PHY140Y Aid Sheet for Final Exam

Basic Definitions

$$F = ma = m\frac{dv}{dt} = m\frac{d^2x}{dt^2} \qquad \text{and} \qquad \tau = I\alpha = I\frac{d\omega}{dt} = I\frac{d^2\theta}{dt^2} \tag{1}$$

Force Laws

$$\vec{F} = \frac{GmM}{r^2}\hat{r} \quad \text{Law of Universal Gravitation} \tag{2}$$

$$\vec{F} = \frac{1}{4\pi\epsilon_0}\frac{q_1 q_2}{r^2}\hat{r} \quad \text{Coulomb's Law,} \tag{3}$$

Special Relativity

The Lorentz transformations that relate coordinates x, y, z and t of an event in frame S with coordinates x', y', z' and t' of the same event in a frame moving with velocity $\vec{v} = v\hat{x}$ relative to S are

$$x' = \gamma\,(x - vt) \qquad x = \gamma\,(x' + vt') \tag{4}$$

$$y' = y \quad \text{and} \quad z' = z \tag{5}$$

$$t' = \gamma\left(t - vx/c^2\right) \qquad t = \gamma\left(t' + vx'/c^2\right), \tag{6}$$

where $\gamma \equiv 1/\sqrt{1-(v/c)^2}$.

Moments of Inertia

The moment of inertia of a volume V with mass density $\rho(\vec{r})$ is

$$I \equiv \int_V r^2\,\rho(\vec{r})\,dV. \tag{7}$$

$$I = \frac{MR^2}{2} \quad \text{solid disk with axis through centre} \tag{8}$$

$$I = \frac{Ml^2}{12} \quad \text{thin rod with axis through centre } \perp \text{ to rod} \tag{9}$$

$$I = \frac{2MR^2}{5} \quad \text{uniform solid sphere with axis through centre} \tag{10}$$

Constants

$$k = 1.38 \times 10^{-23}\ \text{J/K}^\circ \qquad h = 2\pi\hbar = 6.63 \times 10^{-34}\ \text{J s} \tag{11}$$

$$G = 6.67 \times 10^{-11}\ \text{N m}^2/\text{kg}^2 \qquad c = 3.00 \times 10^{10}\ \text{cm/s} \tag{12}$$

$$a_o = 5.29 \times 10^{-11}\ \text{m} \qquad \epsilon_0 = 8.85 \times 10^{-12}\ \text{C}^2/\text{N m}^2 \tag{13}$$

Units

$$1\ \text{cal} = 4.184\ \text{J} = 4.184 \times 10^7\ \text{erg}$$
$$1\ \text{eV} = 1.602 \times 10^{-19}\ \text{J}$$
$$1\ \text{atm} = 1.013 \times 10^6\ \text{dynes/cm}^2 = 0.987\ \text{bar}$$
$$1\ \text{hp} = 746\ \text{Watts} = 746\ \text{J/s} = 7.46 \times 10^9\ \text{erg/s}$$
$$0^\circ\text{C} = 273^\circ\ \text{K}$$