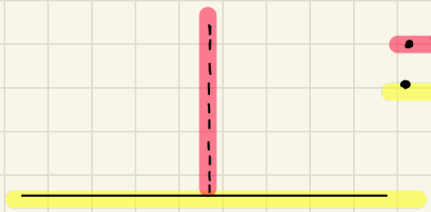
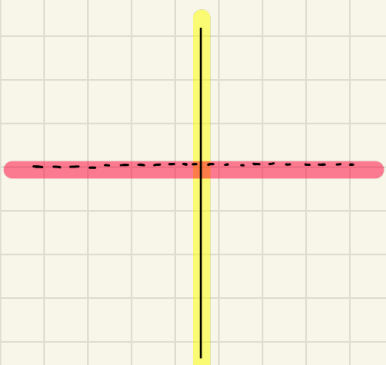
Reflection and Refraction

- the surface normal
  - its always perpendicular to the surface



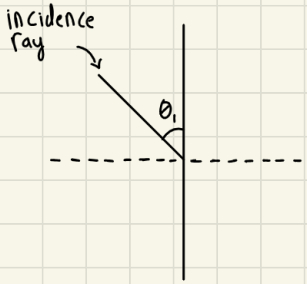
or



- before you do anything when solving a snells law problem you must identify the surface normal

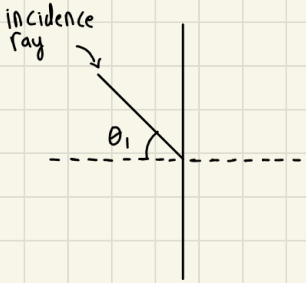
- the angel of incidence θ_1 is measured from the surface normal to the incidence ray

incorrect

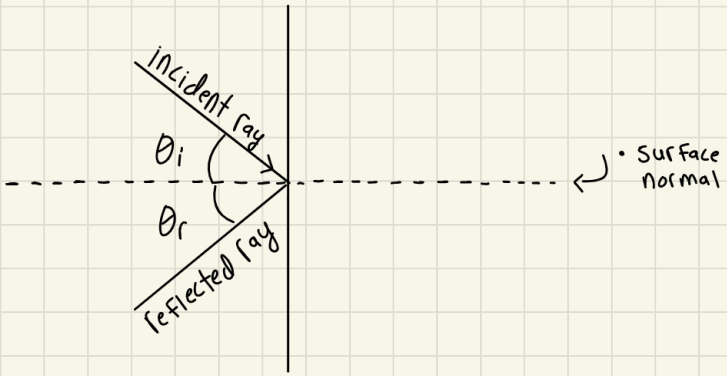


- this here is incorrect because you are measuring from the surface to the incidence ray

correct



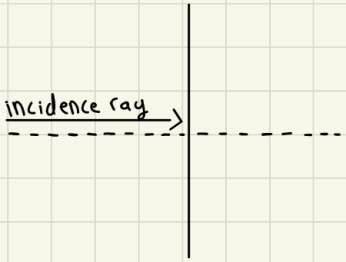
- this is correct because you are measuring from the incidence ray to the surface normal



- the angel of incidence is equal to the angel of reflection

$$\theta_i = \theta_r$$

- if the incidence ray goes through the normal it has an angel of zero



✡ you can see the incidence ray is perpendicular to the surface

- index of refraction

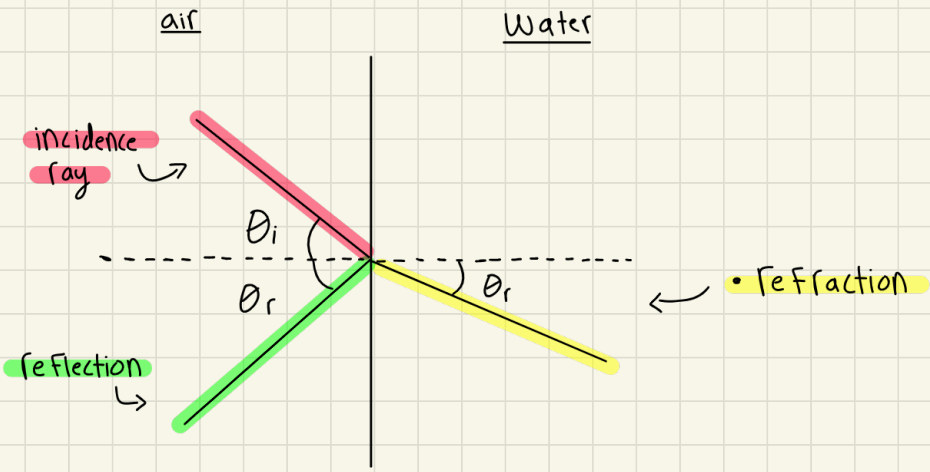
$$n = \frac{c}{v}$$

- n = index of refraction
- c = speed of light in a vaccum
- v = speed of light light in the material

✡ the higher the index of refraction the slower light travels in that material

✡ the smaller the index of refraction the faster the light travels in that material

- if $n_2 > n_1$ the lights refraction bends toward the surface normal
- if $n_2 < n_1$ the lights refraction bends away from the surface normal



$n_i = 1$ $n_a = 1.33$

- refraction is when light changes direction because it changes directions because it speed as it moves from one material to another

- Snells law
  - describes how light bends (refracts) when it passes from one material to another with refractive index

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

  - n_1 = refractive index of first medium
  - n_2 = refractive index of second medium
  - θ_1 = angel of incidence (measured from surface normal)
  - θ_2 = angel of refraction (measured from the normal)

- critical angle
- at a critical angel θ_c the refracted angel θ_2 is 90° since $\sin(90°) = 1$ Plugging that in:

$$n_1 \sin(\theta_c) = n_2 (1)$$

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

$$\theta = \sin^{-1}\left(\frac{n_2}{n_1}\right)$$

the critical angel depends on both n_1 and n_2, but its only exists when light travels from the medium with refractive index n_1 into refractive refractive index n_2 where:

$$n_1 > n_2$$

- if $n_1 \leq n_2$ then there is no critical angel and no total internal reflection possible

- total internal reflection

- light does refract (doesn't pass into second medium)
- instead, it reflects entirely back inside the first denser medium
- so the light keeps traveling inside the original medium

- For total internal reflection to happen, two conditions must be met

1) light must travel from a denser medium to a less denser medium

$$n_1 > n_2$$

2) the angel of incidence θ_1 must be greater then the crital angel

$$\theta_1 > \theta_c$$