constant acceleration motion

$d = \frac{1}{2}(v_f + v_i)t \qquad d = v_0 t + \frac{1}{2}at^2 \qquad v_f = v_i + at \qquad v_f^2 = v_i^2 + 2ad$

projectile motion $\quad x = x_0 + v_0 t\cos\theta_i \qquad y = y_0 + v_0 t\sin\theta_i - (1/2)gt^2$

max height $= \dfrac{(v_0\sin\alpha)^2}{2g} \qquad$ flight time $= \dfrac{2v_0\sin\alpha}{g} \qquad$ range $= \dfrac{v_0^2\sin 2\alpha}{g}$

work $\quad W = \mathbf{F}\cdot\mathbf{d} = \int_{x_i}^{x_f}\mathbf{F}dx = \Delta KE = P\cdot t = -\Delta U = (1/2)kx^2$

$W_{you} = \Delta U_{field} = -W_{field}$

potential energy (conservative work)

$\Delta U = mg\Delta h \qquad U_{spring} = (1/2)k(x_f - x_0)^2 \qquad \dfrac{dU}{dx} = -F_x \qquad F_x = -kx$

conservation of energy

$K_i + U_i = K_f + U_f \qquad \Delta KE = W \qquad KE_{\text{total}} + U_{\text{total}} = E_{\text{total mech}}$

$W = \Delta E_{mech} + \Delta E_{th}$ - to keep track of non-conservative forces

power $\quad P = \dfrac{dW}{dt} = \mathbf{F}\cdot\mathbf{v} = \tau\omega \quad$ non-constant acceleration $\qquad Pt = (1/2)mv^2 \qquad P = \tau\omega$

center of mass $\quad \dfrac{\sum m_i\mathbf{r}_i}{M} \qquad I' = I_{cm} + Md^2$, d is distance from c.o.m.

intertia $\quad I = \sum_i m_i r_i^2 \qquad I = \int r^2 dm$

linear momentum $\quad \mathbf{p} = m\mathbf{v}$

impulse $\quad \mathbf{I} = \int \mathbf{F}dt = \Delta\mathbf{p}$

newton's 2nd law $\quad \mathbf{F}_{net} = d\mathbf{p}/dt$

average force $\quad \mathbf{F}_{ave} = 1/\Delta t\int\mathbf{F}dt = \mathbf{I}/\Delta t$

rotational motion

angular displacement	θ	spatial displacement	$x = \theta r$
angular velocity	$\omega = \dfrac{d\theta}{dt}$	spatial velocity	$v = \omega r$
angular acceleration	$\alpha = \dfrac{d\omega}{dt}$	spatial linear acc.	$a = \alpha r$
		spatial centr. acc.	$v^2/r = \omega^2 r$

torque

$\tau = \mathbf{r}\times\mathbf{F} = I\alpha = rF\sin\theta = r_\perp F = \dfrac{d\mathbf{L}}{dt}$

angular momentum

$\mathbf{L} = \mathbf{r}\times\mathbf{p} = I\omega = m(\mathbf{r}\times\mathbf{v}) = rp\sin\theta$

angular impulse

$\Delta\mathbf{L} = \int\tau dt$

gravity

$\mathbf{F}_{1,2} = -\dfrac{Gm_1m_2}{r_{1,2}^2}\mathbf{r}_{1,2} \qquad \mathbf{F} = -\dfrac{Gm_1m_2}{r^2} \qquad U(r) = -\dfrac{Gm_1m_2}{r} \qquad E = \dfrac{1}{2}mv^2 - \dfrac{GMm}{r}$

simple harmonic motion

$$ma_x = -kx \qquad \ddot{x} - \frac{k}{m}x = 0$$

waves

$x = A\cos(\omega t + \phi)$ | $v = -\omega A\sin(\omega t + \phi)$ | $a = -\omega^2 A\cos(\omega t + \phi) = -\omega^2 x$

$y(x,t) = A\cos\left(\frac{2\pi}{\lambda}(x - vt)\right)$ | $y(x,t) = A\cos(kx - \omega t)$ | traveling wave to the right

$K = \frac{1}{2}kA^2\sin^2(\omega t + \phi)$ | $U = \frac{1}{2}kA^2\cos^2(\omega t + \phi)$ | $E = \frac{1}{2}kA^2$

$T = \frac{1}{f} = \frac{2\pi}{\omega} = \frac{2\pi}{\sqrt{k/m}}$ | simple pend. $T = 2\pi\sqrt{\frac{l}{g}}$ | $I\alpha = -mgL\sin\theta$

$\omega = \sqrt{k/m}$ | physical $T = 2\pi\sqrt{\frac{I_{total}}{M_{total}gd_{c.o.m.}}}$ | $I\alpha = -mgh\sin\theta$

$v = \sqrt{T/\mu}$ | speed of wave on string

$v = \lambda / T = \omega / k$ | just the vibrations

$k = 2\pi / \lambda$ | angular wave number

$\wp = 1/2\mu\omega^2 A^2 v$ $\mu = \Delta m/\Delta x$

Elastic Modulus = stress/strain | stress = force per unit area | strain = degree of dermation | stress is proportional to strain with a k, elastic modulus.

$Y = \frac{F/A}{\Delta L/L_i}$ $S = \frac{F/A}{\Delta x/h}$ $B = \frac{\Delta F/A}{\Delta V/V_i}$ Young, Sheer, Bulk

$A_1 v_1 = A_2 v_2$ fluid

$FA = FA$ fluid

$P + 1/2\rho v^2 + \rho g y = \text{constant}$

$v = \sqrt{B/\rho}$ speed of sound wave B=Bulk Modulus

$\Delta P = \Delta P_{\max}\sin(kx - \omega t)$ $\Delta P_{\max} = \rho v \omega s_{\max}$

$I = \wp/A = 1/2\rho v(\omega s_{\max})^2$ Intensity of sound wave

$I = \Delta P_{\max}^2/2\rho v$

$\beta = 10\log(I/I_o)$ Decibals

$f' = \left(\frac{v \pm v_O}{v \mp v_S}\right) f$ Doppler effect

$+v_O$ ans $-v_S$ is toward is increase in f

$-v_O$ and $+v_S$ is away is decrease in f

$y = 2A\cos(\phi/2)\sin(kx - \omega t + \phi/2)$ Resultant of 2

$\Delta r = \phi\lambda/2\pi$ Relation between path diff and phase

$y = (2A\sin kx)\cos\omega t$ standing wave

$f_b = |f_1 - f_2|$ Beat frequency

$\alpha = \Delta L/L_i/\Delta T$ average coefficient of lin. Expans

$W = \int P dV$

$\Delta E_{\text{int}} = Q - W$

$W = nRT\ln(V_f/V_i)$ work done ideal gas isothermal

$\wp = kA|dT/dx|$ Thermal conduction

$\wp = \sigma A e T^4$ Radiation

$PV^{C_P/C_V \text{ or } \gamma} = \text{constant}$

$e = 1 - Q_c / Q_h$ thermal efficiency

$e_C = 1 - T_c / T_h$ thermal of Carnot Engine

$q = mc\Delta T$

$q = mL_{heat}$

$v = \sqrt{\frac{3k_bT}{m}} = \sqrt{\frac{3RT}{M}}$

$K_{av} = 3/2\, k_bT$

$Q = nC_v\Delta T$

$Q = nC_L\Delta T$

$\mathbf{E} = \mathbf{F}_e / q_0$

$\mathbf{F}_E = kq_1q_2 / r^2$

$\mathbf{E}_o = kq_o / r^2$

$C = Q / \Delta V$

$U = kq_1q_2 / r = q_{test}E_or_{ot}$ (like mgh) $= q_{test}V = -W$

$V_o = kq_o / r = U / q_{test} = E_or$

$E_x = -dV / dx \quad E_r = -dV / dr$

$\Delta V = \Delta U / q_{test} = -\int_\infty^0 E\ ds$ for uniform field $= -Ed$

$\Delta U / \Delta t = \Delta Q \Delta V / \Delta t = I\Delta V = \wp$

$\wp = IV = I^2R = \Delta V^2 / R =$ Watt

$\Phi_E = \int_{surface} \mathbf{E} \cdot d\mathbf{A} = q_{in} / \in_0$ (for closed surfaces)

$2k_e\lambda / r$ for linear

$\sigma / 2 \in_0$ for surface, just outside, no 2

k_eQ / r^2 for outside hollow conducting sphere

k_eQ / r^2 for uniform insulator sphere outside

$k_e Qr/R^3$ for uniform insulator sphere inside

$\Delta V = \Delta U/q = -\int \mathbf{E}\cdot d\mathbf{s} = -Ed$ in uniform field

$\tau = \mathbf{p}\times\mathbf{E}$

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

$I = dQ/dt$

$J(\text{current density}) = I/A = nqv_d = A/m^2$ x

$R = \Delta V/I = \rho\ell/A$

$\mathbf{F}_B = I\mathbf{L}\times\mathbf{B}$

$\tau = \mu\times\mathbf{B}$ $\mu = IA = I\pi r^2 = 1/2evr = (e/2m_e)L = \hbar\sqrt{2}(e/2m_e)$

$U = -\mu\cdot\mathbf{B}$

$$d\mathbf{B} = \frac{\mu_0 I d\mathbf{s}\times\hat{\mathbf{r}}}{4\pi r^2}$$

$$\frac{F_B}{\ell} = \frac{\mu_0 I_1 I_2}{2\pi a}$$

$$\oint \mathbf{B}\cdot d\mathbf{s} = \mu_0 I$$

$$\Phi_B = \int \mathbf{B}\cdot d\mathbf{A}$$