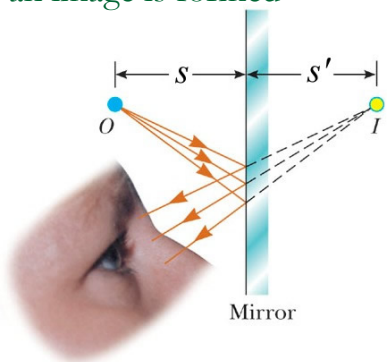
Specular Reflection
•The surface is *flat* at distance scales near or above the wavelength of light
•It looks "shiny", like a mirror.

Specular vs. Diffuse Reflection



Diffuse Reflection
•The surface is *rough* at distance scales near or above the wavelength of light
•Almost ***all*** surfaces reflect in this way!

How an image is formed



Virtual Image in a flat mirror

- Light rays emerging from an object obey the law of reflection for the specular surface of a mirror
- Our mind imagines that the rays emerge from points beyond the mirror.
- This thing beyond the mirror is called an image. No light rays actually pass through the image, so it is "virtual".
- It is convenient to describe the size and location of the image as if it were an actual thing.

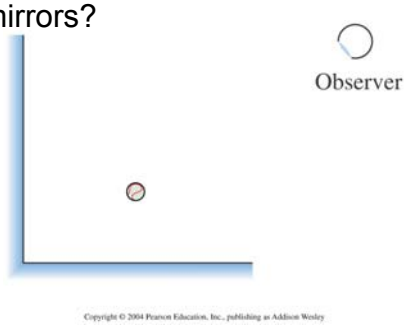
Two plane mirrors form a right angle. How many images of the ball can you see in the mirrors?

A. 1

B. 2

C. 3

D. 4

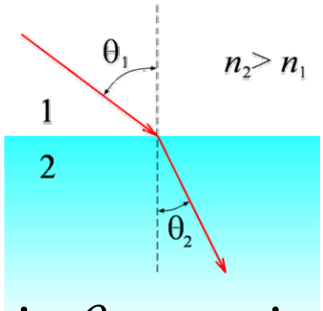


Index of Refraction

$$v_{medium} = \frac{c}{n}$$

- v_{medium} is the speed of light in a transparent medium.
- c is the speed of light in a vacuum (c=3.00×10^8 m/s)
- n is a dimensionless constant: $n \geq 1$
- n=1 in a vacuum

Snell's Law of Refraction



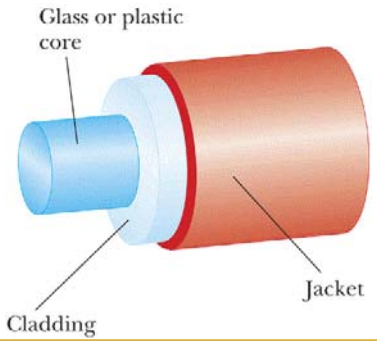
$$n_1 \sin\theta_1 = n_2 \sin\theta_2$$

Total Internal Reflection

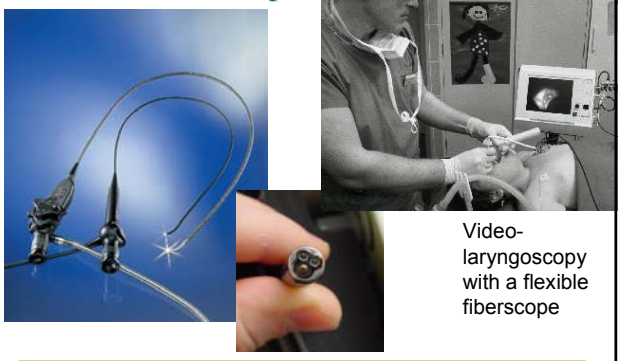
- Occurs when $n_2 < n_1$
- θ_c = critical angle.
- When $\theta_1 \geq \theta_c$, no light is transmitted through the boundary; 100% reflection

$$\sin\theta_c = \frac{n_2}{n_1}$$

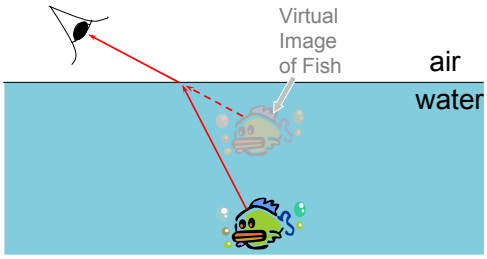
An Optical Fibre



Medical Fibrescopes

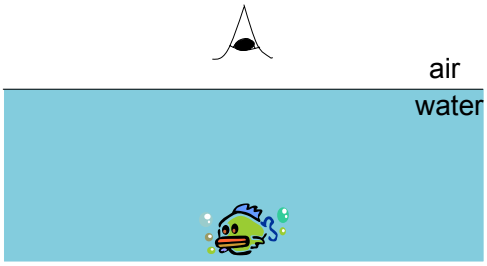


Video-laryngoscopy with a flexible fiberscope



A fish swims below the surface of the water. An observer sees the fish at:

A. a greater depth than it really is.
B. its true depth.
C. a smaller depth than it really is.



A fish swims *directly* below the surface of the water. An observer sees the fish at:

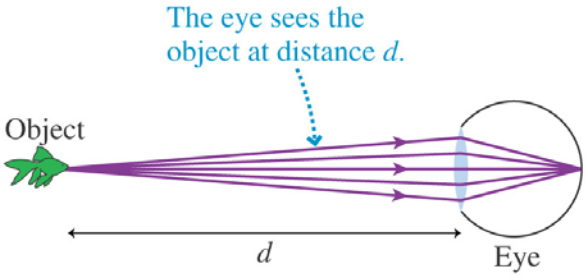
A. a greater depth than it really is.

B. its true depth.

C. a smaller depth than it really is.

Depth perception

A fish out of water



Apparent Depth

A fish in the aquarium