Formula Sheet

Mechanics

$m\frac{d\mathbf{v}}{dt} = \mathbf{F}$ $\quad K_2 - K_1 = W$

$K = \frac{1}{2}mv^2$ $\quad W = -\int_{\mathbf{x}_1}^{\mathbf{x}_2} d\mathbf{x}\cdot\mathbf{F}$

circular motion

$a = \omega^2 r$, $v = \omega r$, $\omega = \frac{2\pi}{T}$

$\mathbf{v} = \mathbf{a}t + \mathbf{v}_0$, $v^2 = v_0^2 + 2ax$

$\mathbf{x} = \mathbf{x}_0 + \mathbf{v}_0 t + \frac{1}{2}\mathbf{a}t^2$

$m_e = 9.1 \times 10^{-31}$ kg

$m_p = 1.67 \times 10^{-27}$ kg

harmonic motion

$\ddot{x} + \omega^2 x = 0$

Rotational Motion

$\frac{dL}{dt} = \frac{d}{dt} I\omega = \tau$

$\tau = Fl$

$K = \frac{1}{2}I\omega^2$

$I = \sum_i m_i r_i^2$

$L = mvl$

Taylor Series

$f(\epsilon) \simeq f(0) + f'(0)\epsilon + \frac{1}{2}f''(0)\epsilon^2 + \cdots$

Electrostatics

$\mathbf{F} = q'\mathbf{E}$, $U = q'V$

$\mathbf{E} = \frac{q}{4\pi\epsilon_0}\frac{\hat{r}}{r^2}$ pt charge

$V = \frac{q}{4\pi\epsilon_0}\frac{1}{r}$ pt charge

$\mathbf{E} = \frac{\lambda}{2\pi\epsilon_0}\frac{\hat{r}}{r}$ line charge

$E = \frac{\sigma}{\epsilon_0}$ surface conductor

$E = \frac{\sigma}{2\epsilon_0}$ sheet charge

$\frac{1}{4\pi\epsilon_0} = 9\times10^{9}\,\frac{Nm^2}{C^2}$, $\epsilon_0 = 8.85\times10^{-12}\,\frac{C^2}{Nm^2}$

$e = 1.6\times10^{-19}$ C, $1\,eV = 1.6\times10^{-19}$ J

$p = qd$ dipole, $\boldsymbol{\tau} = \mathbf{p}\times\mathbf{E}$ dipole

$U = -\mathbf{p}\cdot\mathbf{E}$ dipole

$E = p/4\pi\epsilon_0 r^3$ dipole

K = dielectric const.

$\oint K\mathbf{E}\cdot d\hat{A} = \frac{q}{\epsilon_0}$

$V_2 - V_1 = -\int_{x_1}^{x_2}\mathbf{E}\cdot d\mathbf{x}$

$V = -Ex$ uniform E

$\mathbf{E} = -\nabla V$

$E_x = -\partial V/\partial x$

$E_y = -\partial V/\partial y$

$E_z = -\partial V/\partial z$

Circuits

$R = \rho \frac{L}{A}$

$J = neV_d = I/A$

$I = dQ/dt$

$V = IR$
$P = I^2 R$

$$\left.\begin{aligned} R &= R_1 + R_2 + \cdots \\ \frac{1}{C} &= \frac{1}{C_1} + \frac{1}{C_2} + \cdots \end{aligned}\right\} \text{series}$$

$$\left.\begin{aligned} \frac{1}{R} &= \frac{1}{R_1} + \frac{1}{R_2} + \cdots \\ C &= C_1 + C_2 + \cdots \end{aligned}\right\} \text{parallel}$$

$\sum_{in} I_{in} = \sum_{out} I_{out}$ pt rule

$\sum_i V_i = 0$ loop rule

$C = \frac{Q}{V}$ $C = \frac{\epsilon_0 A}{d}$ parallel plate cap

$U = \frac{1}{2} C V^2$

$u_E = \frac{1}{2} \epsilon_0 E^2$

$\tau = RC$ for RC circuit

$Q = Q_0 (1 - e^{-t/RC})$

$I = I_0 e^{-t/RC}$

Magnetostatics

$U = -\underset{\sim}{\mu} \cdot \underset{\sim}{B}$

$\mu = IA$

$\underset{\sim}{\tau} = \underset{\sim}{\mu} \times \underset{\sim}{B}$

$\underset{\sim}{F}_M = q \underset{\sim}{v} \times \underset{\sim}{B}$ charge

$d\underset{\sim}{F} = I \, d\underset{\sim}{L} \times \underset{\sim}{B}$ wire

$\Omega = \frac{qB}{m}$