

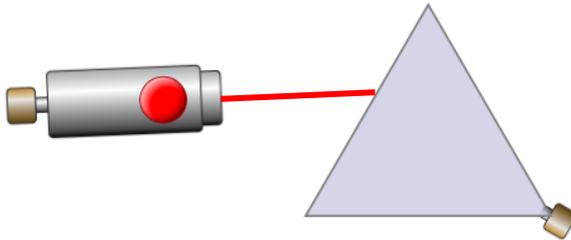


videos

### 3.6.2 Ray diagrams

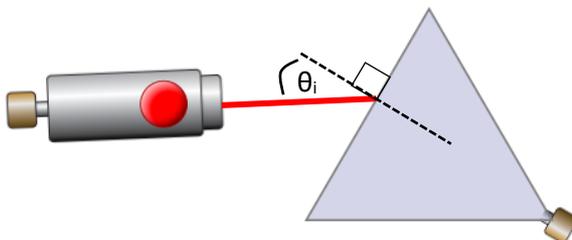
Students often find drawing ray diagrams a challenge. The way to do it successfully is to work through a problem step by step, using Snell's law to calculate angles at each boundary.

Let us take a look at an example.



Here we have a glass triangular prism (in air), and a ray incident on the front surface. Where does the ray go?

The first thing to do is to draw a normal line where the ray hits the surface. Make sure that you use a protractor to do this.



The next thing is to measure the angle of incidence  $\theta_i$ . This is measured relative to the normal line.

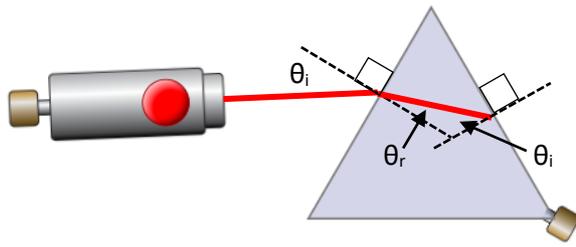
Next, use Snell's law to work out the angle of refraction  $\theta_r$ .

In this case:

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

for air  $n_1=1$ . Therefore:

$$\theta_2 = \sin^{-1} \left[ \frac{\sin \theta_1}{n_2} \right]$$



Now draw a normal line where the ray hits the surface. Again, use a protractor.

You must be careful going from a more optically dense medium into a less optically dense medium. If the angle of incidence is greater than the critical

angle the ray will totally internally reflect.

Check that the angle of incidence doesn't exceed the critical angle.

$$\theta_c = \sin^{-1} \left[ \frac{n_2}{n_1} \right]$$

For glass into air,  $n_2=1$ ,  $n_1=1.5$ .

Therefore:

$$\theta_c = \sin^{-1} \left[ \frac{1}{1.5} \right] = 41.8^\circ$$

If the angle of incidence exceeds the critical angle, just draw a reflected ray of the inside surface.

If the angle is less than the critical angle the ray should emerge. In this case you will need to apply Snell's law to work out the angle of refraction.

It is advisable to have a feel for whether the angle will get bigger or smaller going from one medium into another. Just remember that the angle will get bigger if the light speeds up (e.g. glass into air) and it will get smaller if the light slows down (e.g. air into glass).

*Attempt to draw the path of the rays in the following diagrams. In all cases blocks are glass in air. You can check your answers here:*

[https://phet.colorado.edu/sims/html/bending-light/latest/bending-light\\_en.html](https://phet.colorado.edu/sims/html/bending-light/latest/bending-light_en.html)

