

Some useful constants and formulae

Speed of light	$c = 2.9979 \times 10^8 \text{ m/s}$	Gravitational constant	$G = 6.67 \times 10^{-11} \text{ N} \cdot \text{m}^2 / \text{kg}^2$
Permittivity constant	$\epsilon_0 = 8.85 \times 10^{-12} \text{ F/m}$	Permeability constant	$\mu_0 = 1.26 \times 10^{-6} \text{ H/m}$
Near point $P_N = 25 \text{ cm}$		Planck's constant	$h = 6.63 \times 10^{-34} \text{ J} \cdot \text{s} = 4.14 \times 10^{-15} \text{ eV} \cdot \text{s}$
$e = 1.60 \times 10^{-19} \text{ C}$		atomic mass $m(^1_1\text{H}) = 1.007825 \text{ u}$	
$m_e = 9.11 \times 10^{-31} \text{ kg} = 0.000549 \text{ u}$		$1 \text{ u} = 1.6605 \times 10^{-27} \text{ kg} = 931.5 \text{ MeV}/c^2$	
$m_p = 1.6726 \times 10^{-27} \text{ kg} = 1.00728 \text{ u}$		$1 \text{ eV} = 1.602 \times 10^{-19} \text{ J}$	
$m_N = 1.6749 \times 10^{-27} \text{ kg} = 1.008665 \text{ u}$		$hc = 1240 \text{ eV} \cdot \text{nm}$	

Transverse Waves:

$$y(x, t) = y_m \sin(kx - \omega t) \quad k = \frac{2\pi}{\lambda} \quad \omega = \frac{2\pi}{T} = 2\pi f \quad v = \frac{\lambda}{T} = \lambda f = \frac{\omega}{k}$$

Electromagnetic Waves:

$$E(x, t) = E_m \sin(kx - \omega t) \quad B(x, t) = B_m \sin(kx - \omega t) \quad \frac{E_m}{B_m} = c$$

$$E_{rms} = \frac{E_m}{\sqrt{2}} \quad c = \frac{1}{\sqrt{\epsilon_0 \mu_0}} \quad \vec{S} = \frac{1}{\mu_0} \vec{E} \times \vec{B}$$

$$S = \frac{1}{\mu_0} EB = \frac{1}{c\mu_0} E^2 \quad I = \frac{1}{c\mu_0} E_{rms}^2 \quad I = \frac{P_{source}}{4\pi r^2}$$

$$\text{Unpolarized Light: } I = \frac{1}{2} I_0$$

$$\text{Fully Polarized Light: } I = I_0 \cos^2 \theta$$

$$\text{Law of reflection } \theta_1' = \theta_1$$

$$\text{Snell's Law } n_1 \sin \theta_1 = n_2 \sin \theta_2$$

$$\text{Total internal reflection } \theta_c = \sin^{-1} \frac{n_2}{n_1}$$

$$\text{Brewster angle } \theta_B = \tan^{-1} \frac{n_2}{n_1}$$

$$\text{Total Absorption } p_c = \frac{I}{c}$$

$$\text{Total Reflection } p_r = \frac{2I}{c}$$

Mirrors and Lenses:

$$\text{Spherical Mirrors/Thin Lenses: } \frac{1}{p} + \frac{1}{i} = \frac{1}{f} \quad m = -\frac{i}{p}$$

$$\text{Spherical Mirrors: } f = \frac{r}{2}$$

$$\text{Refracting Surface: } \frac{n_1}{p} + \frac{n_2}{i} = \frac{n_2 - n_1}{r} \quad i = -\frac{n_2}{n_1} p$$

$$n = \frac{c}{v} \quad \lambda_n = \frac{\lambda}{n} \quad \Delta\phi = \frac{2\pi L}{\lambda} (n_2 - n_1) \quad \Delta\phi = \frac{2\pi\Delta L}{\lambda}$$

$$\text{magnifier } m_\theta = P_N/f$$

$$\text{microscope } m = -[l P_N]/f_{ob} f_{ey}$$

$$\text{telescope } m = -f_{ob}/f_{ey}$$

$$\text{Constructive Interference: } \Delta L = d \sin \theta = m\lambda, \quad m = 0, 1, 2, \dots$$

Destructive Interference: $\Delta L = d \sin \theta = \left(m + \frac{1}{2}\right) \lambda$ $m = 0, 1, 2, \dots$

Intensity in double-slit interference $I = 4I_0 \cos^2 \frac{\phi}{2}$ $\phi = \frac{2\pi d}{\lambda} \sin \theta$

Interference from thin films: Maxima: $2L = \left(m + \frac{1}{2}\right) \frac{\lambda}{n_2}$ **Minima:** $2L = m \frac{\lambda}{n_2}$

Single-slit Diffraction:

Minima $a \sin \theta = m\lambda$ **Intensity** $I(\theta) = I_m \left(\frac{\sin \alpha}{\alpha}\right)^2$, where $\alpha = \frac{\phi}{2} = \frac{\pi a}{\lambda} \sin \theta$

Resolvability:

Resolving angle $\theta = 1.22\lambda/a$ circular aperture $\theta = 1.22\lambda/D$

Resolving power $RP = \theta L$

Resolving power for microscope (telescope) $RP = 1.22 \lambda f/D$

Double-slit Diffraction:

$I(\theta) = I_m (\cos^2 \beta) \left(\frac{\sin \alpha}{\alpha}\right)^2$, where $\alpha = \frac{\pi a}{\lambda} \sin \theta$ and $\beta = \frac{\pi d}{\lambda} \sin \theta$ **Maxima lines** $d \sin \theta = m\lambda$

Diffraction gratings:

Half-width of line $\Delta\theta_{hw} = \frac{\lambda}{Nd \cos \theta}$