Draft Formula sheet for 7 May 2009 Physics 2 midterm

Chapter 10
Dynamics of Rotational Motion

$$\tau = Fl = rF\sin(\theta) = F_{\tan} r$$

$$\vec{\tau} = \vec{r} \times \vec{F}$$

$$\sum \tau_z = I\alpha_z$$

$$K = \frac{1}{2}Mv_{cm}^2 + \frac{1}{2}I_{cm}\omega^2$$

$$v_{cm} = R\omega$$

$$\sum \vec{F}_{ext} = M\vec{a}_{cm}$$

$$\sum \tau_z = I_{cm}\alpha_z$$

$$W = \int_{\theta_1}^{\theta_2} \tau_z d\theta$$

$$W = \tau_z(\theta_2 - \theta_1)$$

$$W_{tot} = \int_{\omega_1}^{\omega_2} I\omega_z d\omega_z = \frac{1}{2}I\omega_2^2 - \frac{1}{2}I\omega_1^2$$

$$P = \tau_z\omega_z$$

$$\vec{L} = \vec{r} \times \vec{p} = \vec{r} \times m\vec{v}$$

$$\vec{L} = I\vec{\omega}$$

$$\sum \vec{\tau} = \frac{d\vec{L}}{dt}$$

Chapter 11 Equilibrium and Elasticity

Conditions for equilibrium

$$\sum \vec{F} = 0$$

$$\sum F_x = 0 \quad \sum F_y = 0 \quad \sum F_z = 0$$

$$\sum \vec{\tau} = 0$$

$$\vec{r}_{cm} = \frac{m_1\vec{r}_1 + m_2\vec{r}_2 + m_3\vec{r}_3 + \cdots}{m_1 + m_2 + m_3 + \cdots} = \frac{\sum_i m_i\vec{r}_i}{\sum_i m_i}$$

$$\frac{\text{Stress}}{\text{Strain}} = \text{Elastic modulus}$$

$$Y = \frac{\text{Tensile stress}}{\text{Tensile strain}} = \frac{F_\perp / A}{\Delta l / l_0} = \frac{F_\perp}{A}\frac{l_0}{\Delta l}$$

$$p = \frac{F_\perp}{A} \text{ (pressure in a fluid)}$$

$$B = \frac{\text{Bulk stress}}{\text{Bulk strain}} = -\frac{\Delta p}{\Delta V / V_0}$$

$$S = \frac{\text{Shear stress}}{\text{Shear strain}} = \frac{F_\parallel / A}{x / h} = \frac{F_\parallel}{A}\frac{h}{x}$$

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Chapter 12 Gravitation

$$F_g = \frac{Gm_1 m_2}{r^2}$$

Weight of a body of mass m at the earth's surface

$$w = F_g = \frac{Gm_E m}{R_E^2}$$

Acceleration due to gravity at the earth's surface

$$g = \frac{Gm_E}{R_E^2}$$

$$U = -\frac{Gm_E m}{r}$$

$$v = \sqrt{\frac{Gm_E}{r}} \quad \text{(circular orbit)}$$

$$T = \frac{2\pi r}{v} = 2\pi r\sqrt{\frac{r}{Gm_E}} = \frac{2\pi r^{3/2}}{\sqrt{Gm_E}}$$

$$R_s = \frac{2GM}{c^2} \quad \text{(Schwarzchild radius)}$$

Chapter 13 Periodic motion

$$f = \frac{1}{T} \qquad T = \frac{1}{f}$$

(relationships between frequency and period)

$$\omega = 2\pi f = \frac{2\pi}{T} \text{(angular frequency)}$$

$$F_x = -kx$$

(restoring force exerted by an ideal spring)

$$a_x = \frac{d^2x}{dt^2} = -\frac{k}{m}x \quad \text{(simple harmonic motion)}$$

$$\omega = \sqrt{\frac{k}{m}} \quad \text{(simple harmonic motion)}$$

$$f = \frac{\omega}{2\pi} = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$$

(simple harmonic motion)

$$T = \frac{1}{f} = \frac{2\pi}{\omega} = 2\pi\sqrt{\frac{m}{k}}$$

(simple harmonic motion)

$$x = A\cos(\omega t + \phi) \quad \text{(harmonic displacement)}$$

$$E = \frac{1}{2}mv_x^2 + \frac{1}{2}kx^2 = \frac{1}{2}kA^2 = \text{constant}$$

(total mechanical energy)

Angular or rotational harmonic motion

$$\omega = \sqrt{\frac{\kappa}{I}} \quad \text{and} \quad f = \frac{1}{2\pi}\sqrt{\frac{\kappa}{I}}$$

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Simple pendulum

$$\omega = \sqrt{\frac{k}{m}} = \sqrt{\frac{mg/L}{m}} = \sqrt{\frac{g}{L}}$$

$$f = \frac{\omega}{2\pi} = \frac{1}{2\pi}\sqrt{\frac{g}{L}}$$

$$T = \frac{2\pi}{\omega} = \frac{1}{f} = 2\pi\sqrt{\frac{L}{g}}$$

Physical pendulum

$$\omega = \sqrt{\frac{mgd}{I}}$$

$$T = 2\pi\sqrt{\frac{I}{mgd}}$$

Damping - small

$$x = Ae^{-(b/2m)t}\cos(\omega' t + \phi)$$

$$\omega' = \sqrt{\frac{k}{m} - \frac{b^2}{4m^2}}$$

Driven oscillator

$$A = \frac{F_{\max}}{\sqrt{\left(k - m\omega_d^2\right)^2 + b^2\omega_d^2}}$$

Chapter 14   Fluid mechanics

$$\rho = \frac{m}{V}$$ (definition of density)

$$p = \frac{dF_\perp}{dA}$$ (definition of pressure)

$$p_2 - p_1 = -\rho g\left(y_2 - y_1\right)$$

(pressure in a fluid of uniform density)

$$p = p_0 + \rho g h$$

(pressure in a fluid of uniform density)

$$A_1 v_1 = A_2 v_2$$

(continuity equation, incompressible fluid)

$$\frac{dV}{dt} = Av$$ (volume flow rate)

$$p_1 + \rho g y_1 + \frac{1}{2}\rho v_1^2 = p_2 + \rho g y_2 + \frac{1}{2}\rho v_2^2$$

Bernoulli's equation