Quiz

1) A candle 3cm high is placed 15cm in front of a concave mirror whose f=10cm and c=20cm. Find the location, size and type of image (Draw a diagram)

2) What type of mirror is it if f=-21cm? What will the image size be if the object is 13cm tall and 15cm away from the mirror? (calculation only)

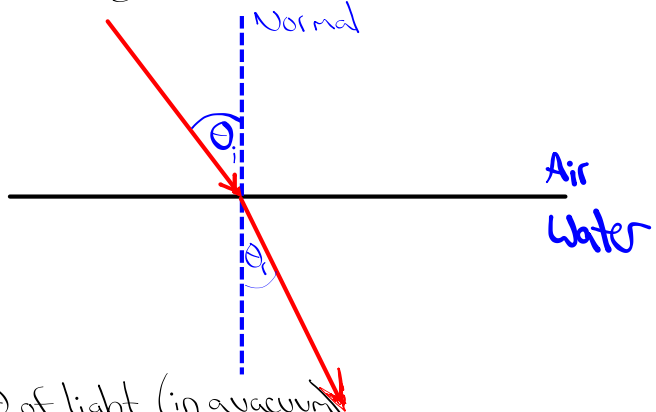
3) An object 3.5cm high is placed 16cm in front of a concave mirror whose f=11cm. Find the location, size and type of image. (calculation then diagram)

Refraction

- light passing through different media

Ex. Stick in water – optical illusion
- looks like stick is bending

When light passes from one media to another, it changes its direction.



Speed of light (in a vacuum)

$c = 3.0 \times 10^8$ m/s

Speed of light in a substance, "x"

V_x

Index of Refraction (n_x)

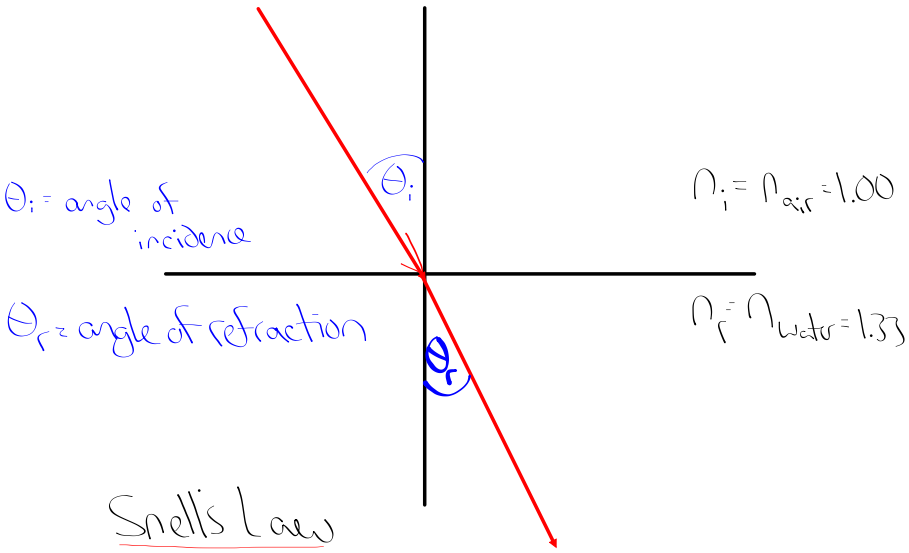
$$n_x = \frac{c}{V_x}$$

Substance (x)	n_x
air	1.00
water	1.33
ethanol	1.36
plastic	1.50
glass	1.52
NaCl	1.52
Zircon	1.92
Diamon	2.52

For refraction to take place we need:

1.) 2 different media

2.) light must approach at an angle to the media boundary



Snell's Law

$$n_i \cdot \sin\theta_i = n_r \cdot \sin\theta_r$$

$n_i \cdot \sin\theta_i$: incident ray

$n_r \cdot \sin\theta_r$: refracted ray

Note:

Fast (low n)

Slow (high n) (FAST!)

Towards the Normal

Slow (high n)

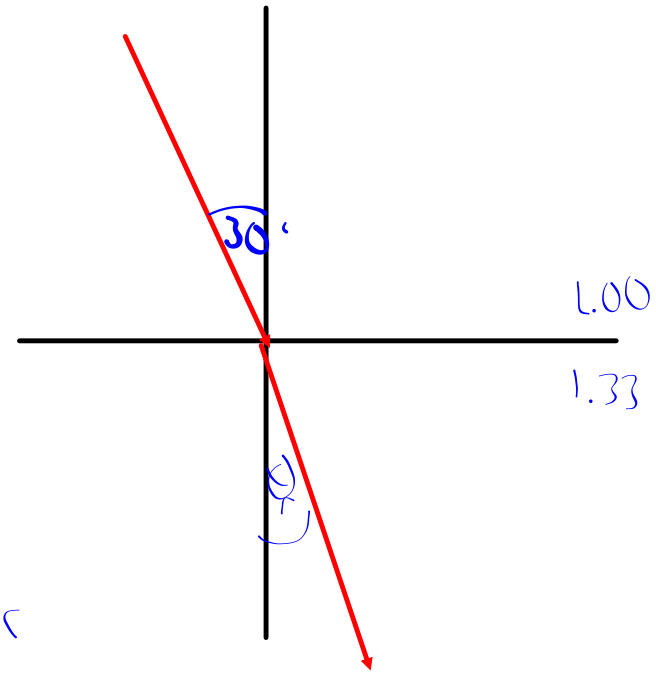
Fast (low n) (San Francisco Airport)

Away from the normal

Ex. A ray of light (in air) approaches a boundary of water at an angle of 30°. What will be the angle of the refracted ray?

$n_{air} = 1.00$ $\theta_i = 30°$

$n_{water} = 1.33$ $\theta_r = ?$



FST

Note: Calculator in "DEG" mode

$$n_i \sin\theta_i = n_r \sin\theta_r$$

$$\frac{n_i \sin\theta_i}{n_r} = \sin\theta_r$$

$$\frac{(1.00)\sin 30}{1.33} = \sin\theta_r$$

$$\sin\theta_r = 0.3759$$

$$\theta_r = \sin^{-1}(0.3759)$$ Shift $\sin^{-1}$

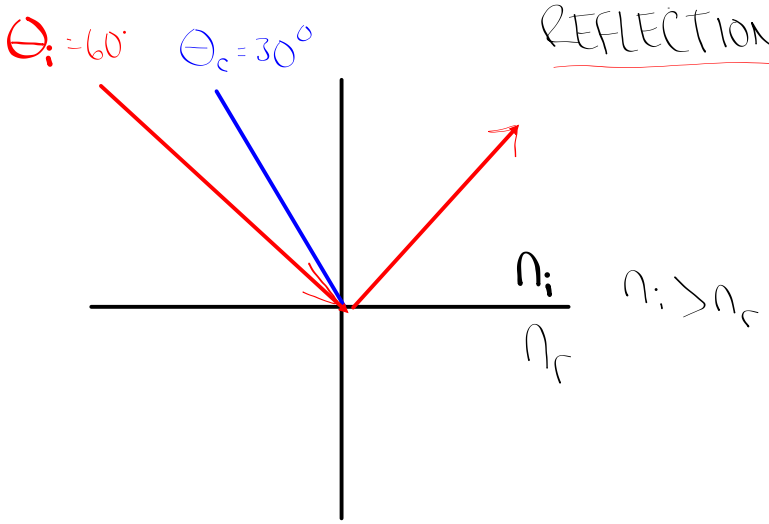
$$\theta_r = 22.1°$$

Critical Angle

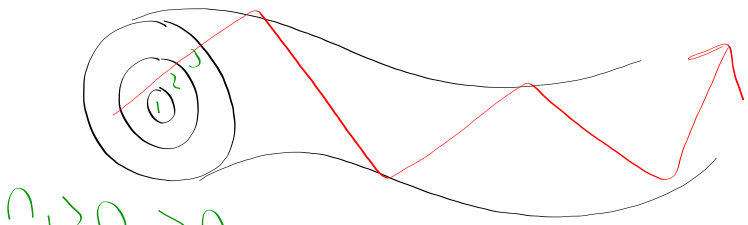
- applie when light travels from dense media (high n) to less dense media (low n)
- the angle limit in which refraction can occur in a given substance is called the "critical angle"

θ_c = critical angle

if $\theta_i > \theta_c$ we get TOTAL INTERNAL REFLECTION



Application: Fibre Optic Cables



* Critical Angle Formula *

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

low

high