

This print-out should have 12 questions. Multiple-choice questions may continue on the next column or page – find all choices before answering. The due time is Central time.

Please notice that for your homework to be considered towards your grade, it needs to be submitted one hour before the corresponding recitation starts. Work submitted after this time, but before the DUE DATE on top of this page, will be accepted but not graded.

PLEASE REMEMBER THAT YOU MUST CARRY OUT YOUR CALCULATIONS TO AT LEAST THREE SIGNIFICANT FIGURES. YOUR ANSWER MUST BE WITHIN ONE PERCENT OF THE CORRECT RESULT TO BE MARKED AS CORRECT BY THE SERVER.

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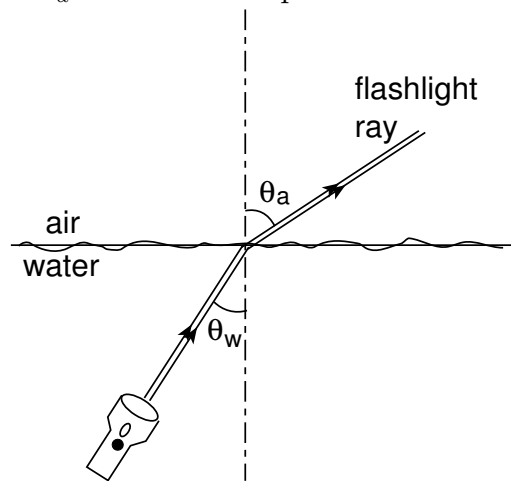
### Flashlight Under Water

35:06, trigonometry, numeric, > 1 min, normal.

001

*Given:* The index of refraction of transparent liquid (similar to water but with a different index of refraction) is 1.33.

A flashlight held under the transparent liquid shines out of the transparent liquid in a swimming pool. This beam of light exiting the surface of the transparent liquid makes an angle of  $\theta_a = 44^\circ$  with respect to the vertical.



At what angle  $\theta_w$  (with respect to the vertical) is the flashlight being held under transparent liquid? Answer in units of  $^\circ$ .

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002

The flashlight is slowly turned away from the vertical direction.

At what angle will the beam no longer be visible above the surface of the pool? Answer in units of  $^\circ$ .

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### Helium Neon Laser 02

35:06, trigonometry, numeric, > 1 min, normal.

003

The wavelength of red light in air is 632.8 nm.

What is its frequency? Answer in units of Hz.

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004

What is its wavelength in glass that has an index of refraction of 1.31? Answer in units of nm.

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005

What is its speed in the glass? Answer in units of m/s.

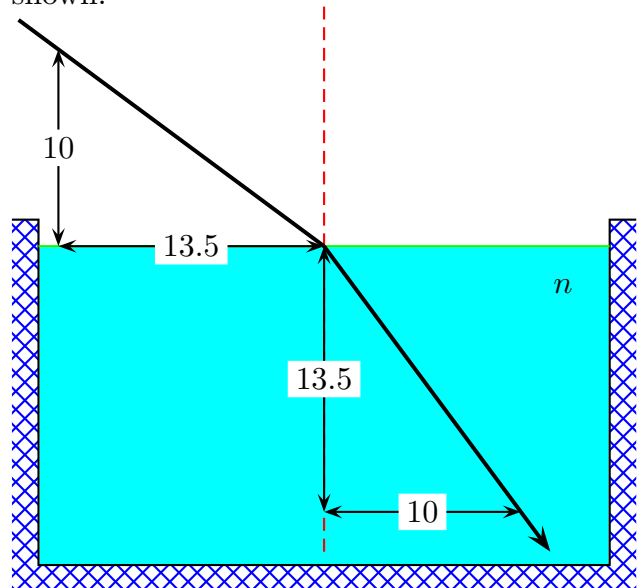
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### Refraction 04

35:06, trigonometry, numeric, > 1 min, normal.

006

In the figure, a ray of light enters the liquid from air and is bent toward the normal as shown.



What is the index of refraction  $n$  for the liquid?

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**Tipler PSE5 31 80**

35:09, trigonometry, numeric, < 1 min, normal.

**007**

Light is incident from air on a transparent substance at an angle of  $58^\circ$  with the normal. The reflected and refracted rays are observed to be mutually perpendicular.

What is the index of refraction of the transparent substance?

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**008**

What is the critical angle for total internal reflection in this substance? Answer in units of  $^\circ$ .

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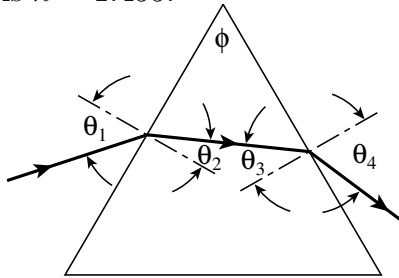
**Silica Prism**

35:07, trigonometry, numeric, > 1 min, normal.

**009**

Light of wavelength 700 nm is incident on the face of a silica prism at an angle of  $\theta_1 = 75^\circ$  (with respect to the normal to the surface). The apex angle of the prism is  $\phi = 60^\circ$ .

Given: The value of the index of refraction for silica is  $n = 1.455$ .



Find the angle of refraction at this first surface. Answer in units of  $^\circ$ .

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**010**

Find the angle of incidence at the second surface. Answer in units of  $^\circ$ .

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**011**

Find the angle of refraction at the second surface. Answer in units of  $^\circ$ .

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**012**

Find the angle between the incident and emerging rays. Answer in units of  $^\circ$ .