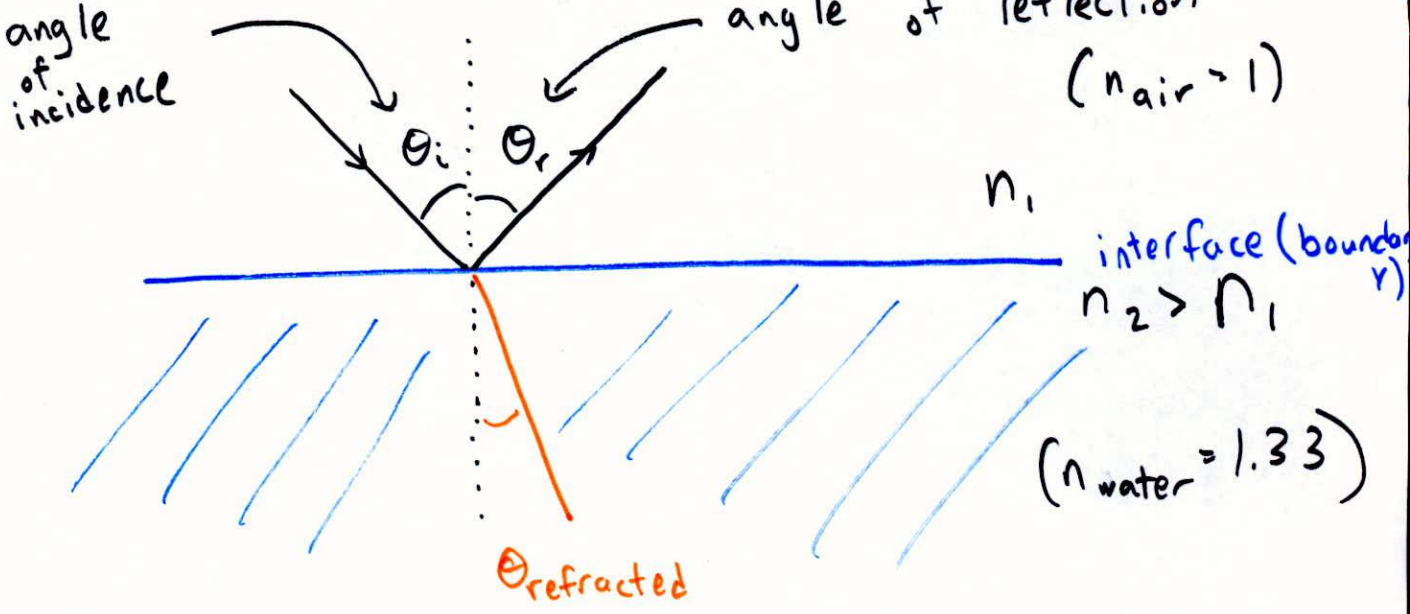
Phys 2C 2/27

1. Reflection vs Refraction
2. Reflection Examples
3. Snell's Law / Refraction
4. Total Internal Reflection

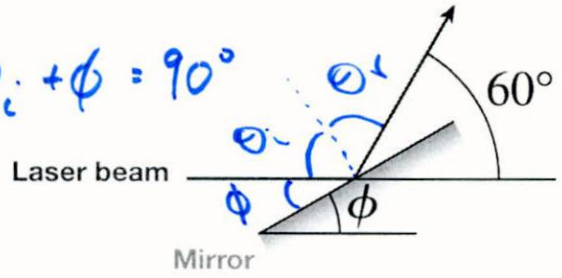
(1) **Ray model**: - Light travels in a straight line (light ray)

- speed of light in $v = \frac{c}{n}$
- Light rays travel forever until they interact w/ matter
  - at an interface: reflect or refract
  - within material: scatter or absorb



The mirror in the following figure deflects a horizontal laser beam by 60°. What is the angle Φ?

$\theta_r = \theta_i$



$\theta_i + \phi = 90°$

$\theta_i + \theta_r + 60° = 180°$

$\Rightarrow 2\theta_i = 120°$

$\theta_i = 60°$

$\Rightarrow \boxed{\phi = 30°}$

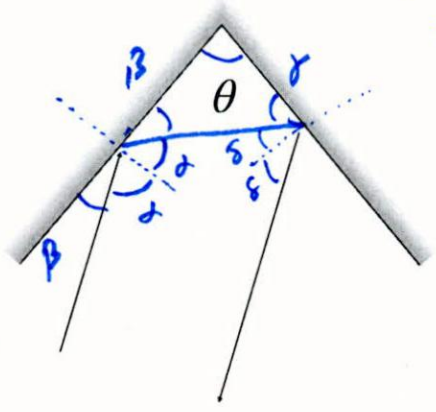
1. 20°
2. 30°
3. 40°
4. 45°

A laser beam is incident on the left mirror in the following figure. If I want the reflected beam to be always parallel to the incident beam regardless of the direction of the incident beam, what should the angle θ be?

$\beta = \frac{\pi}{2} - \alpha$

$\gamma = \pi - \beta - \theta$

$= \alpha + \frac{\pi}{2} - \theta$



$\delta = \frac{\pi}{2} - \gamma$

$= \theta - \alpha$

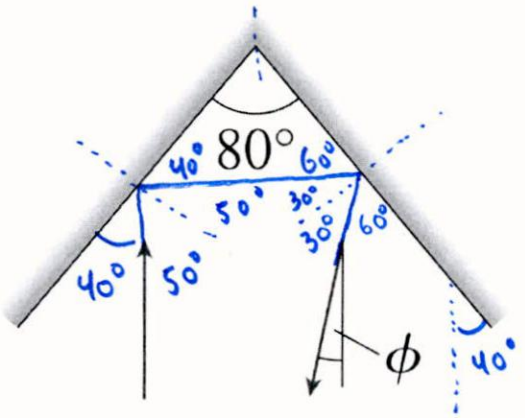
$\theta = \alpha + \delta$

1. 45°
2. 60°
3. 90°
4. 120°

parallelogram $2\alpha + 2\delta = 180°$

$\Rightarrow \boxed{\theta = 90°}$

Now if θ is $80°$, what is the angle ϕ of the reflected laser beam?

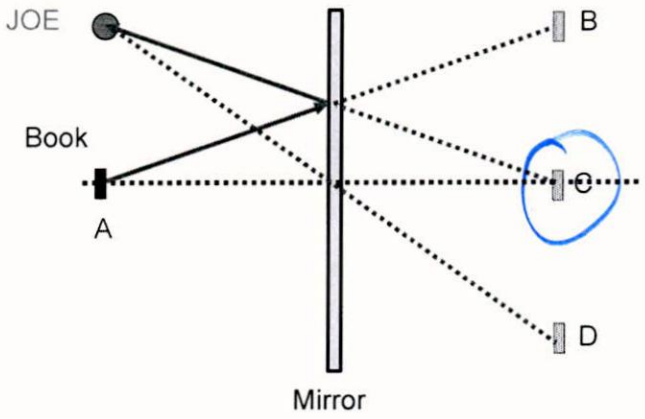


1. $15°$
2. $30°$
3. $45°$
4. $20°$

$40° + \phi = 60°$

$\phi = 20°$

Joe sees the image of a book as shown from above. Where does Joe see the image. (Joe would see the object as being at the image point if he didn't know that the mirror existed.)

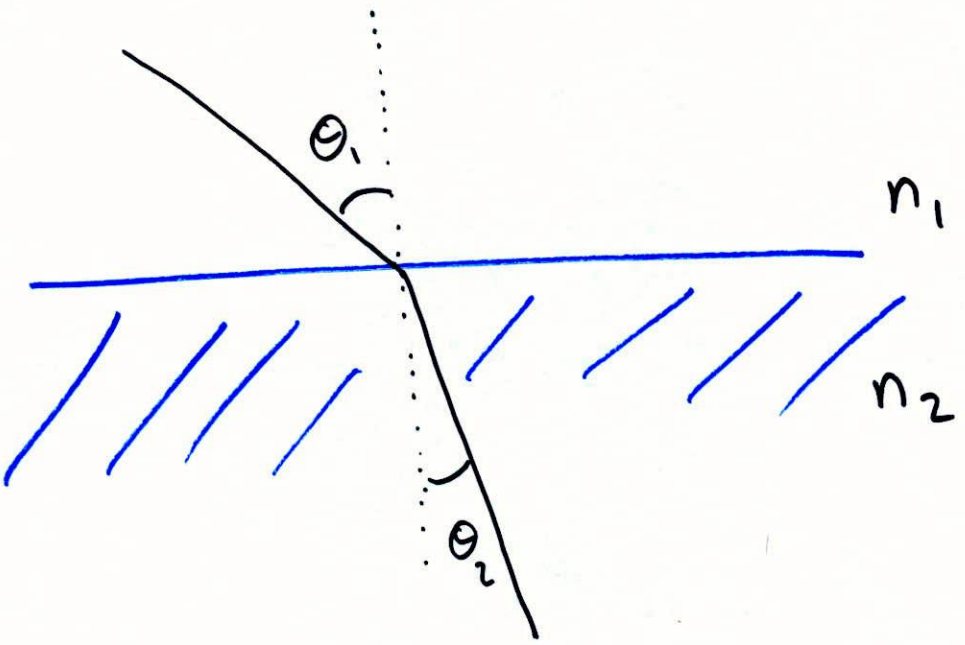


Solid line: actual path of light ray.

Dotted line: apparent path of light ray.

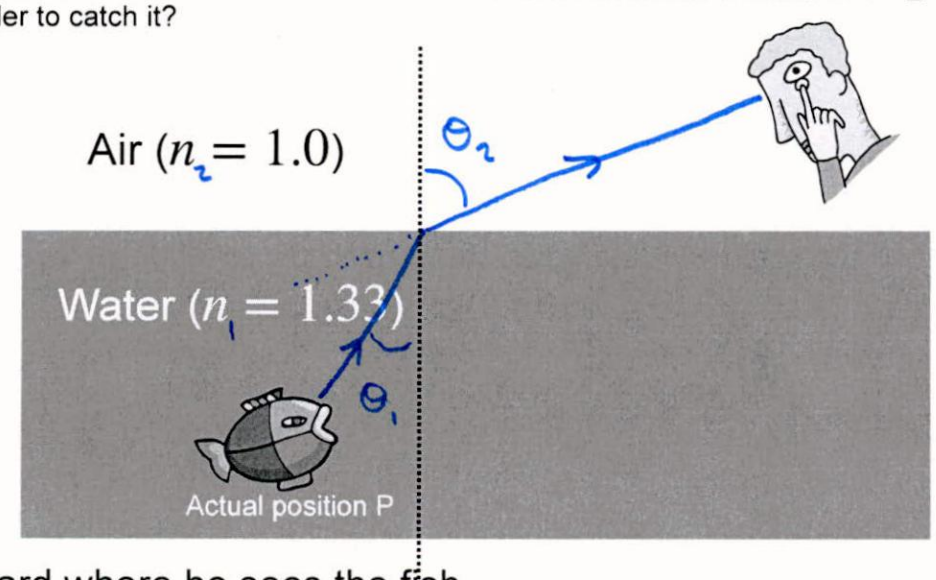
1. A
2. B
3. C
4. D
5. None of the above

③ Snell's Law



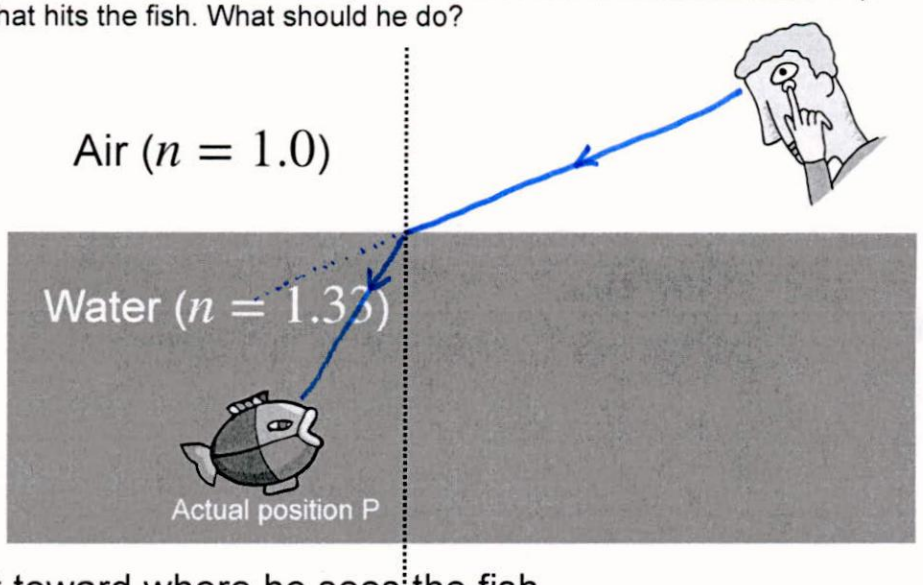
$$n_1 \sin\theta_1 = n_2 \sin\theta_2$$

A fish swims below the surface of the water at P. Where should a fisherman throw a spear in order to catch it?



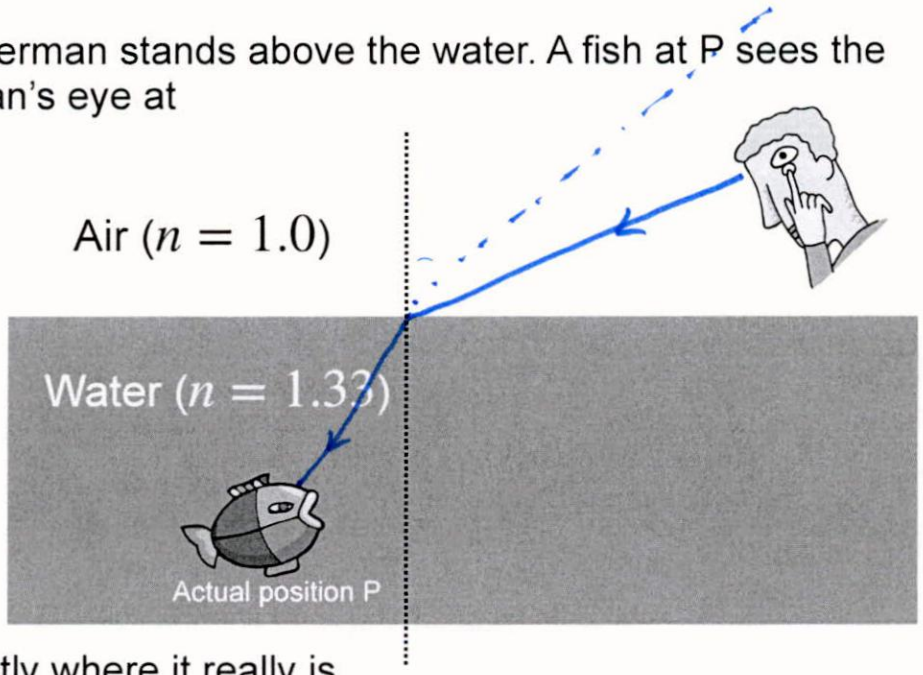
1. Toward where he sees the fish.
2. Above where he sees the fish.
3. Below where he sees the fish.

A fish swims below the surface of the water at P. Now the fisherman decides to point a laser beam that hits the fish. What should he do?



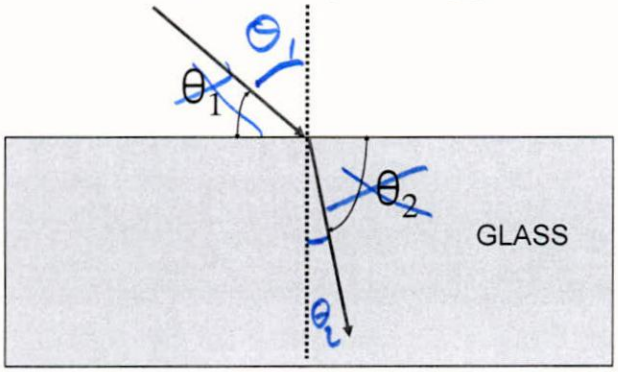
1. Point toward where he sees the fish
2. Point above where he sees the fish
3. Point below where he sees the fish

The fisherman stands above the water. A fish at P sees the fisherman's eye at



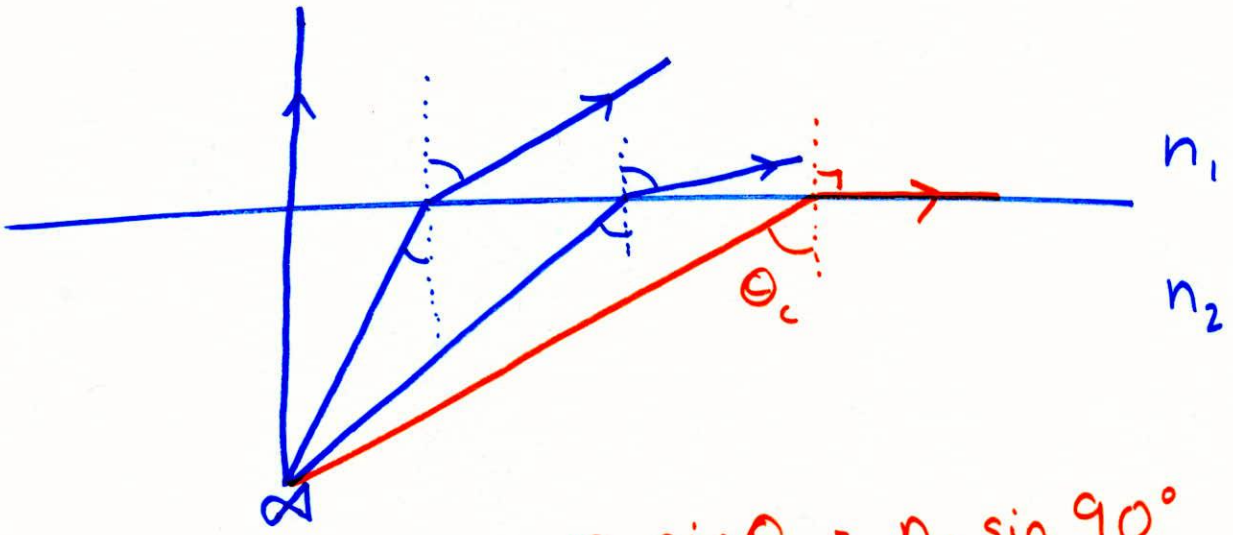
1. Exactly where it really is.
2. Above where it really is.
3. Below where it really is.

Your lecturer just drew the ***incorrect*** "refraction of light" sketch for light incident from air onto a blue glass plate, as shown below. What would you suggest to make it right?



1. Make θ_2 smaller.
2. State that as drawn, $n_2 < n_1$.
3. Curve the ray in the lower medium.
4. Figure all angles from the perpendicular dotted line.
5. None of the above.

⑨ Total Internal Reflection



$$n_2 \sin\theta_c = n_1 \sin 90^\circ$$

$$n_2 \sin\theta_c = n_1$$

$$\boxed{\sin\theta_c = \frac{n_1}{n_2} < 1}$$

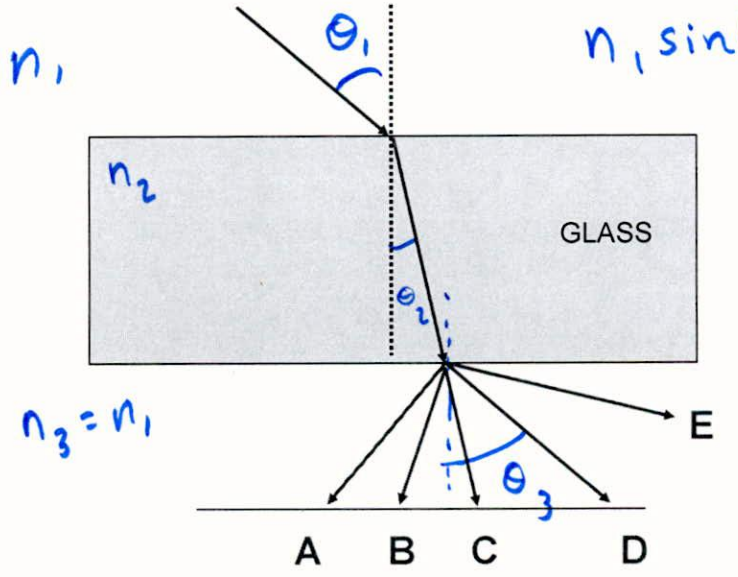
critical angle

If $\theta_{inc} > \theta_c$,

no light get out

(good for optical fibers!)

The light exits the same glass plate shown in the previous sketch. Select the direction that it will go when it exits the glass.

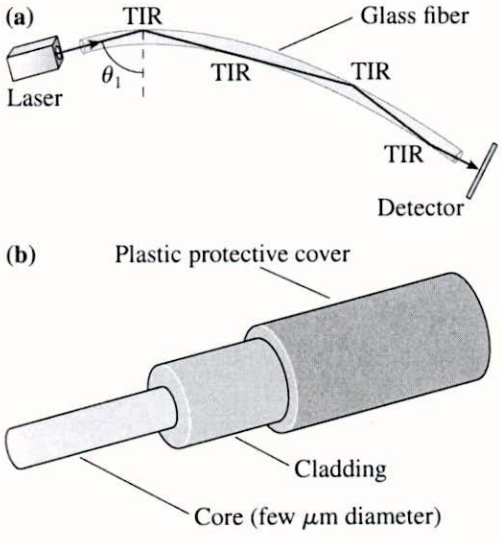


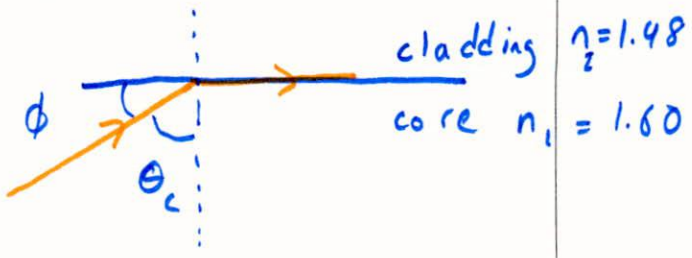
$n_1 \sin\theta_1 = n_2 \sin\theta_2 = n_3 \sin\theta_3$

$\Rightarrow \boxed{\theta_1 = \theta_3}$

1. A $n_3 = n_1$
2. B
3. C
4. D
5. E

14. || The glass core of an optical fiber has an index of refraction 1.60. The index of refraction of the cladding is 1.48. What is the maximum angle a light ray can make with the wall of the core if it is to remain inside the fiber?





$n_1 \sin\theta_c = n_2 \sin 90^\circ$

$\theta_c = \arcsin\left(\frac{n_2}{n_1}\right) = \arcsin\left(\frac{1.48}{1.60}\right)$

$= 67.7^\circ$

$\phi = 90^\circ - \theta_c = \boxed{22.3^\circ}$