Physics 2314, Formula sheet for Final

Kinematics

Particle under constant velocity:

$x = x_i + v_x t$

$y = y_i + v_y t$

Particle under constant acceleration:

$v_x = v_{xi} + a_x t \qquad x = x_i + v_{xi} t + \frac{1}{2} a_x t^2 \qquad v_x^2 = v_{xi}^2 + 2a_x(x - x_i)$

$v_y = v_{yi} + a_y t \qquad y = y_i + v_{yi} t + \frac{1}{2} a_y t^2 \qquad v_y^2 = v_{yi}^2 + 2a_y(y - y_i)$

Uniform circular motion: centripetal acceleration $a = \dfrac{v^2}{r} = \omega^2 r \qquad v = \omega r$

Laws of motion

2nd Newton's law: net force $\mathbf{F} = m\mathbf{a}$

Weight: $\mathbf{F}_g = m\mathbf{g}$

Normal force: $\mathbf{N}$ (perpendicular to the surface)

Tension force: $\mathbf{T}$ (along the cord)

Friction force: $F_s \le \mu_s N$ (static), $F_k = \mu_k N$ (kinetic)

Work and energy

Work done by a force: $W = \displaystyle\int \mathbf{F}\, d\mathbf{r}$

Kinetic energy: translational $K = \dfrac{1}{2} m v^2$, rotational $K = \dfrac{1}{2} I \omega^2$

Potential energy: gravitaion $U = mgy$, spring $U = \dfrac{1}{2} k x^2$

Conservation of energy (conservative forces only): $K_i + U_i = K_f + U_f$

Conservation of energy (general): $K_i + U_i = K_f + U_f + W_{\text{noncon}}$

Rotation

Constant angular acceleration:

$\omega_f = \omega_i + \alpha t \qquad \theta_f = \theta_i + \omega_i t + \dfrac{1}{2}\alpha t^2 \qquad \omega_f^2 = \omega_i^2 + 2\alpha(\theta_f - \theta_i)$

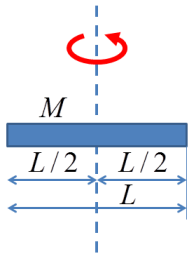
Moment of inertia:

$I = \displaystyle\sum_i m_i r_i^2$ (discrete)

$I = \displaystyle\int r^2\, dm$ (continuous)

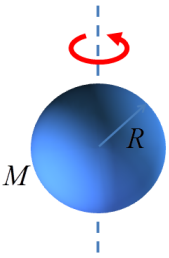
Parallel-axis theorem:

$I = I_{CM} + MD^2$



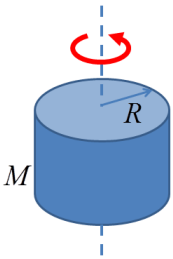
Thin rod about center

$I = \dfrac{1}{12} ML^2$



Solid sphere

$I = \dfrac{2}{5} MR^2$



Solid disk or cylinder

$I = \dfrac{1}{2} MR^2$

Angular momentum: $\mathbf{L} = \mathbf{r} \times \mathbf{p}, \quad L = I\omega$ Torque: $\tau = \mathbf{r} \times \mathbf{F}, \quad \tau = I\alpha$

Universal gravitation: $F = G\dfrac{m_1 m_2}{r^2}$

Useful constants

Gravitational acceleration $g = 9.80\ \text{m/s}^2$

Gravitational constant $G = 6.674 \times 10^{-11}\ \text{N} \cdot \text{m}^2/\text{kg}^2$