Formula Sheet for LSU Physics 2113, First Exam, Spring '15

- **Constants, definitions:**

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

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

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

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

$c = 3.00\times 10^{8}\,\mathrm{m/s}$ $\quad m_p = 1.67\times 10{-27}\,\mathrm{kg}$ $\quad 1\ \mathrm{eV} = \mathrm{e(1V)} = 1.60\times 10^{-19}\,\mathrm{J}$

dipole moment: $\vec{p} = q\vec{d}$ $\quad m_e = 9.11\times 10^{-31}\,\mathrm{kg}$ $\quad$ 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):**

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

$W = -\Delta U$ (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: $|\vec{E}| = \frac{2k\lambda}{r}$

Electric field at the center of uniformly charged arc of angle ϕ: $|\vec{E}| = \frac{\lambda\sin(\phi/2)}{2\pi\epsilon_0 R}$

Torque on a dipole in an $\vec{E}$ field: $\vec{\tau} = \vec{p}\times\vec{E}$, $\quad$ Potential energy of a dipole in $\vec{E}$ field: $U = -\vec{p}\cdot\vec{E}$