

# Physics Formulas

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## Vectors

$$V_x = V \cos \mathbf{q}$$

$$V_y = V \sin \mathbf{q}$$

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

$$\tan \mathbf{q} = \frac{V_y}{V_x}$$

## Kinematics

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

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

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

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

$$v = v_0 + at$$

$$x = x_0 + v_0t + \frac{1}{2}at^2$$

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

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

## Force

$$F_{spring} = -kx$$

$$w = mg$$

$$F_k = \mathbf{m}_k N$$

$$F_s \leq \mathbf{m}_s N$$

## Circular Motion

$$\mathbf{q} = \frac{s}{r}$$

$$\bar{\mathbf{w}} = \frac{\Delta \mathbf{q}}{\Delta t}$$

$$\mathbf{w} = \frac{v_{\perp}}{r}$$

$$f = \frac{\mathbf{w}}{2\mathbf{p}}$$

$$T = \frac{1}{f} = \frac{2\mathbf{p}}{\mathbf{w}}$$

$$\bar{\mathbf{a}} = \frac{\Delta \mathbf{w}}{\Delta t}$$

$$\mathbf{a} = \frac{a_{\perp}}{r}$$

$$a_r = \frac{v^2}{r} = \mathbf{w}^2 r = v\mathbf{w}$$

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

## Work and Energy

$$W = F_{\parallel} d$$

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

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

$$U_{grav} = mgh$$

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

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

## Momentum

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

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

## Harmonic Oscillation

$$\mathbf{w} = \sqrt{\frac{k}{m}}$$

$$T = 2\mathbf{p}\sqrt{\frac{m}{k}}$$

$$T \cong 2\mathbf{p}\sqrt{\frac{L}{g}}$$

$$T \cong 2\mathbf{p}\sqrt{\frac{I}{mgd}}$$

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

## Waves

$$\mathbf{w} = 2\mathbf{p}f \quad k = \frac{2\mathbf{p}}{\mathbf{l}}$$

$$T = \frac{1}{f} = \frac{2\mathbf{p}}{\mathbf{w}}$$

$$v = \mathbf{l}f = \frac{\mathbf{w}}{k} = \frac{\mathbf{l}}{T}$$

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

## Sound

$$v_s = 331.29 \text{ m/s at } 1 \text{ atm, } 0^\circ\text{C,}$$

$$v_s = 343 \text{ m/s at } 1 \text{ atm, } 20^\circ\text{C}$$

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

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

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

$$\text{String: } v = \sqrt{\frac{\text{Tension}}{m}}$$

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

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

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

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

Doppler Effect

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

## Geometric Optics

$$\text{Snell's Law: } n_1 \sin \mathbf{q}_1 = n_2 \sin \mathbf{q}_2$$

$$\text{Critical Angle: } \mathbf{q}_C = \sin^{-1}\left(\frac{n_2}{n_1}\right)$$

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

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

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

$$\text{Angular Magnification: } M_{\mathbf{q}} = \frac{f_{objective}}{f_{ocular}}$$

## Wave Optics

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

$$n = c/v$$

$$\text{Polarization: } I = I_{\max} \cos^2 \mathbf{q}$$

$$\text{Double-Slit maxima: } d \sin \mathbf{q} = m\mathbf{l}$$

$$d \sin \mathbf{q} = (m + \frac{1}{2})\mathbf{l} \quad (\text{minima})$$

$$\text{Thin Film: } 2nd = (m + \frac{1}{2})\mathbf{l} \quad (\text{maxima})$$

$$2nd = m\mathbf{l} \quad (\text{minima})$$