Physics 110 Formulas

Equations of Motion

displacement:
$$\begin{cases} x_f = x_i + v_{ix}t + \frac{1}{2}a_x t^2 \\ y_f = y_i + v_{iy}t + \frac{1}{2}a_y t^2 \end{cases}$$

velocity:
$$\begin{cases} v_{fx} = v_{ix} + a_x t \\ v_{fy} = v_{iy} + a_y t \end{cases}$$

time-independent:
$$\begin{cases} v_{fx}^2 = v_{ix}^2 + 2a_x\Delta x \\ v_{fy}^2 = v_{iy}^2 + 2a_y\Delta y \end{cases}$$

Uniform Circular Motion

$$F_r = ma_r = m\frac{v^2}{r}; \quad a_r = \frac{v^2}{r}$$

$$v = \frac{2\pi r}{T}$$

$$F_G = G\frac{m_1 m_2}{r^2}$$

Geometry /Algebra

Circles   *Triangles*   *Spheres*

$C = 2\pi r$ $A = \frac{1}{2}bh$ $A = 4\pi r^2$

$A = \pi r^2$ $V = \frac{4}{3}\pi r^3$

Quadratic equation : $ax^2 + bx + c = 0$,

whose solutions are given by : $x = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

Vectors

magnitude of a vector: $v = |\vec{v}| = \sqrt{v_x^2 + v_y^2}$

direction of a vector: $\phi = \tan^{-1}\left(\dfrac{v_y}{v_x}\right)$

Useful Constants

$g = 9.8 \,{}^{m}/_{s^2}$ $G = 6.67\times10^{-11} \,{}^{Nm^2}/_{kg^2}$

$N_A = 6.02\times10^{23} \,{}^{atoms}/_{mole}$ $k_B = 1.38\times10^{-23} \,{}^{J}/_K$

$\sigma = 5.67\times10^{-8} \,{}^{W}/_{m^2 K^4}$ $v_{sound} = 343 \,{}^{m}/_{s}$

Linear Momentum/Forces

$$\vec{p} = m\vec{v}$$

$$\vec{p}_f = \vec{p}_i + \vec{F}\Delta t$$

$$\vec{F} = m\vec{a}$$

$$\vec{F}_s = -k\vec{x}$$

$$F_f = \mu F_N$$

Work/Energy

$$K_t = \frac{1}{2}mv^2$$

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

$$U_g = mgh$$

$$U_S = \frac{1}{2}kx^2$$

$$W_T = Fd\cos\theta = \Delta E_T$$

$$W_R = \tau\theta = \Delta E_R$$

$$W_{net} = W_R + W_T = \Delta E_R + \Delta E_T$$

$$\Delta E_R + \Delta E_T + \Delta U_g + \Delta U_S = 0$$

$$\Delta E_R + \Delta E_T + \Delta U_g + \Delta U_S = -\Delta E_{diss}$$

Heat

$$T_C = \frac{5}{9}[T_F - 32]$$

$$T_F = \frac{9}{5}T_C + 32$$

$$L_{new} = L_{old}(1 + \alpha\Delta T)$$

$$A_{new} = A_{old}(1 + 2\alpha\Delta T)$$

$$V_{new} = V_{old}(1 + \beta\Delta T): \beta = 3\alpha$$

$$PV = Nk_B T$$

$$\frac{3}{2}k_B T = \frac{1}{2}mv^2$$

$$\Delta Q = mc\Delta T$$

$$P_C = \frac{\Delta Q}{\Delta t} = \frac{kA}{L}\Delta T$$

$$P_R = \frac{\Delta Q}{\Delta T} = \varepsilon\sigma A\Delta T^4$$

$$\Delta U = \Delta Q - \Delta W$$

Rotational Motion

$$\theta_f = \theta_i + \omega_i t + \frac{1}{2}\alpha t^2$$

$$\omega_f = \omega_i + \alpha t$$

$$\omega^2_f = \omega^2_i + 2\alpha\Delta\theta$$

$$\tau = I\alpha = rF$$

$$L = I\omega$$

$$L_f = L_i + \tau\Delta t$$

$$\Delta s = r\Delta\theta: \ v = r\omega: \ a_t = r\alpha$$

$$a_r = r\omega^2$$

Fluids

$$\rho = \frac{M}{V}$$

$$P = \frac{F}{A}$$

$$P_d = P_0 + \rho g d$$

$$F_B = \rho g V$$

$$A_1 v_1 = A_2 v_2$$

$$\rho_1 A_1 v_1 = \rho_2 A_2 v_2$$

$$P_1 + \frac{1}{2}\rho v^2_1 + \rho g h_1 = P_2 + \frac{1}{2}\rho v^2_2 + \rho g h_2$$

Simple Harmonic Motion/Waves

$$\omega = 2\pi f = \frac{2\pi}{T}$$

$$T_S = 2\pi\sqrt{\frac{m}{k}}$$

$$T_P = 2\pi\sqrt{\frac{l}{g}}$$

$$v = \pm\sqrt{\frac{k}{m}}A\left(1 - \frac{x^2}{A^2}\right)^{\frac{1}{2}}$$

$$x(t) = A\sin\left(\frac{2\pi t}{T}\right)$$

$$v(t) = A\sqrt{\frac{k}{m}}\cos\left(\frac{2\pi t}{T}\right)$$

$$a(t) = -A\frac{k}{m}\sin\left(\frac{2\pi t}{T}\right)$$

$$v = f\lambda = \sqrt{\frac{F_T}{\mu}}$$

$$f_n = nf_1 = n\frac{v}{2L}$$

$$I = 2\pi^2 f^2 \rho v A^2$$

Sound

$$v = f\lambda = (331 + 0.6T)\,\frac{m}{s}$$

$$\beta = 10\log\frac{I}{I_0}; \ I_o = 1\times10^{-12}\,\frac{W}{m^2}$$

$$f_n = nf_1 = n\frac{v}{2L}; \ f_n = nf_1 = n\frac{v}{4L}$$