Algebra-based Physics II Review for Chap. 24-27

Cha. 24. Electromagnetic waves

Basic characters:

$$E(t) = E_0 \sin \omega t \qquad E_{rms} = \frac{E_0}{\sqrt{2}} \qquad E = cB \qquad c = f \cdot \lambda$$

$$B(t) = B_0 \sin \omega t \qquad B_{rms} = \frac{B_0}{\sqrt{2}} \qquad \omega = 2\pi f \qquad c = \frac{1}{\sqrt{\varepsilon_0 \mu_0}}$$

Energy density:

$$u = \frac{\varepsilon_0}{2} E^2 + \frac{1}{2\mu_0} B^2 = \varepsilon_0 E^2 = \frac{1}{\mu_0} B^2$$

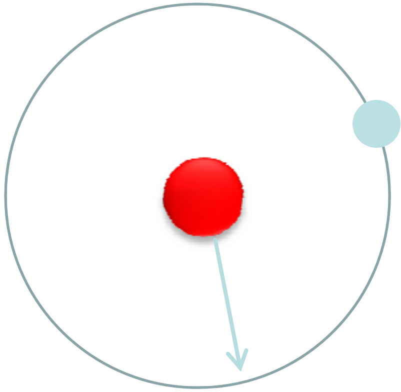
$$\bar{u} = \frac{\varepsilon_0}{2} E_{rms}^2 + \frac{1}{2\mu_0} B_{rms}^2 = \varepsilon_0 E_{rms}^2 = \frac{1}{\mu_0} B_{rms}^2$$

Intensity:

$$S = \frac{P}{A} = \frac{E}{t \cdot A} = cu \qquad \bar{S} = c\bar{u}$$

$$S = cu = \frac{c\varepsilon_0}{2} E^2 + \frac{c}{2\mu_0} B^2 = c\varepsilon_0 E^2 = \frac{c}{\mu_0} B^2$$

Example: What fraction of the power radiated by the sun is intercepted by the planet Mercury? The radius of Mercury is 2.44×10^6 m, and its mean distance from the sun is 5.79×10^{10} m. Assume that the sun radiates uniformly in all direction.



Doppler Effect:

$$f_o = f_s\left(1 \pm \frac{v_{rel}}{c}\right)$$

$$\frac{\lambda_s}{\lambda_o} = 1 \pm \frac{v_{rel}}{c}$$

Doppler shift

+ if v_{rel} is towards

- if v_{rel} is away

Polarization:

Malus' Law: $S = S_0 \cos^2\theta$

Calculate the intensity change

Cha. 25 & 26: Geometric Optics

Mirrors and Lenses

Law of reflection: $\theta_r = \theta_i$

Mirror/lens equation: $\frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{f}$

Magnification: $m = \frac{h_i}{h_o} = -\frac{d_i}{d_o}$

focal length ***f***
- *0.5 *R* for spherical mirror
- **-** for convex mirror, diverging lens
- **+** for concave mirror, converging lens

Index of refraction:

$$n = \frac{c}{v} = \frac{\lambda_{vac}}{\lambda}$$

Snell's Law: $n_1 \sin\theta_1 = n_2 \sin\theta_2$

Apparent depth: $d' = d\left(\frac{n_2}{n_1}\right)$
- n_1 contains incident ray
- n_2 contains refracted ray

Total Internal reflection (critical angle): $\sin\theta_c = \frac{n_2}{n_1}$

Brewster's Angle: $\tan\theta_B = \frac{n_2}{n_1}$
- n_1 contains incident ray
- n_2 contains refracted ray

Cha. 27: Interference & Diffraction

Linear superposition principle
- **In phase: Constructive**
- **Out of the phase: Destructive**

Double slit $\quad \boldsymbol{m} = 0, 1, 2, 3, \ldots$

$$d \sin\theta = \begin{cases} m\lambda & \text{bright fringes (constructive)} \\ (m+\frac{1}{2})\lambda & \text{dark fringes (destructive)} \end{cases}$$

Single slit $\quad \boldsymbol{m} = 1, 2, 3, \ldots$

$$\sin\theta = \frac{m\lambda}{W}$$ *dark* fringe of order m

Thin film interference

$$2t + shift? = m\lambda$$ Constructive interference

$$2t + shift\ ? = m\lambda + \frac{1}{2}\lambda$$ Destructive interference

Cha. 27: Interference & Diffraction

Circular aperture - Resolving power - Rayleigh Criterion

$$\sin\theta \approx \theta > 1.22\frac{\lambda}{D}$$

Diffraction grating

Principal maxima (bright fringes)

$$\sin\theta = m\frac{\lambda}{d}$$