PHY 102 College Physics Outline

Ch. 18. Electric Forces and Fields

1. Charge, Conductors.
2. Coulomb's Law: $F = k\frac{q_1 q_2}{r^2}$, $k = \frac{1}{4\pi\epsilon_0}$
3. Electric Field: $\mathbf{E} = \dfrac{\mathbf{F}}{q}$,
4. $E = k\frac{q}{r^2}$, (pt charge)
5. Field lines.

Ch. 19. Electric Potential Energy and Electric Potential

1. Work to move charge: $W = -qV$
2. Potential: $V = -k\frac{q}{r}$ (pt charge)
3. Parallel Plates: $E = \dfrac{\sigma}{\epsilon_0}$, $\sigma = \dfrac{Q}{A}$
4. $V = Ed$ (Uniform Field)
5. Capacitance: $Q = CV$
6. Parallel plates: $C = \dfrac{\kappa\epsilon_0 A}{d}$
7. Stored Energy: $U = \frac{1}{2}CV^2$.
8. Dielectrics: $\kappa = \dfrac{E_0}{E}$

Ch. 20. Current and Resistance

1. Current: $I = \dfrac{\Delta q}{\Delta t}$
2. Ohm's Law: $V = IR$
3. Resistance (Wire): $R = \rho\dfrac{L}{A}$
4. Temperature Dependence: $\rho = \rho_0(1 + \alpha\Delta T)$, $R = R_0(1 + \alpha\Delta T)$
5. Electric Power: $P = IV$, $P = I^2R$
6. AC circuits, $V = V_0\sin(2\pi ft)$
7. Peak and RMS: $V_{\text{rms}} = \dfrac{V_0}{\sqrt{2}}$
8. Average Power: $P_{\text{ave}} = I_{\text{rms}}V_{\text{rms}}$

Ch. 21. Electric Circuits

1. Series Resistance: $R = R_1 + R_2$
2. Parallel Resistance: $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$
3. Terminal Voltage: $V = \mathcal{E} - Ir$
4. Kirchoff's Rules: Point and Loop
5. Capacitors: $\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2}$
6. Parallel Capacitors: $C = C_1 + C_2$
7. RC - Charging Capacitor: $\tau = RC$.

Ch. 22. Magnetism

1. Magnetic Force for
   (a) a moving charge: $F = qvB\sin\theta$
   (b) Current in Wire: $F = ILB\sin\theta$
2. Cyclotron radius: $r = \dfrac{mv}{qB}$
3. Torque on loop: $\tau_{\max} = NIAB$,
4. Fields from currents
   (a) Straight wire: $B = \dfrac{\mu_0 I}{2\pi r}$
   (b) Current Loop: $B = \dfrac{\mu_0 I}{2R}$
   (c) Solenoid: $B = \mu_0 nI$, $n = N/\ell$
   (d) Crossed fields: $v = E/B$

Ch. 23. Electromagnetic Induction

1. Magnetic flux: $\Phi = BA\cos\theta$
2. Faraday's Law: $\mathcal{E} = -N\dfrac{\Delta\Phi}{\Delta t}$
3. Lenz's Law, Induced emf
4. Motional Emf: $\mathcal{E} = B\ell v$
5. Generators: $\mathcal{E} = NAB\omega\sin\omega t$
6. Transformers: $\dfrac{V_s}{V_p} = \dfrac{N_s}{N_p} = \dfrac{I_p}{I_s}$
7. Mutual Inductance: $\mathcal{E} = -M\dfrac{\Delta I_p}{\Delta t}$
8. Self Inductance: $\mathcal{E} = -L\dfrac{\Delta I}{\Delta t}$
9. Solenoid: $L = \mu_0 n^2 A\ell$
10. Stored energy: $U = \frac{1}{2}LI^2$
11. AC circuits
    (a) $\mathcal{E} = I_0\sin\omega t$, $\omega = 2\pi f$, $f = \frac{1}{t}$
    (b) $I = I_0\sin\omega t$,
    (c) $V_{\text{rms}} = I_{\text{rms}}Z$, Impedance Z: $Z = \sqrt{R^2 + (X_L - X_C)^2}$
    (d) Inductive and Capacitive Reactances: $X_L = 2\pi fL$, $X_C = \dfrac{1}{2\pi fC}$
    (e) $\tan\phi = \dfrac{X_L - X_C}{R}$
    (f) Power loss $= VI\cos\phi$
    (g) Resonance: $X_L = X_C \Rightarrow f_0 = \dfrac{1}{2\pi\sqrt{LC}}$

Ch. 24. Electromagnetic Waves

1. Wavespeed: $v = f\lambda$
2. Speed of light in vacuum: $c = \dfrac{1}{\sqrt{\epsilon_0\mu_0}} = 3.0\times10^8$ m/s
3. Ranges in spectrum - visible, microwave, infrared, ultraviolet, radio, x-rays
4. $E = cB$
5. Energy $u = \frac{\epsilon_0}{2}E^2 + \frac{1}{2\mu_0}B^2$
6. Intensity $S = cu = c\epsilon_0 E^2$

Ch. 25. Geometric Optics

1. Plane mirrors: $i = r$
2. Spherical mirrors: $R = 2f$, $\dfrac{1}{f} = \dfrac{1}{d_o} + \dfrac{1}{d_i}$, $M = \dfrac{h_i}{h_o} = -\dfrac{d_i}{d_o}$
3. Index of Refraction: $n = \dfrac{c}{v}$
4. Snell's Law: $n_1\sin\theta_1 = n_2\sin\theta_2$
5. Total Internal Reflection: $\sin\theta_c = \dfrac{n_2}{n_1}$
6. Apparent depth $d' = \dfrac{n_2}{n_1}d$
7. Thin Lenses: converging $f > 0$, diverging $f < 0$: $\dfrac{1}{f} = \dfrac{1}{d_o} + \dfrac{1}{d_i}$, $M = \frac{h_i}{h_o} = -\frac{d_i}{d_o}$
8. Dispersion - Prisms and rainbows

Ch. 26. Optical Devices

1. Lens Power (Diopters): $P = 1/f$
2. Near point (25 cm) and far point (∞)
3. Vision correction
4. Magnifying glass
5. Telescopes, $M = \frac{\theta'}{\theta} \approx -\frac{f_o}{f_e}$, and Microscopes, $m = m_e m_0$

Ch. 27. Wave Optics

1. Linear superposition
2. Interference (m integer below)
   (a) Constructive: $\Delta L = m\lambda$
   (b) Destructive: $\Delta L = \left(m + \frac{1}{2}\right)\lambda$
   (c) Thin films: $\lambda_n = \lambda/n$, $2t + \text{shift}_1 + \text{shift}_2 = A\lambda_n$ for $A = m$ (max), $A = m + \frac{1}{2}$ (min)
   Shift $= \begin{cases} \frac{1}{2}\lambda_n, & n_2 > n_1, \\ 0, & n_1 > n_2 \end{cases}$
3. Wavelength in medium: $\lambda_n = \lambda/n$
4. Double slit (m integer): $d\sin\theta = \begin{cases} m\lambda, & \text{max}, \\ \left(m + \frac{1}{2}\right)\lambda, & \text{min} \end{cases}$
5. Single slit: $W\sin\theta = m\lambda$ (min), $m \neq 0$
6. Diffraction: $d\sin\theta = m\lambda$ (max),
7. Rayleigh Criterion: $\theta_{\min} = 1.22\dfrac{\lambda}{D}$
8. Polarization, Malus' Law: $S = S_0\cos^2\theta$ Brewster's angle: $\tan\theta_B = \dfrac{n_2}{n_1}$

Ch. 28. Special Relativity

1. Einstein's Postulates
2. Time dilation $\Delta t = \gamma\Delta t_o$ $\gamma = \dfrac{1}{\sqrt{1 - v^2/c^2}}$
3. Length contraction $L = \dfrac{L_0}{\gamma}$
4. Relativistic Momentum $p = \gamma m_0 u$
5. Relativistic Energy $E = \gamma mc^2$, $E_0 = mc^2$.
6. Velocity Addition $u = \dfrac{v + u'}{1 + vu'/c^2}$

Ch. 29. Quantum Physics

1. Energy quantization: $E = nhf$
2. Photoelectric effect: $hf = KE_{\max} + BE$
3. Photons: $E = hf$, $p = \dfrac{E}{c} = \dfrac{h}{\lambda}$
4. Compton Effect
5. deBroglie Wavelength: $\lambda = \dfrac{h}{mv}$
6. Uncertainty Principle

Constants

1. $g = 9.8$ m/s^2
2. $k = 9.0\times10^9$ Nm^2/C^2
3. $e = 1.602\times10^{-19}$ C
4. $c = 3.0\times10^8$ m/s
5. 1eV $= 1.602\times10^{-19}$ J
6. $\epsilon_0 = 8.85\times10^{-12}$ C^2/Nm^2
7. $h = 6.626\times10^{-34}$ Js