FREE AP PHYSICS 1 FORMULA SHEET

All the Essential Formulas You Need for Test Day

Unit 1: Kinematics

- Average velocity: v_avg = **Δx / Δt**
- Acceleration: **a = Δv / Δt**
- Final velocity (time relation): **$v = v_0 + a\,t$**
- Position (time relation): **$x = x_0 + v_0\,t + (1/2)\,a\,t^2$**
- Velocity–displacement relation:
  $v^2 = v_0^2 + 2a\,(x - x_0)$
- Average velocity (constant acceleration):
  v_avg = (v + v_0) / 2

Unit 2: Force and Translational Dynamics

- Newton's Second Law: **ΣF = m a**
- Weight (force of gravity near Earth): **F_g = m g**
- Universal gravitation: **$F = G\,(m_1\,m_2) / r^2$**
- Friction (kinetic or static): **f = μ N**
- Spring force (Hooke's Law): **F_s = −k x**
- Centripetal acceleration: **a_c = v^2 / r**
- Centripetal force: **F_c = m v^2 / r**

Unit 3: Work, Energy & Power

- Work: **W = F d cosθ**
- Power (work/time): **P = W / t**
- Power (force and velocity): **P = F v cosθ**
- Kinetic energy: **KE = ½ m v^2**
- Gravitational potential energy: **PE_g = m g y**
- Elastic potential energy: **PE_s = ½ k x^2**
- Work–energy theorem: **W_net = ΔKE**
- Conservation of mechanical energy (no non-conservative work):
  KE_initial + PE_initial = KE_final + PE_final

Unit 4: Linear Momentum

- Linear momentum: **p = m v**
- Impulse (force × time): **J = F Δt**
- Impulse–momentum theorem: **J = Δp**
- Conservation of momentum (isolated system): **Σp_initial = Σp_final**
- Center of mass (1D):
  x_cm = (Σ m_i x_i) / (Σ m_i)

Constants

g = 9.8 m/s², G = 6.67 × 10^{-11} N·m²/kg², P_0 = 1.01 × 10^5 Pa, c = 3.0 × 10^8 m/s

Unit 5: Torque & Rotational Dynamics

- Torque: **τ = r F sinθ**
- Net torque and angular acceleration: **Στ = I α**
- Moment of inertia (point masses):
  I = Σ m_i r_i^2
- Parallel-axis theorem: **I = I_cm + M d^2**
- Angular velocity (time relation): **$\omega = \omega_0 + \alpha\,t$**
- Angular position (time relation):
  $\theta = \theta_0 + \omega_0\,t + (1/2)\,\alpha\,t^2$
- Angular velocity–displacement relation:
  $\omega^2 = \omega_0^2 + 2\,\alpha\,(\theta - \theta_0)$
- Tangential velocity: **v = ω r**
- Tangential acceleration: **a_t = α r**
- Centripetal acceleration: **a_c = v^2 / r = ω^2 r**

Unit 6: Energy and Momentum of Rotating Systems

- Rotational kinetic energy: **KE_rot = ½ I ω^2**
- Angular momentum: **L = I ω**
- Torque and angular momentum: **τ = dL / dt**
- Rolling without slipping (velocity relation):
  v_cm = ω R
- Total kinetic energy (rolling object):
  KE_total = ½ M v_{cm}^2 + ½ I_cm ω^2

Unit 7: Oscillations

- Hooke's Law: **F_s = -k x**
- Period of a mass–spring system:
  T_spring = 2π √(m / k)
- Period of a simple pendulum (small angle):
  T_pend = 2π √(L / g)
- Frequency and period: **f = 1 / T**
- General SHM displacement:
  x(t) = A cos(2π f t) or x(t) = A sin(2π f t)

Unit 8: Fluids

- Density: **ρ = m / V**
- Pressure: **P = F / A**
- Hydrostatic pressure: **$P = P_0 + \rho\,g\,h$**
- Gauge pressure: **P_gauge = ρ g h**
- Buoyant force: **F_b = ρ g V_displaced**
- Continuity equation: **$A_1\,v_1 = A_2\,v_2$**
- Bernoulli's equation: **P + ½ ρ v^2 + ρ g y = constant**