Achievable

AP PHYSICS 1 DUMP SHEET

Momentum and rotation

Momentum and impulse

- Momentum: $\vec{p} = m\vec{v}$
- Impulse: $\vec{J} = \Delta\vec{p}$, $\vec{J} = \vec{F}_{\text{avg}}\Delta t$
- Newton's second law: $\sum \vec{F} = \frac{\Delta\vec{p}}{\Delta t}$
- Conservation of momentum: $\vec{p}_i = \vec{p}_f$
- Perfectly inelastic collision: $m_1v_{1i} + m_2v_{2i} = (m_1 + m_2)v_f$
- Elastic collision: $p_i = p_f$ and $K_i = K_f$
- Center of mass:
  - $x_{\text{cm}} = \frac{\sum m_ix_i}{\sum m_i}$
  - $v_{\text{cm}} = \frac{\sum m_iv_i}{\sum m_i}$

Torque and rotational dynamics

- Torque: $\tau = rF\sin\theta$
- Newton's second law for rotation: $\sum \tau = I\alpha$
- Rotational equilibrium: $\sum F_x = 0$, $\sum F_y = 0$, $\sum \tau = 0$
- Rolling without slipping: $v_{\text{cm}} = \omega R$, $a_{\text{cm}} = \alpha R$
- Angular kinematics:
  - $\omega = \omega_0 + \alpha t$
  - $\theta = \theta_0 + \omega_0 t + \frac{1}{2}\alpha t^2$
  - $\omega^2 = \omega_0^2 + 2\alpha\Delta\theta$
- Rotational analogs:

Linear	x	v	a	m	F	p	$K = \frac{1}{2}mv^2$
Rotational	θ	ω	α	I	τ	L	$K_{\text{rot}} = \frac{1}{2}I\omega^2$

Rotational energy and angular momentum

- Rotational kinetic energy: $K_{\text{rot}} = \frac{1}{2}I\omega^2$
- Total kinetic energy: $K_{\text{total}} = \frac{1}{2}mv_{\text{cm}}^2 + \frac{1}{2}I\omega^2$
- Angular momentum: $L = I\omega$
- Net torque: $\tau_{\text{net}} = \frac{\Delta L}{\Delta t}$
- Conservation of angular momentum, if $\sum \tau_{\text{ext}} = 0$:
  - $L_i = L_f$
  - $I_i\omega_i = I_f\omega_f$
- Moment of inertia, common forms:
  - Point mass: $I = mr^2$
  - Hoop: $I = MR^2$
  - Solid disk: $I = \frac{1}{2}MR^2$
  - Solid sphere: $I = \frac{2}{5}MR^2$
  - Rod, about its center: $I = \frac{1}{12}ML^2$
  - Rod, about one end: $I = \frac{1}{3}ML^2$