

AP Physics C: Mechanics Cheat Sheet

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Unit 1: Kinematics

- **Kinematics in One Dimension:**

- **Displacement:** $\Delta x = x_f - x_i$

- **Velocity:** $(v = \frac{dx}{dt})$

- **Acceleration:** $(a = \frac{dv}{dt})$

- **Equations of Motion:** $\mathbf{v} = \mathbf{v}_0 + \mathbf{a}t$
 $(x = x_0 + v_0t + \frac{1}{2}at^2)$

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

- **Kinematics in Two Dimensions:**

- **Position Vector:** $(\vec{r} = x\hat{i} + y\hat{j})$

- **Velocity Vector:** $(\vec{v} = \frac{d\vec{r}}{dt} = v_x\hat{i} + v_y\hat{j})$

- **Projectile Motion:** $(\mathbf{x}(t) = \mathbf{v}_0t)$

$$(y(t) = v_{0y}t - \frac{1}{2}gt^2)$$

- **Relative Velocity:** $(\vec{v}_{AB} = \vec{v}_A - \vec{v}_B)$

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Unit 2: Newton's Laws of Motion

- **Newton's First and Second Law:**

- **First Law (Inertia):** $(\vec{F}_{\text{net}} = 0 \Rightarrow \text{constant velocity})$

- **Second Law:** $(\vec{F}_{\text{net}} = m\vec{a})$

- **Weight:** $W = mg$

- **Circular Motion: Centripetal Acceleration:** $(a_c = \frac{v^2}{r})$

- **Centripetal Force:** $(F_c = m\frac{v^2}{r})$

- **Uniform Circular Motion: Constant speed, changing velocity direction.**

- **Newton's Third Law: Action-Reaction: For every action, there is an equal and opposite reaction, $(\vec{F}_{AB} = -\vec{F}_{BA})$.**

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Unit 3: Work, Energy, and Power

- **Work-Energy Theorem:** $(W = \Delta K = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2)$
- **Forces and Potential Energy: Gravitational Potential Energy:** $U_g = mgh$
- **Elastic Potential Energy:** $(U_s = \frac{1}{2}kx^2)$

- **Conservative Forces:** $(\vec{F} = -\frac{dU}{dx})$
- **Conservation of Energy: Mechanical Energy:** $E = K + U$
- **Conservation:** $(E_i = E_f)$ (No non-conservative forces)
- **Power:** $(P = \frac{dW}{dt} = Fv)$
- **Units: Watts (W)**

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Unit 4: Systems of Particles and Linear Momentum

- **Center of Mass: Center of Mass :**

- **(Discrete Particles):** $(\vec{r}_{\text{cm}} = \frac{1}{M} \sum m_i \vec{r}_i)$

- **Impulse and Momentum:**

- **Momentum:** $(\vec{p} = m\vec{v})$

- **Impulse:** $(\vec{J} = \Delta\vec{p} = \int \vec{F} dt)$

- **Impulse-Momentum Theorem:** $(\vec{J} = \Delta\vec{p})$

- **Conservation of Linear Moment**

- **Elastic Collisions:** $(\vec{p}_{\text{initial}} = \vec{p}_{\text{final}}, K_{\text{initial}} = K_{\text{final}})$

- **Inelastic Collisions:** $(\vec{p}_{\text{initial}} = \vec{p}_{\text{final}}), (K_{\text{initial}} > K_{\text{final}})$

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Unit 5: Rotation

- **Torque and Rotational Statics:** Torque: $T = rF\sin\theta$
- **Rotational Equilibrium:** $\Sigma T = 0$
- **Rotational Kinematics:**
- **Angular Displacement:** $(\theta = \theta_0 + \omega_0 t + \frac{1}{2}\alpha t^2)$
- **Angular Velocity:** $\omega = \omega_0 + \alpha t$
- **Angular Acceleration:** $(\alpha = \frac{d\omega}{dt})$
- **Rotational Dynamics and Energy:** Rotational Inertia: $I = \Sigma m_i r_i^2$
- **Newton's Second Law for Rotation:** $\tau = I\alpha$
- **Rotational Kinetic Energy:** $(K = \frac{1}{2}I\omega^2)$
- **Angular Momentum and Its Conservation:** Angular Momentum:
 $L = I\omega$
- **Conservation of Angular Momentum:** $(\vec{L}_{\text{initial}} = \vec{L}_{\text{final}})$

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Unit 6: Oscillations

- **Simple Harmonic Motion (SHM):**
- **Position:** $(x(t) = A\cos(\omega t + \theta))$
- **Velocity:** $(v(t) = -A\omega\sin(\omega t + \theta))$
- **Acceleration:** $(a(t) = -A\omega^2\cos(\omega t + \theta))$
- **Springs:Hooke's Law:** $F_s = -kx$
- **Spring Constant:** $k, (\omega = \sqrt{\frac{k}{m}})$
- **Pendulums:Simple Pendulum:** $(T = 2\pi\sqrt{\frac{L}{g}})$
- **Angular Frequency:** $(\omega = \sqrt{\frac{g}{L}})$

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Unit 7: Gravitation

- **Gravitational Forces :**

- **Newton's Law of Universal Gravitation:** $(F_g = G \frac{m_1 m_2}{r^2})$

- $(G = 6.674 \times 10^{-11} \text{ Nm}^2/\text{Kg}^2)$

- **Gravitational Potential Energy:** $(U_g = -G \frac{m_1 m_2}{r})$

- **Orbits of Planets and Satellites:Orbital Speed:** $(v = \sqrt{\frac{GM}{r}})$

- **Orbital Period:** $(T = 2\pi \sqrt{\frac{r^3}{GM}})$ (Kepler's Third Law)

Additional Notes: