Formula Sheet for LSU Physics 2113, First Exam, Fall '16

- **Constants, definitions:**

$g = 9.8\,\frac{\text{m}}{\text{s}^2}$	$\varepsilon_o = 8.85\times10^{-12}\,\frac{\text{C}^2}{\text{Nm}^2}$	$k = \frac{1}{4\pi\varepsilon_o} = 8.99\times10^{9}\,\frac{\text{Nm}^2}{\text{C}^2}$
$G = 6.67\times10^{-11}\,\text{m}^3/(\text{kg}\cdot\text{s}^2)$	$R_{Earth} = 6.37\times10^{6}\,\text{m}$	Area of a cylinder: $A = 2\pi r\ell$
$c = 3.00\times10^{8}\,\text{m/s}$	$M_{Earth} = 5.98\times10^{24}\,\text{kg}$	Volume of a cylinder: $V = \pi r^2\ell$
$e = 1.602\times10^{-19}\,\text{C}$	$R_{Moon} = 1.74\times10^{6}\,\text{m}$	Area of a circle: $A = \pi r^2$
$1\,\text{eV} = e\,(1\text{V}) = 1.60\times10^{-19}\,\text{J}$	$M_{Moon} = 7.36\times10^{22}\,\text{kg}$	Area element: $dA = 2\pi r dr$
$m_p = 1.67\times10^{-27}\,\text{kg}$	$M_{Sun} = 1.99\times10^{30}\,\text{kg}$	Area of a sphere: $A = 4\pi r^2$
$m_e = 9.11\times10^{-31}\,\text{kg}$	Earth-Sun distance $= 1.50\times10^{11}\,\text{m}$	Volume of a sphere: $V = \frac{4}{3}\pi r^3$
dipole moment: $\vec{p} = q\vec{d}$	Earth-Moon distance $= 3.82\times10^{8}\,\text{m}$	Volume element: $dV = 4\pi r^2 dr$

Uniform charge densities: $\lambda = \frac{Q}{L}$, $\sigma = \frac{Q}{A}$, $\rho = \frac{Q}{V}$

- **Kinematics (constant acceleration):**

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

- **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):**

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

$W = -\Delta U$ (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): $a_g = \frac{GM}{r^2}$

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

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

- **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: $|\vec{E}| = k\frac{|\,q\,|}{r^2}$, $\quad$ An infinite line charge: $|\vec{E}| = \frac{2k\lambda}{r}$

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

At the center of uniformly charged arc of angle ϕ: $|\vec{E}| = \frac{\lambda\sin(\phi/2)}{2\pi\varepsilon_0 R}$

Along the line through the center of uniformly charged disk: $|\vec{E}| = \frac{\sigma}{2\varepsilon_0}\left(1 - \frac{z}{\sqrt{z^2 + R^2}}\right)$

Of an infinite non-conducting plane: $E = \frac{\sigma}{2\varepsilon_o}$

An infinite conducting plane or close to the conducting surface: $E = \frac{\sigma}{\varepsilon_o}$

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:** $U = -\vec{p}\cdot\vec{E}$

- **Electric flux:** $\Phi = \int \vec{E}\cdot d\vec{A}$
- **Gauss' law:** $\varepsilon_o \oint \vec{E}\cdot d\vec{A} = q_{enc}$