

**Formula Sheet, Phys 101 (Revised Jan 31, 2015)**

**Fluids:**

$$P = P_0 + \rho gh$$

$$A_1 v_1 = A_2 v_2$$

$$P_{\text{gauge}} = P - P_0$$

$$P + \frac{1}{2} \rho v^2 + \rho gh = \text{constant}$$

$$F_B = m_f g = \rho_f g V$$

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

**Harmonic Motion:**

$$F = -kx$$

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

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

$$x(t) = A \cos(\omega t + \phi_0)$$

$$v(t) = -A\omega \sin(\omega t + \phi_0)$$

$$a(t) = -A\omega^2 \cos(\omega t + \phi_0) = -\omega^2 x(t)$$

$$\omega = 2\pi f = \frac{2\pi}{T} \quad \left(f = \frac{1}{T}\right)$$

$$\omega = \sqrt{\frac{k}{m}} \quad (\text{spring})$$

$$\omega = \sqrt{\frac{g}{L}} \quad (\text{simple pendulum})$$

$$E = \frac{1}{2} kA^2 = \frac{1}{2} mv_{\text{max}}^2$$

$$x_{\text{max}}(t) = Ae^{-bt/2m}$$

$$x(t) = Ae^{-bt/2m} \cos(\omega_D t + \phi)$$

$$E(t) = E_0 e^{-bt/m}$$

$$\omega_D = \sqrt{\frac{k}{m} - \frac{b^2}{4m^2}}$$

**Travelling Waves:**

$$k = \frac{2\pi}{\lambda}$$

$$v = f\lambda = \frac{\omega}{k}$$

$$v = \sqrt{\frac{T}{\mu}}$$

General equation for a travelling wave:

$$D(x, t) = D_M \sin(kx \mp \omega t + \phi_0)$$

**Sound:**

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

$$I = \frac{P}{4\pi r^2} \quad (\text{spherical wave})$$

$$\beta(\text{dB}) = 10 \log_{10} \left( \frac{I}{I_0} \right)$$

$$f = f_0 \left( \frac{1 \pm \frac{v_o}{v}}{1 \mp \frac{v_s}{v}} \right) = f_0 \left( \frac{v \pm v_o}{v \mp v_s} \right)$$

$$f_{\text{beat}} = |f_2 - f_1|$$

**Interference & diffraction:**

$$n = \frac{c}{v}$$

$$\lambda_n = \frac{\lambda}{n}$$

Thin film interference:

$$\Delta\phi = 2\pi \frac{\Delta x}{\lambda} + \Delta\phi_0$$

2-slit interference, with small angle approximation ( $m = 0, \pm 1, \pm 2, \dots$ ):

Bright fringes:

$$y_{\text{bright}} = m \frac{\lambda L}{d}$$

Dark fringes:

$$y_{\text{dark}} = \left(m + \frac{1}{2}\right) \frac{\lambda L}{d}$$

Single-slit diffraction minima with small angle approximation:

$$y_{\text{dark}} = p \frac{\lambda L}{a}, \quad \text{where } p = \pm 1, \pm 2, \dots$$

$$\text{Circular aperture: } \theta_{\text{min}} = 1.22 \frac{\lambda}{D}$$

**Areas & volumes:**

$$A(\text{circle}) = \pi r^2$$

$$A(\text{sphere}) = 4\pi r^2$$

$$V(\text{sphere}) = \frac{4}{3} \pi r^3$$

$$V(\text{cylinder}) = \pi r^2 h$$

**Constants:**

$$P_0 = P_{\text{atmosphere}} = 1.013 \times 10^5 \text{ Pa};$$

$$\rho_{\text{fresh water}} = 1.00 \times 10^3 \text{ kg/m}^3;$$

$$\rho_{\text{air}} = 1.29 \text{ kg/m}^3;$$

$$\rho_{\text{mercury}} = 13.6 \times 10^3 \text{ kg/m}^3;$$

$$g = 9.81 \text{ m/s}^2$$

$$I_0 = 10^{-12} \text{ W/m}^2;$$

$$v_{\text{sound}}(\text{in air}) = 343 \text{ m/s}$$