Achievable

AP PHYSICS 1 DUMP SHEET

# Kinematics, forces and energy

## Kinematics

- Average velocity: $v_{\text{avg}} = \dfrac{\Delta x}{\Delta t}$
- Average acceleration: $a_{\text{avg}} = \dfrac{\Delta v}{\Delta t}$
- Constant acceleration:
  - $v = v_0 + at$
  - $x = x_0 + v_0 t + \frac{1}{2}at^2$
  - $v^2 = v_0^2 + 2a\Delta x$
  - $\Delta x = \dfrac{v + v_0}{2}\, t$
- Projectile motion:
  - $x = x_0 + v_{0x}t$
  - $v_x = v_{0x}$
  - $v_{0x} = v_0 \cos\theta$
  - $y = y_0 + v_{0y}t - \frac{1}{2}gt^2$
  - $v_y = v_{0y} - gt$
  - $v_{0y} = v_0 \sin\theta$
- Range on level ground: $R = \dfrac{v_0^2 \sin 2\theta}{g}$
- Maximum height: $h_{\max} = \dfrac{v_{0y}^2}{2g}$

## Forces and Newton's laws

- Newton's second law: $\sum \vec{F} = m\vec{a}$
- Weight: $F_g = mg$
- Normal force: $F_N$ is perpendicular to the surface
- Incline components:
  - $F_{g,\parallel} = mg\sin\theta$
  - $F_{g,\perp} = mg\cos\theta$
  - $F_N = mg\cos\theta$ on a simple incline
- Centripetal acceleration and force:
  - $a_c = \dfrac{v^2}{r}$
  - $\sum F_c = m\dfrac{v^2}{r}$
- Static friction: $f_s \le \mu_s F_N$
- Kinetic friction: $f_k = \mu_k F_N$
- Spring force: $F_{\text{spring}} = -kx$
- Tension: $T$ is the same throughout an ideal string
- Circular motion:
  - $v = \dfrac{2\pi r}{T}$
  - $\omega = \dfrac{2\pi}{T} = 2\pi f$
  - $v = \omega r$
  - $a_c = \omega^2 r$

## Work, energy and power

- Work: $W = Fd\cos\theta$
- Work-energy theorem: $W_{\text{net}} = \Delta K$
- Kinetic energy: $K = \frac{1}{2}mv^2$
- Gravitational potential energy: $U_g = mgh$
- Spring potential energy: $U_s = \frac{1}{2}kx^2$
- Energy of a system: $\Delta E_{\text{system}} = W_{\text{external}}$
- With nonconservative work: $K_i + U_i + W_{\text{nc}} = K_f + U_f$
- Work done by kinetic friction: $W_{\text{friction}} = -f_k d$
- Power: $P = \dfrac{W}{t}$, $P = Fv\cos\theta$
- Efficiency: $\eta = \dfrac{\text{useful output}}{\text{input}}$