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Lecture 1. The Nature of Light

H1. Rank the following radiations according to their associated photon energies, greatest first: (a) yellow light from a sodium vapor lamp, (b) a gamma ray emitted by a radioactive nucleus, (c) a radio wave emitted by the antenna of a commercial radio station, (d) a microwave beam emitted by airport traffic control radar. Give your reason.

H2. What is the photon energy for yellow light from a highway sodium lamp at a wavelength of 589 nm?

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Lecture 2. Reflection and Refraction

H1. A beam of light has a wavelength of 650 nm in vacuum.
(a) What is the speed of this light in a liquid whose index of refraction at this wavelength is 1.47?
(b) What is the wavelength of these waves in the liquid?

H2. Light of a certain frequency has a wavelength of 526 nm in water (n=1.33). What is the wavelength of this light in benzene (n=1.50)?

H3. A ray of light traveling in water is incident on an interface with a flat piece of glass. The wavelength of the light in the water is 726 nm, and its wavelength in the glass is 544 nm. If the ray in water makes an angle of 56.0° with respect to the normal to the interface, what angle does the refracted ray in the glass make with respect to the normal?

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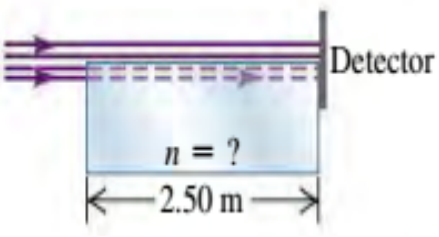
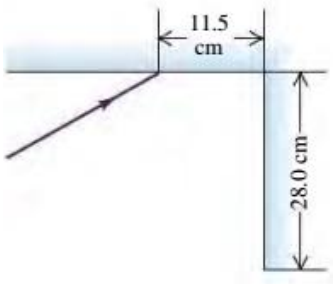
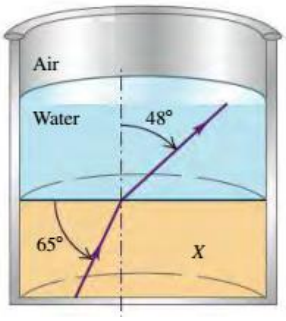
H4. A laser beam shines along the surface of a block of transparent material. Half of the beam goes straight to a detector, while the other half travels through the block and then hits the detector. The time delay between the arrival of the two light beams at the detector is 6.25 ns. What is the index of refraction of this material?



H5. Two plane mirrors intersect at **right** angles. A laser beam strikes the first of them at a point 11.5 cm from their point of intersection, as shown in the figure. For what angle of incidence at the first mirror will this ray strike the midpoint of the second mirror (which is 28.0 cm long) after reflecting from the first mirror?



H6. As shown in the figure, a layer of water covers a slab of material X in a beaker. A ray of light traveling upward follows the path indicated. Using the information on the figure, find (a) the index of refraction of material X and (b) the angle the light makes with the normal in the air.



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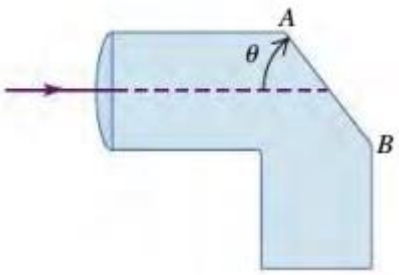
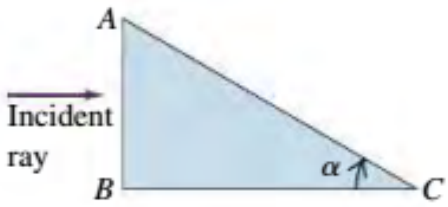
Lecture 4. Total Internal Reflection

H1. **Light Pipe**. Light enters a solid pipe made of plastic having an index of refraction of **1.60**. The light travels parallel to the upper part of the pipe. You want to cut the face AB so that all the light will reflect back into the pipe after it first strikes that face. (a) What is the largest that θ can be if the pipe is in air? (b) If the pipe is immersed in water of refractive index **1.33**, what is the largest that θ can be?



H2. Light is incident along the normal on face AB of a glass prism of refractive index 1.52, as shown in the figure. Find the largest value the angle a can have without any light refracted out of the prism at face AC if (a) the prism is immersed in air and (b) the prism is immersed in water.



H3. The critical angle for total internal reflection at a liquid–air interface is 42.5°.
(a) If a ray of light traveling in the liquid has an angle of incidence at the interface of 35.0°, what angle does the refracted ray in the air make with the normal?
(b) If a ray of light traveling in air has an angle of incidence at the interface of 35.0°, what angle does the refracted ray in the liquid make with the normal?