Physics 204A Equation Sheet for Final Exam

Laws, Principles, Useful Relationships, and Other Information

Definition of Velocity: $\vec{v} \equiv \frac{d\vec{r}}{dt}$ Definition of Acceleration: $\vec{a} \equiv \frac{d\vec{v}}{dt}$ Centripetal Acceleration: $a_c = \frac{v^2}{r}$

Kinematic Eq's: $v = v_o + at \quad x = x_o + v_o t + \frac{1}{2}at^2 \quad v^2 = v_o^2 + 2a(x - x_o) \quad x - x_o = \frac{1}{2}(v + v_o)t$

Newton's Second Law $\Sigma\vec{F}_{ext} = m\vec{a}_{cm}$ or $\Sigma\vec{F} = \frac{d\vec{p}}{dt}$ Mass/weight Rule $F_g = mg$

Def'n of Coef. of Friction $\mu \equiv \frac{F_{fr}}{F_n}$ Definition of Work $W \equiv \int \vec{F} \bullet d\vec{s}$ Def'n of Kinetic Energy $K \equiv \frac{1}{2}mv^2$

Work-Energy Theorem $W_{net} = \Delta K$ Definition of Power $P \equiv \frac{dW}{dt}$ Law of Cons. of Energy $\Delta K + \Delta U = W_{nc}$

Def'n of Potential Energy $\Delta U \equiv -W_c$ Gravitational P.E. $U_g = mgy$ Spring Potential Energy $U_s = \frac{1}{2}kx^2$

Def'n of Center of Mass $\vec{r}_{cm} \equiv \frac{\int \vec{r}\,dm}{M}$ Def'n of Linear Momentum $\vec{p} \equiv m\vec{v}$ Def'n of Impulse $\vec{J} \equiv \int_{t_o}^{t} \vec{F}dt$

Impulse-Momentum Theorem $\Delta\vec{p} = \vec{J}$ Def'n of Angular Velocity: $\omega \equiv \frac{d\theta}{dt}$ Def'n of Angular Acc.: $\alpha \equiv \frac{d\omega}{dt}$

Linear/Angular Relationships $s = r\theta \quad v_t = r\omega \quad a_t = r\alpha \quad a_c = \omega^2 r$ Def'n of Torque $\vec{\tau} \equiv \vec{r} \times \vec{F}$ $(\tau = F_\perp r = Fr_\perp)$

2nd Law for Rotation $\Sigma\tau = I\alpha$ or $\Sigma\vec{\tau} = \frac{d\vec{L}}{dt}$ Def'n of Rotational Inertia $I \equiv \int r^2 dm$

Rotational K.E. $K = \frac{1}{2}I\omega^2$ Angular Momentum (Rigid Body) $\vec{L} = I\vec{\omega}$ Def'n of Angular Momentum $\vec{L} \equiv \vec{r} \times \vec{p}$

Law of Gravitation $\vec{F}_g = G\frac{m_1 m_2}{r^2}\hat{r}$ Gravitational P.E. $U_g = -G\frac{Mm}{r}$ Gravitational Field $\vec{g}(r) = G\frac{M}{r^2}\hat{r}$

Definition of Density $\rho \equiv \frac{m}{V}$ Definition of Pressure $P \equiv \frac{F}{A}$ Pressure in a Static Fluid $P = \rho gh$

Archimedes' Principle $F_B = m_f g$ Equation of Continuity $A_1 v_1 = A_2 v_2$

Bernoulli's Equation $P_1 + \rho g h_1 + \frac{1}{2}\rho v_1^2 = P_2 + \rho g h_2 + \frac{1}{2}\rho v_2^2$ Hooke's Rule $\vec{F}_s = -k\vec{x}$

Eq's of Motion for SHM: $a(x) = -\omega^2 x$ $v(x) = \pm\omega\sqrt{A^2 - x^2}$

$x(t) = A\cos(\omega t + \delta)$ $v(t) = -\omega A\sin(\omega t + \delta)$ $a(t) = -\omega^2 A\cos(\omega t + \delta)$

spring $\omega = \sqrt{\frac{k}{m}}$ simple pendulum $\omega = \sqrt{\frac{g}{\ell}}$ torsional pendulum $\omega = \sqrt{\frac{\kappa}{I_p}}$ physical pendulum $\omega = \sqrt{\frac{mgr}{I_p}}$

Moments of Inertia (about the cm unless noted):

hoop: mr^2 disk: $\frac{1}{2}mr^2$ solid sphere: $\frac{2}{5}mr^2$ hollow sphere: $\frac{2}{3}mr^2$

rod: $\frac{1}{12}m\ell^2$ rod (about one end): $\frac{1}{3}m\ell^2$ plate: $\frac{1}{12}m(a^2 + b^2)$

Acceleration due to gravity $g = 9.80\ m/s^2$ Gravitational Constant $G = 6.67\text{x}10^{-11}\ \frac{N\cdot m^2}{kg^2}$

Earth - mass: 5.98×10^{24} kg radius: 6.38×10^6 m

Moon - mass: 7.36×10^{22} kg radius: 1.74×10^6 m Earth - moon distance: 3.82×10^8 m

Sun - mass: 1.99×10^{30} kg radius: 6.96×10^8 m Sun - Earth distance: 1.50×10^{11} m