Physics Formulas

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Vectors

$$V_x = V\cos\theta$$

$$V_y = V\sin\theta$$

$$V = \sqrt{{V_x}^2 + {V_y}^2}$$

$$\tan\theta = \frac{V_y}{V_x}$$

Kinematics

$$\bar{v} = \frac{x_2 - x_1}{t_2 - t_1}$$

$$\bar{v} = \frac{v_f + v_0}{2}$$

$$x = x_0 + \bar{v}t$$

$$\bar{a} = \frac{v_2 - v_1}{t_2 - t_1}$$

$$v = v_0 + at$$

$$x = x_0 + v_0 t + \tfrac{1}{2}at^2$$

$${v^2} - {v_0}^2 = 2a(x - x_0)$$

$$x = x_0 + \left(\frac{v_0 + v}{2}\right)t$$

Force

$$F_{spring} = -kx$$

$$w = mg$$

$$F_k = \mu_k N$$

$$F_s \le \mu_s N$$

Circular Motion

$$\theta = \frac{s}{r}$$

$$\bar{\omega} = \frac{\Delta\theta}{\Delta t}$$

$$\omega = \frac{v_\perp}{r}$$

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

$$T = \frac{1}{f} = \frac{2\pi}{\omega}$$

$$\bar{\alpha} = \frac{\Delta\omega}{\Delta t}$$

$$\alpha = \frac{a_\perp}{r}$$

$$a_r = \frac{v^2}{r} = \omega^2 r = v\omega$$

$$F_c = \frac{mv^2}{r} = m\omega^2 r = mv\omega$$

Work and Energy

$$W = F_{//}\, d$$

$$W = \Delta E = \Delta K + \Delta U$$

$$K = \tfrac{1}{2}mv^2$$

$$U_{grav} = mgh$$

$$\bar{P} = \frac{\Delta W}{\Delta t} = \mathbf{F}\cdot\mathbf{v}$$

$$U_{spring} = \tfrac{1}{2}kx^2$$

Momentum

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

$$\bar{\mathbf{F}} = \frac{\Delta\mathbf{p}}{\Delta t}$$

Harmonic Oscillation

$$\omega = \sqrt{\frac{k}{m}}$$

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

$$T \cong 2\pi\sqrt{\frac{L}{g}}$$

$$T \cong 2\pi\sqrt{\frac{I}{mgd}}$$

$$E = \tfrac{1}{2}mv^2 + \tfrac{1}{2}kx^2 = \tfrac{1}{2}kA^2$$

Waves

$$\omega = 2\pi f \qquad k = \frac{2\pi}{\lambda}$$

$$T = \frac{1}{f} = \frac{2\pi}{\omega}$$

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

$$y(x,t) = y_{\max}\sin(kx - \omega t)$$

Sound

v_s = 331.29 m/s at 1 atm, 0°C,
v_s = 343 m/s at 1 atm, 20°C

$$\beta = (10\text{ dB})\log\frac{I}{I_0}$$

$I_0 = 0.9937 \times 10^{-12}$ W/m^2

$$I = \frac{P}{4\pi r^2}$$

String: $v = \sqrt{\dfrac{Tension}{\mu}}$

$$f_n = \frac{nv}{2L}\ ,\ n = 1, 2, 3, \ldots$$

Pipe, Open Ends: $f_n = \dfrac{vn}{2L}$

One End: $f_n = \dfrac{vn}{4L}$

Beats: $f_{beat} = f_2 - f_1$

Doppler Effect

$$f_{observed} = f_{source}\frac{v_{sound} \pm v_{observer}}{v_{sound} \mp v_{source}}$$

Geometric Optics

Snell's Law: $n_1\sin\theta_1 = n_2\sin\theta_2$

Critical Angle: $\theta_C = \sin^{-1}\left(\dfrac{n_2}{n_1}\right)$

Lenses and Mirrors: $\dfrac{1}{s} + \dfrac{1}{s'} = \dfrac{1}{f}$

(s and s' are positive on same side of mirror or opposite sides of lens)

Linear Magnification: $M = -\dfrac{s'}{s}$

Angular Magnification: $M_\theta = \dfrac{f_{objective}}{f_{ocular}}$

Wave Optics

$c = 3.00 \times 10^8$ m/s

$n = c/v$

Polarization: $I = I_{\max}\cos^2\theta$

Double-Slit maxima: $d\sin\theta = m\lambda$

$d\sin\theta = (m + \tfrac{1}{2})\lambda$ (minima)

Thin Film: $2nd = (m + \tfrac{1}{2})\lambda$ (maxima)

$2nd = m\lambda$ (minima)