FREE AP PHYSICS C: MECHANICS FORMULA SHEET

All the Essential Formulas You Need for Test Day

Unit 1: Kinematics

- Velocity: **$v = dx/dt$**
- Acceleration: **$a = dv/dt = d^2x/dt^2$**
- Average velocity: **$v_{avg} = \Delta x / \Delta t$**
- Kinematic equations (constant a):
  $v = v_0 + a\,t$
  $x = x_0 + v_0\,t + (1/2)\,a\,t^2$
  $v^2 = v_0^2 + 2a(x - x_0)$

Unit 2: Force and Translational Dynamics

- Newton's 2nd Law: **$\Sigma F = m\,a$**
- Momentum (general form): **$F = dp/dt$**
- Weight: **$F_g = m\,g$**
- Friction: **$f = \mu\,N$**
- Hooke's Law: **$F_s = -k\,x$**

Unit 3: Work, Energy, and Power

- Work (calculus form): **$W = \int F \cdot dx$**
- Kinetic energy: **$KE = \frac{1}{2}\,m\,v^2$**
- Potential energy (gravitational): **$U_g = m\,g\,y$**
- Potential energy (spring): **$U_s = \frac{1}{2}\,k\,x^2$**
- Power: **$P = dW/dt = F \cdot v$**
- Work–energy theorem: **$W_{net} = \Delta KE$**

Constants

- $g = 9.8\ m/s^2$
- $\pi \approx 3.1416$
- $G = 6.67 \times 10^{-11}\ N{\cdot}m^2/kg^2$
- $M_e = 5.97 \times 10^{24}\ kg$ (mass of Earth)
- $R_e = 6.37 \times 10^{6}\ m$ (radius of Earth)

Unit 4: Linear Momentum

- Momentum: **$p = m\,v$**
- Impulse: **$J = \int F\,dt = \Delta p$**
- Conservation of momentum:
  $\Sigma p_{initial} = \Sigma p_{final}$
- Center of mass: **$r_{cm} = (\Sigma\, m_i\, r_i) / (\Sigma\, m_i)$**

Unit 5: Torque and Rotational Dynamics

- Torque: **$\tau = r \times F = r\,F\,\sin\theta$**
- Net torque: **$\Sigma\tau = I\,\alpha$**
- Moment of inertia: **$I = \Sigma\, m_i\, r_i^2$**
- Angular momentum: **$L = I\,\omega$**
- Torque relation: **$\tau = dL/dt$**
- Rolling without slipping: **$v = \omega\,r$**

Unit 6: Energy and Momentum of Rotating Systems

- Rotational kinetic energy: **$KE_{rot} = \frac{1}{2}\,I\,\omega^2$**
- Total kinetic energy (rolling):
  $KE_{total} = \frac{1}{2}\,M\,v^2 + \frac{1}{2}\,I\,\omega^2$
- Angular momentum:
  $L = r \times p$ (particle), $L = I\,\omega$ (rigid body)
- Conservation of angular momentum:
  $L_{initial} = L_{final}$

Unit 7: Oscillations

- ooke's Law: **$F = -k\,x$**
- Period of spring: **$T = 2\pi\,\sqrt{(m / k)}$**
- Period of pendulum (small angle):
  $T = 2\pi\,\sqrt{(L / g)}$
- SHM general solution: **$x(t) = A\cos(\omega t + \varphi)$**
- Angular frequency:
  $\omega = \sqrt{(k/m)}$ (spring), $\omega = \sqrt{(g/L)}$ (pendulum)