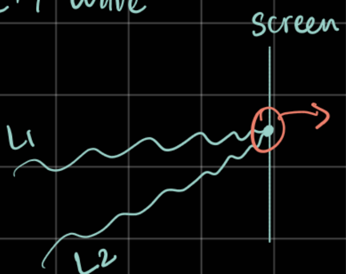
The Nature of Light & Laws of Geometric Optics

Light is everywhere

Light

theories

EM Wave



stronger intensity than $(L_1 + L_2)$

OR

destroy each other and become dark

$\lambda \Rightarrow$ Wavelength

$\lambda = \frac{c}{f} \Rightarrow$ Speed of light

photons

↑

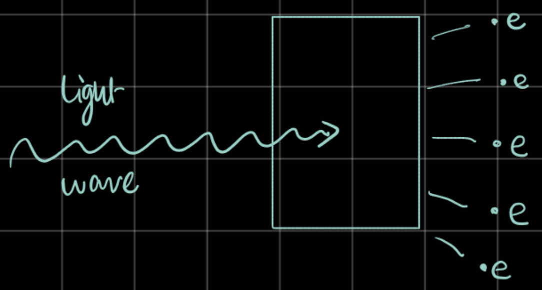
Stream of Particles

↓

Newton

↓

Photoelectric Effect



Electron kinetic energy is independent of intensity of light wave

Particles → Quantized Energy

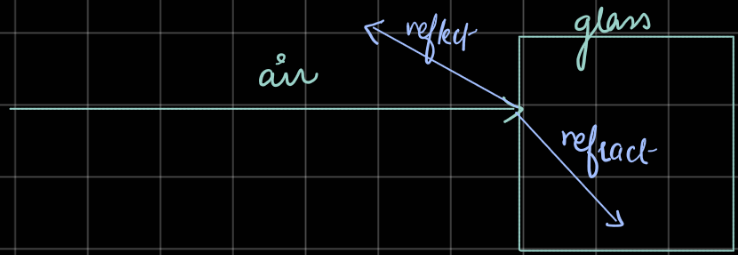
$E = hf$

↓

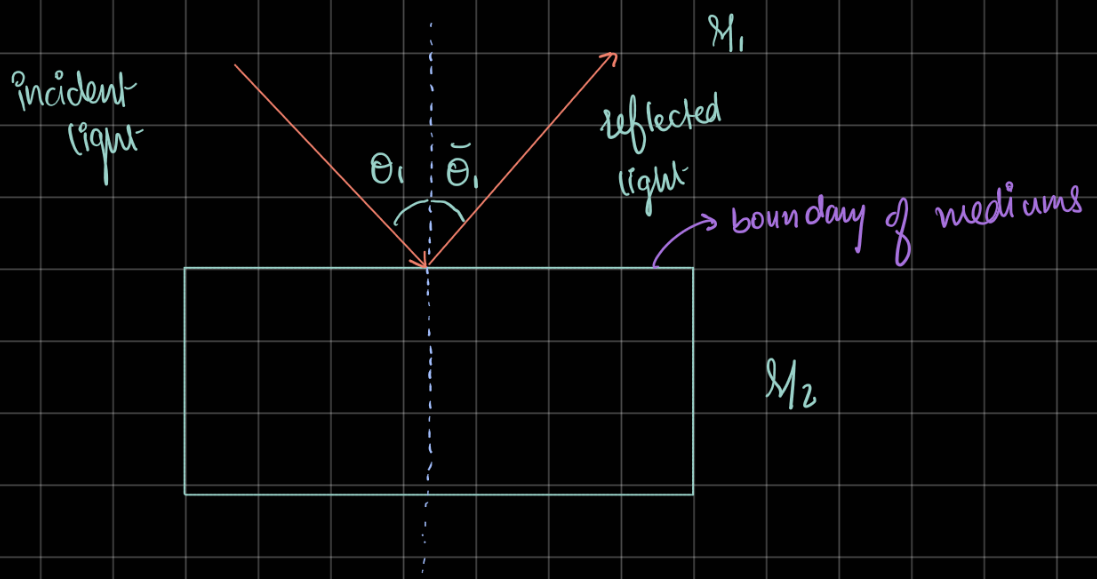
Blank's constant

$= 6 \times 10^{-34}$ Js

Light travels in a straight as long as it travels in the same medium



Laws of Reflection & Refraction



Laws of Reflection

1) Angle of incidence = Angle of Reflection

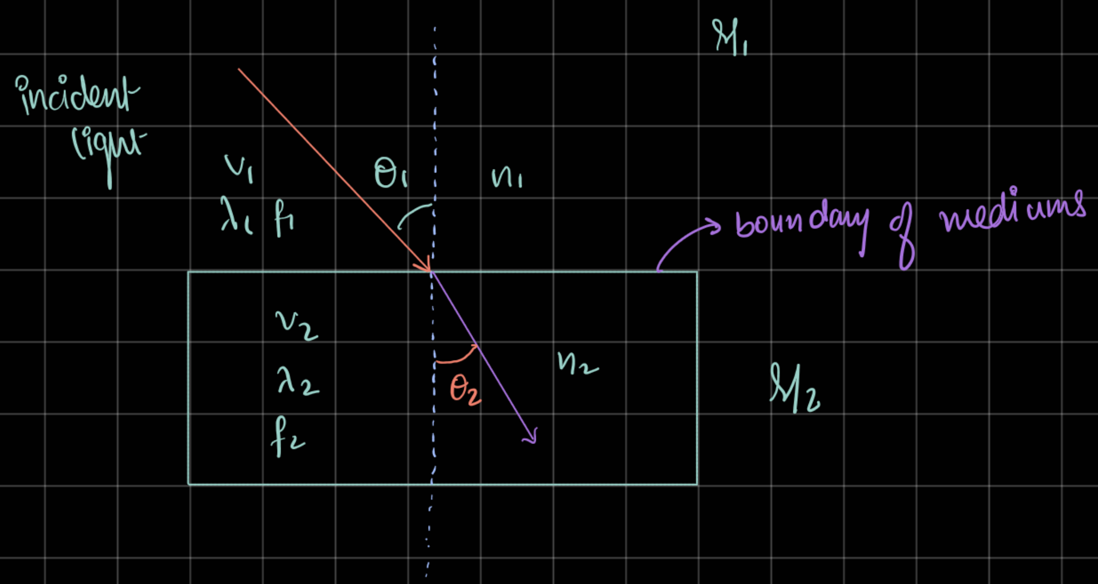
$\theta_1 = \bar{\theta}_1$

↳ Assumes smooth surface

Specular Reflection

If surface is not smooth, we have diffuse reflection.

Refraction



Snell's Law

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

Index of refraction ≥ 1 $= \dfrac{c}{v}$ ⇒ Speed of light
⇒ Speed of light in medium

$n_1 = \dfrac{c}{v_1}$ $\lambda_1 = \dfrac{v_1}{f_1}$

$n_2 = \dfrac{c}{v_2}$ $\lambda_2 = \dfrac{v_2}{f_2}$

$$\frac{\sin\theta_1}{\sin\theta_2} = \frac{n_1}{n_2} = \frac{v_2}{v_1} = \frac{\lambda_2}{\lambda_1}$$

$$\underbrace{f_1 = f_2}$$

frequency of light wave remains the same

If $n_1 > n_2$
$\theta_2 > \theta_1$
line away from normal

If $n_2 > n_1$
$\theta_1 > \theta_2$
line closer to normal

$$n = \frac{\lambda}{\lambda_n} \left[\frac{\text{vaccum}}{\text{medium}}\right]$$

Dispersion

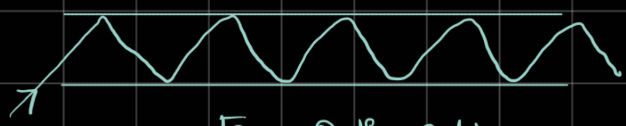
Index of refraction is a function of wave length

$n = f(\lambda)$

Violet light bends most

Red light bends least

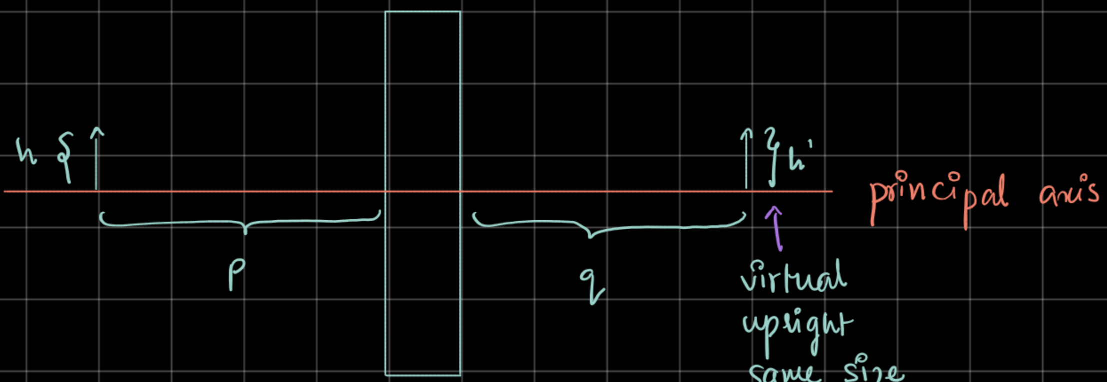
Total Internal Reflection



Fiber Optic Cable

$$\sin\theta_c = \frac{n_2}{n_1} \Rightarrow \text{Critical Angle}$$

Images by Reflection



flat mirror

p: object distance
q: image distance

$p = q$

$M = +1$ (upright)

if inverted then $M \Rightarrow -ve$

h = object height
h' = image height

M: Magnification

$$M = \frac{q}{p} = \frac{h'}{h}$$

if $M > 1$
image > object

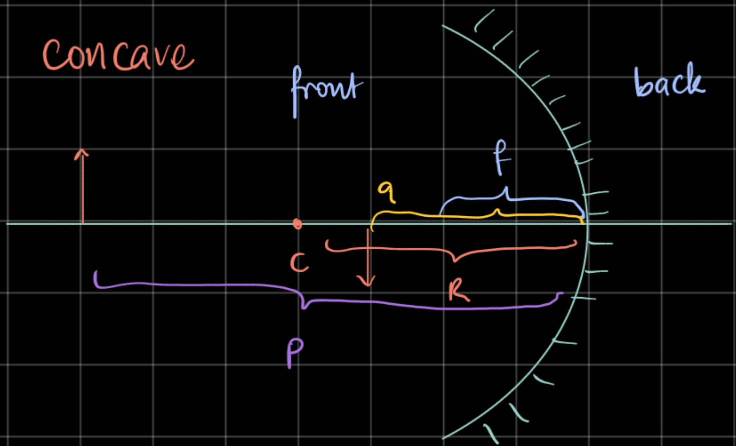
if $M > 1$
object > image

Image
- real → q is +ve
- virtual → q is −ve

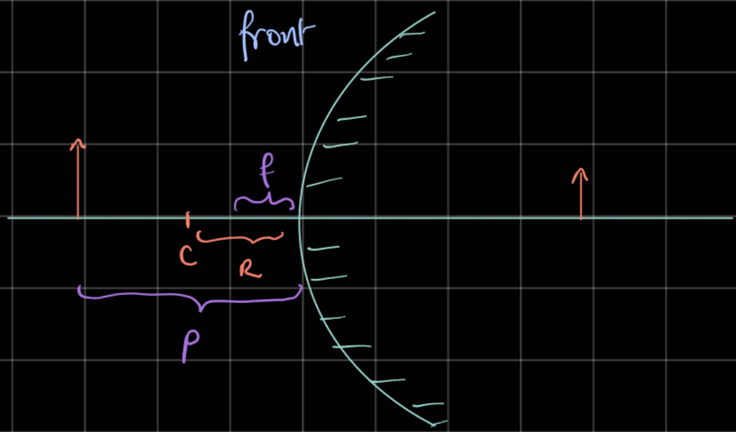
$$M = \frac{-q}{p} = \frac{h'}{h}$$

Spherical Mirrors

concave



convex



virtual q −ve
upright M +ve
always smaller $M \leq 1$

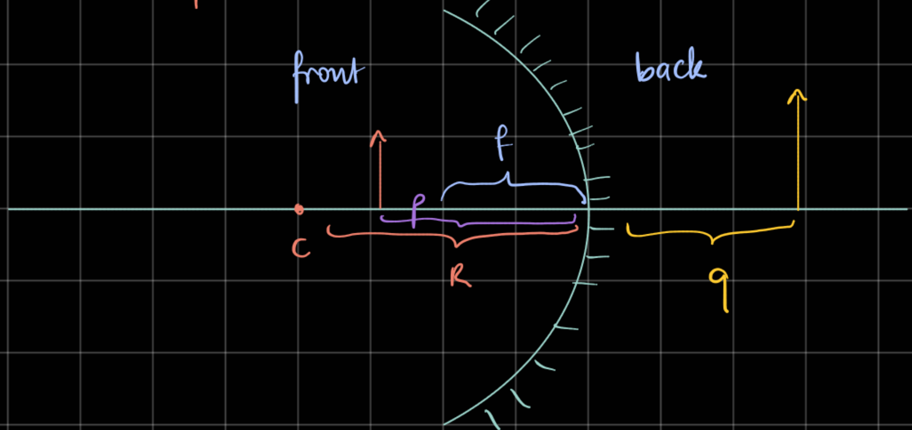
smaller $M \leq 1$
real M −ve
inverted q +ve

} if $p > R$

$$\frac{1}{p} + \frac{1}{q} = \frac{1}{f} = \frac{2}{R}$$

f = focal point

Concave $p < R$



virtual q −ve
upright M +ve
larger $M \geq 1$