Formula Sheet for LSU Physics 2113, First Exam, Fall '14

- **Constants, definitions:**

$g = 9.8\,\frac{\text{m}}{\text{s}^2}$ $\quad R_{Earth} = 6.37 \times 10^6\,\text{m}$ $\quad M_{Earth} = 5.98 \times 10^{24}\,\text{kg}$

$G = 6.67 \times 10^{-11}\,\frac{\text{m}^3}{\text{kg}\cdot\text{s}^2}$ $\quad R_{Moon} = 1.74 \times 10^6\,\text{m}$ $\quad$ Earth-Sun distance $= 1.50\times10^{11}\,\text{m}$

$M_{Sun} = 1.99 \times 10^{30}\,\text{kg}$ $\quad M_{Moon} = 7.36 \times 10^{22}\,\text{kg}$ $\quad$ Earth-Moon distance $= 3.82\times10^{8}\,\text{m}$

$\epsilon_o = 8.85 \times 10^{-12}\,\frac{\text{C}^2}{\text{Nm}^2}$ $\quad k = \frac{1}{4\pi\epsilon_o} = 8.99 \times 10^9\,\frac{\text{Nm}^2}{\text{C}^2}$ $\quad e = 1.60 \times 10^{-19}\,\text{C}$

$c = 3.00 \times 10^8\,\text{m/s}$ $\quad 1\text{ eV} = \text{e}(1\text{V}) = 1.60\times10^{-19}\,\text{J}$

dipole moment: $\vec{p} = q\vec{d}$ $\quad$ charge densities: $\lambda = \frac{Q}{L}$, $\sigma = \frac{Q}{A}$, $\rho = \frac{Q}{V}$

Area of a circle: $A = \pi r^2$ $\quad$ Area of a sphere: $A = 4\pi r^2$ $\quad$ Volume of a sphere: $V = \frac{4}{3}\pi r^3$

Area of a cylinder: $A = 2\pi r\ell$ $\quad$ Volume of a cylinder: $V = \pi r^2 \ell$

- **Units:**

Joule = J = N·m

- **Kinematics (constant acceleration):**

$v = v_o + at \qquad x - x_o = \frac{1}{2}(v_o + v)t \qquad x - x_o = v_o t + \frac{1}{2}at^2 \qquad v^2 = v_o^2 + 2a(x - x_o)$

- **Circular motion:**

$F_c = ma_c = \frac{mv^2}{r}, \quad T = \frac{2\pi r}{v}, \quad v = \omega r$

- **General (work, def. of potential energy, kinetic energy):**

$K = \frac{1}{2}mv^2 \qquad \vec{F}_{\text{net}} = m\vec{a} \qquad E_{\text{mech}} = K + U$

$W = -\Delta U$ (by field) $\quad W_{ext} = \Delta U = -W$ (if objects are initially and finally at rest)

- **Gravity:**

Newton's law: $|\vec{F}| = G\frac{m_1 m_2}{r^2}$ $\quad$ Gravitational acceleration (planet of mass M): $a_g = \frac{GM}{r^2}$

Gravitational Field: $\vec{g} = -G\frac{M}{r^2}\hat{r} = -\frac{dV_g}{dr}$ $\quad$ Gravitational potential: $V_g = -\frac{GM}{r}$

Law of periods: $T^2 = \left(\frac{4\pi^2}{GM}\right) r^3$ $\quad$ Potential Energy: $U = -G\frac{m_1 m_2}{r_{12}}$

Potential Energy of a System (more than 2 masses): $U = -\left(G\frac{m_1 m_2}{r_{12}} + G\frac{m_1 m_3}{r_{13}} + G\frac{m_2 m_3}{r_{23}} + \ldots\right)$

Gauss' law for gravity: $\oint_S \vec{g} \cdot d\vec{S} = -4\pi G M_{ins}$

- **Electrostatics:**

Coulomb's law: $|\vec{F}| = k\frac{|\,q_1\,||\,q_2\,|}{r^2}$ $\quad$ Force on a charge in an electric field: $\vec{F} = q\vec{E}$

Electric field of a point charge: $|\vec{E}| = k\frac{|\,q\,|}{r^2}$

Electric field of a dipole on axis, far away from dipole: $\vec{E} = \frac{2k\vec{p}}{z^3}$

Electric field of an infinite line charge: $|\vec{E}| = \frac{2k\lambda}{r}$

Torque on a dipole in an electric field: $\vec{\tau} = \vec{p} \times \vec{E}$

Potential energy of a dipole in $\vec{E}$ field: $U = -\vec{p} \cdot \vec{E}$