
Kinematics: $v_x = \frac{dx}{dt}$ $a_x = \frac{dv_x}{dt}$ $v_{xf} = v_{xi} + a_x \Delta t$ $x_f = x_i + v_{xi} \Delta t + \frac{1}{2} a_x \Delta t^2$
 $v_{xf}^2 = v_{xi}^2 + 2a_x(x_f - x_i)$ $a_{rad} = \frac{v^2}{r}$ $T = \frac{2\pi r}{v}$ $f = 1/T$
 $p = mv$ $K = \frac{1}{2}mv^2 = \frac{p^2}{2m}$

Oscillations: $F = -kx$ $x = A \cos(2\pi ft + \phi)$ $\omega = 2\pi f = \frac{2\pi}{T}$ $f = \frac{1}{2\pi} \sqrt{k/m}$
 $E = \frac{1}{2}kA^2$ $v_{\max} = (2\pi f)A = \omega A$ $a_{\max} = (2\pi f)^2 A = \omega^2 A$

Waves: $y(x, t) = A \cos\left(\frac{2\pi}{\lambda}x - \frac{2\pi}{T}t\right)$ $k = 2\pi/\lambda$ $v = \lambda f$ $v = \sqrt{\frac{F_T}{\mu}}$ $\mu = \frac{M}{L}$
 $v = \sqrt{\frac{\gamma RT}{M}}$ $f_n = n \frac{v}{2L}$ $f_L = \left(\frac{v \pm v_L}{v \pm v_S}\right) f_S$ $f_{beat} = |f_2 - f_1|$ $I = \frac{P}{A}$

Interference: $\Delta r = m\lambda$ $d \sin \theta = m\lambda$ $a \sin \theta = n\lambda$ $n = \frac{c}{v}$ $\lambda_n = \frac{\lambda}{n}$
 $2nt = m\lambda$ $2nt = \left(m + \frac{1}{2}\right)\lambda$

Optics: $n_1 \sin \theta_1 = n_2 \sin \theta_2$ $\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$ $m = \frac{h_i}{h_o} = -\frac{d_i}{d_o}$

Electric Forces and Fields: $\vec{E} = \frac{K|q|}{r^2} \begin{bmatrix} \text{away from + charge} \\ \text{towards - charge} \end{bmatrix}$ $\vec{E}_{\text{net}} = \sum_i \vec{E}_i$

$\vec{F}_0 = q_0 \vec{E}$ $\epsilon_0 = \frac{1}{4\pi K}$ **Infinite sheet:** $E = \frac{\sigma}{2\epsilon_0}$

Electric Potential: $V = \sum \frac{Kq_i}{r_i}$ $\Delta U = q_0 \Delta V$ $\Delta V = -E \Delta x$ $E_x = -\frac{dV}{dx}$

Capacitance: $Q = C(\Delta V)$ $C = \frac{\epsilon_0 A}{d}$ $\frac{1}{C_{\text{series}}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \dots$

$C_{\text{parallel}} = C_1 + C_2 + C_3 + \dots$ $U = \frac{1}{2}Q(\Delta V)$ $u_e = \frac{1}{2}\epsilon_0 E^2$

Circuits: $I = \frac{dq}{dt}$ $\Delta V = IR$ $R = \frac{\rho L}{A}$ $P = I(\Delta V)$ $R_{\text{series}} = R_1 + R_2 + R_3 + \dots$
 $\frac{1}{R_{\text{parallel}}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \dots$ $\tau = RC$ $q = Q_0 e^{-t/\tau}$ $q = Q_0(1 - e^{-t/\tau})$

Magnetic Forces and Fields: $\vec{F} = q\vec{v} \times \vec{B}$ $\vec{F} = I\vec{L} \times \vec{B}$ $\vec{\mu} = NIA\hat{n}$ $\vec{\tau} = \vec{\mu} \times \vec{B}$
 $\mu_0 I_{\text{encl}} = \oint \vec{B} \cdot d\vec{s}$ **Long solenoid:** $B = \mu_0 n I$ $n = N/L$

Long straight wire: $B = \frac{\mu_0 I}{2\pi r}$ **Center of current loop:** $B = \frac{\mu_0 I}{2r}$

Induction: $\Phi_B = NBA \cos \theta$ $\epsilon = -\frac{d\Phi_B}{dt}$ $\epsilon = vBL$ $\epsilon = -L \frac{di}{dt}$ $U = \frac{1}{2}LI^2$
 $u_m = \frac{B^2}{2\mu_0}$

Electromagnetic Waves: $\vec{F} = q(\vec{E} + \vec{v} \times \vec{B})$ $v_{em} = c = 1/\sqrt{\epsilon_0 \mu_0}$ $c = \lambda f$ $E_0 = cB_0$
 $\vec{S} = \frac{1}{\mu_0}(\vec{E} \times \vec{B})$ $I = S_{\text{ave}} = \frac{1}{2}c\epsilon_0 E^2$

Modern Physics: $E = hf = \frac{hc}{\lambda}$ $p = \frac{h}{\lambda}$ $\Delta E = hf$ $r_n = n^2 a_0$
 $E_n = -\left(\frac{me^4}{8\epsilon_0^2 h^2}\right) \frac{1}{n^2} = -\frac{13.6\text{eV}}{n^2}$ $(\Delta x)(\Delta p_x) \geq h/4\pi$ $E = (\Delta m)c^2$
 $N = N_0 e^{-t/\tau}$ $T_{1/2} = \tau \ln 2$

Vectors: $A_x = A \cos \theta$ $A_y = A \sin \theta$ $A = \sqrt{A_x^2 + A_y^2}$ $\tan \theta = \frac{A_y}{A_x}$
 $\vec{A} \cdot \vec{B} = AB \cos \phi_{AB}$ $\vec{A} \cdot \vec{B} = A_x B_x + A_y B_y + A_z B_z$ $\vec{A} \times \vec{B} = \hat{n} AB \sin \phi_{AB}$

Math: $ax^2 + bx + c = 0$ $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ $(1+x)^n \approx 1 + nx$ for $x \ll 1$

Constants: $R = 8.3145 \text{ J/mol} \cdot \text{K}$ $v_{\text{sound}} = 343 \text{ m/s}$ $c = 2.998 \times 10^8 \text{ m/s}$
 $e = 1.602 \times 10^{-19} \text{ C}$ $K = 8.988 \times 10^9 \text{ Nm}^2/\text{C}^2$ $\epsilon_0 = 1/4\pi K = 8.854 \times 10^{-12} \text{ C}^2/\text{Nm}^2$
 $\mu_0 = 4\pi \times 10^{-7} \text{ T} \cdot \text{m/A}$ $m_e = 9.109 \times 10^{-31} \text{ kg}$ $h = 6.626 \times 10^{-34} \text{ J} \cdot \text{s}$
 $hc = 1239.8 \text{ eV} \cdot \text{nm}$ $a_0 = 0.0529 \text{ nm}$ $1\text{u} = 931.5 \text{ MeV}/c^2 = 1.661 \times 10^{-27} \text{ kg}$