Physics 102 Formula Sheet

Coulomb's law (16-2): $F = k\dfrac{Q_1 Q_2}{r^2} = \dfrac{1}{4\pi\varepsilon_0}\dfrac{Q_1 Q_2}{r^2}$ (magnitude) $\varepsilon_0 = 8.85\times10^{-12}\ C^2/N\cdot m^2$

Gauss's law (16-9): $\Phi_E == \sum_{\substack{closed\\surface}} \vec{E}\bullet\vec{A} = \sum_{\substack{closed\\surface}} F_\perp \Delta A = \dfrac{Q_{encl}}{\varepsilon_0}$

Electric potential due to a point charge (17-5): $V = \dfrac{1}{4\pi\varepsilon_0}\dfrac{Q}{r}$ (assuming $V = 0$ at $r = \infty$)

Capacitance (17-7): $Q = CV$

Parallel-plate capacitor (17-8): $C = \varepsilon_0\dfrac{A}{d}$

Capacitors in parallel (19-5): $C_{eq} = C_1 + C_2 + C_3$

Capacitors in series (19-6): $\dfrac{1}{C_{eq}} = \dfrac{1}{C_1} + \dfrac{1}{C_2} + \dfrac{1}{C_3}$

Energy stored in a capacitor (17-10): $U = \dfrac{1}{2}QV = \dfrac{1}{2}CV^2 = \dfrac{1}{2}\dfrac{Q^2}{C}$

Ohm's law (18-2): $I = \dfrac{V}{R},\quad V = IR$

Resistivity (18-3): $R = \rho\dfrac{l}{A}$

Electric power (18-5,6): $P = IV = I^2R = \dfrac{V^2}{R}$

Root-mean-square (rms) value (18-8): $I_{rms} = \dfrac{I_0}{\sqrt{2}},\quad V_{rms} = \dfrac{V_0}{\sqrt{2}}$

Resistors in series (19-3): $R_{eq} = R_1 + R_2 + R_3$

Resistors in parallel (19-4): $\dfrac{1}{R_{eq}} = \dfrac{1}{R_1} + \dfrac{1}{R_2} + \dfrac{1}{R_3}$

Time constant of RC circuits (19-7): $\tau = RC$

Charging and discharging: $V_C = \varepsilon\left(1 - e^{-t/RC}\right);\qquad V_C = V_0 e^{-t/RC}$.

Magnetic force on an electric current

$F = IlB\sin\theta$ **(20-1)**

Magnetic force on a moving charge

$\vec{F} = q\vec{v}\times\vec{B}$ **(20-5)**

Magnetic field due to a long straight wire

$B = \dfrac{\mu_0}{2\pi}\dfrac{I}{r}$ **(20-6)**

Magnetic field in a long solenoid

$$B = \frac{\mu_0 IN}{l} = \mu_0 In \qquad \textbf{(20-8)}$$

Ampere's law

$$\sum B_{\parallel} \Delta l = \mu_0 I_{encl} \qquad \textbf{(20-9)}$$

Torque on a current loop due to a magnetic field

$$\tau = NIAB \sin\theta \qquad \textbf{(20-10)}$$

Magnetic dipole moment

$$\vec{\mu} = NI\vec{A} \qquad \textbf{(20-11)}$$

Faraday's law

$$\varepsilon = -N \frac{d\Phi_B}{dt} \qquad \textbf{(21-2)}$$

Focal length of a spherical mirror

$$f = \frac{r}{2} \qquad \textbf{(23-1)}$$

The mirror equation; thin lens equation

$$\frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{f} \qquad \textbf{(23-2, 23-8)}$$

$$m = \frac{h_i}{h_o} = -\frac{d_i}{d_o} \qquad \textbf{(23-3, 23-9)}$$

Snell's law

$$n_1 \sin\theta_1 = n_2 \sin\theta_2 \qquad \textbf{(23-5)}$$

Wavelength in medium:

$$\lambda_n = \frac{\lambda}{n} \qquad \textbf{(24-1)}$$

Constructive interference of double-slit experiment

$$d \sin\theta = m\lambda \qquad m = 0, 1, 2, \ldots \qquad \textbf{(24-2a)}$$

Destructive interference of double-slit experiment

$$d \sin\theta = \left(m + \frac{1}{2}\right)\lambda \qquad m = 0, 1, 2, \ldots \qquad \textbf{(24-2b)}$$

Minima of single slit diffraction:

$$D \sin\theta = m\lambda \qquad m = 1, 2, 3, \ldots \qquad \textbf{(24-3)}$$

Principal maxima for diffraction gratings

$$d \sin\theta = m\lambda \qquad m = 0, 1, 2, \ldots \qquad \textbf{(24-4)}$$

Brewster's angle

$$\tan\theta_P = \frac{n_2}{n_1} \qquad \textbf{(24-6)}$$

Resolution limited by a circular aperture

$$\theta = \frac{1.22\lambda}{D} \qquad \textbf{(25-7)}$$

Radius of a nucleus

$$r \approx \left(1.2 \times 10^{-15} m\right)\left(A^{\frac{1}{3}}\right) \qquad \textbf{(30-1)}$$

Einstein's equation

$$E = mc^2$$

Constants:

1. Permittivity of free space
   $\varepsilon_0 = 8.85 \times 10^{-12} \quad C^2 / N \cdot m^2$
2. Charge on an electron
   $e = 1.60 \times 10^{-19} \quad C$
3. Speed of light in vacuum
   $c = 3.00 \times 10^{8} \quad m / s$
4. Permeability of free space
   $\mu_0 = 4\pi \times 10^{-7} \ \ \mathrm{T \cdot m/A}$
5. Unified atomic mass unit
   $1u = 1.6605 \times 10^{-27} kg = 931.5 MeV / c^2$