Study Guide for Test 3

Energy-Related Definitions

Kinetic energy $= K = \frac{1}{2}m|\vec{v}|^2$ (SI unit: J $= \text{kg} \cdot \text{m}^2/\text{s}^2 = \text{N} \cdot \text{m}$)

Gravitational potential energy $= U_g = mgh$

Spring potential energy $= U_s = \frac{1}{2}k_s x^2$, where $k_s = |F_x/x|$

For any position-dependent force $\vec{F}$, $F_x = -dU/dx$

Work $= W = \vec{F} \cdot \vec{\Delta r} = |\vec{F}||\vec{\Delta r}| \cos\theta$

$$\text{Power} = \frac{\text{energy converted or transferred}}{\text{time elapsed}} \quad \text{(SI unit: W = J/s)}$$

1 calorie = energy to raise temperature of 1 g water by 1°C $\approx$ 4.2 J

Energy-Related Principles

Energy conservation: $E_{\text{final}} = E_{\text{initial}}$ (for any isolated system, if *all* forms of energy are included)

Mechanical energy conservation: $K_f + U_f = K_i + U_i$ (if no other forms of energy are involved, in particular, no fuels consumed or thermal energy created)

Work is energy transferred: $\sum W = E_f - E_i$ (where the sum is over all work-doing forces that aren't taken into account as forms of potential energy)

Rotational Motion

You should understand the table of analogies, and be able to use it to remember relations among angular variables:

Linear Motion	Rotational Motion
t	t
x	θ
v_x	ω
a_x	α
m	I
F_x	τ
$\sum F_x = ma_x$	$\sum \tau = I\alpha$
$p_x = mv_x$	$L = I\omega$
$K_{\text{trans}} = \frac{1}{2}mv_x^2$	$K_{\text{rot}} = \frac{1}{2}I\omega^2$

You should understand the use of radians to measure angles in rotational quantities. You should also know the relations between linear and rotational quantities, where t indicates a vector's tangential component and the sums run over all parts of the object or system:

$$\omega = \frac{v_t}{r} \qquad \alpha = \frac{a_t}{r} \qquad I = \sum_i m_i r_i^2 \qquad \tau = r\,F_t \qquad L = \sum_i r_i\,p_{t,i}$$