Physics Equations Cheat Sheet

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January 13, 2025

Coefficients and Constants

Universal Gravitational Constant

$$G = 6.674 \times 10^{-11}$$

Gravity at Earth's Surface

$$g = 9.8\frac{m}{s^2}$$

Mass of Earth

$$M_E = 5.97 \times 10^{24} kg$$

Radius of Earth

$$R_E = 6.37 \times 10^{3} km$$

Position, Velocity, and Acceleration

Displacement

$$\Delta r = \vec{r}_f - \vec{r}_i$$

Average Velocity

$$\vec{v}_{avg} = \frac{\Delta \vec{r}}{\Delta t}$$

Average Velocity (Constant Acceleration)

$$\vec{v}_{avg} = \frac{1}{2}(v_{fx} + v_{ix})$$

Instantaneous Velocity

$$\vec{v} = \lim_{\Delta t \to 0} \frac{\Delta \vec{r}}{\Delta t}$$

Average Acceleration

$$\vec{a}_{avg} = \frac{\Delta \vec{v}}{\Delta t}$$

Instantaneous Acceleration

$$\vec{a} = \lim_{\Delta t \to 0} \frac{\Delta \vec{v}}{\Delta t}$$

Projectile Motion Equations (1 Dimension)

Find velocity with acceleration and time

$$\Delta v_x = a_x \Delta t$$

Find velocity with acceleration and displacement

$$v_{fx}^2 - v_{ix}^2 = 2a\Delta x$$

Find displacement with velocity and time

$$\Delta x = \frac{1}{2}(v_{fx} + v_{ix})\Delta t$$

Find displacement with acceleration and velocity

$$\Delta x = \frac{1}{2}a_x(\Delta t)^2 + v_{ix}\Delta t$$

Circular Projectile Motion Equations

Find angular velocity with angular acceleration and time

$$\Delta\omega = \omega_f - \omega_i = \alpha\Delta t$$

Find angular velocity with angular acceleration and angular displacement

$$\omega_f^2 - \omega_i^2 = 2\alpha\Delta\theta$$

Find angular displacement with angular velocity and time

$$\Delta\theta = \frac{1}{2}(\omega_f + \omega_i)\Delta t$$

Find angular displacement with angular acceleration and initial angular velocity

$$\Delta\theta = \frac{1}{2}\alpha(\Delta t)^2 + \omega_i\Delta t$$

Work, Energy, & Momentum Equations

Work Formula

$$W = F \cdot \Delta r$$

Force Formula

$$F = (-m \cdot g)$$

Gravitational Potential Energy Formula (using gravity near Earth's surface)

$$\Delta U = mg\Delta y = -W_{gravity}$$

(Change in Potential Energy $U = mass_{object} \times gravity \times displacement_y =$ the opposite of $Work_{gravity}$)

General Gravitational Potential Energy Formula

$$U_{gravity} = -\frac{Gm_1m_2}{r}$$

(Potential Energy using the universal gravitational constant)

Kinetic Energy Formula

$$\Delta K = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$$

Mechanical Energy Formula

$$\Delta E_{mechanical} = \Delta K + \Delta U \equiv (\frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2) + (mg\Delta r)$$

Hooke's Law

$$F_{spring} = -k\Delta L$$

Elastic Potential Energy

$$\Delta U_{elastic} = \frac{1}{2}kx^2$$

(k = spring constant/stiffness of spring, x = displacement of spring)

Average Power

$$P_{avg} = \frac{\Delta E}{\Delta t}$$

Instantaneous Power

$$P = \frac{W}{\Delta t} \equiv \frac{F \cdot \Delta r \cdot cos(\theta)}{\Delta t} \equiv F \cdot v \cdot cos(\theta)$$

Linear Momentum Formula

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

(Momentum = mass · velocity)

Impulse Formula

$$\vec{J} = \vec{F}\Delta t = \Delta\vec{p}$$

(Impulse = Force · time ≡ change in momentum)

Torque Equations

Torque Formula

$$\tau = F \cdot r \cdot \sin(\theta)$$

(Torque = Force * displacement * sine of angle theta)