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

- **Electrostatics:**
  - General (work, def. of potential energy, kinetic energy):
  - Circular motion:
  - Units:
    - Joule = J = N·m
  - Kinematics (constant acceleration):
    - Circular motion:
      - $F_c = m \frac{v^2}{r}$, $T = \frac{2\pi r}{v}$, $v = \omega r$
  - General (work, def. of potential energy, kinetic energy):
    - $K = \frac{1}{2}mv^2$, $F_{net} = m\ddot{a}$, $E_{mech} = K + U$
    - $W = -\Delta U$ (by field) $W_{ext} = \Delta U = -W$ (if objects are initially and finally at rest)
  - Gravity:
    - Newton’s law: $|\vec{F}| = G \frac{m_1 m_2}{r^2}$
    - Gravitational Field: $\vec{g} = -G \frac{M}{r^2} \hat{r} = -\frac{dV_g}{dr}$
    - Law of periods: $T^2 = \left(\frac{4\pi^2}{GM}\right) r^3$
    - Potential Energy: $U = -G \frac{m_1 m_2}{r_{12}}$
    - Gauss’ law for gravity: $\int_S \vec{g} \cdot d\vec{S} = -4\pi GM_{ins}$
  - Electrostatics:
    - Coulomb’s law: $|\vec{F}| = k \frac{|q_1||q_2|}{r^2}$
    - 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: $\vec{E} = \frac{2k\vec{p}}{r^3}$
    - Electric field of an infinite line charge: $|\vec{E}| = \frac{2k\lambda}{z^3}$
    - Torque on a dipole in an electric field: $\vec{\tau} = \vec{p} \times \vec{E}$
    - Potential energy of a dipole in $\vec{E}$ field: $U = -\vec{p} \cdot \vec{E}$

- Constants, definitions:
  - $g = 9.8 \frac{m}{s^2}$
  - $G = 6.67 \times 10^{-11} \frac{m^3}{kg \cdot s^2}$
  - $M_{Sun} = 1.99 \times 10^{30} \text{kg}$
  - $\epsilon_0 = 8.85 \times 10^{-12} \frac{C^2}{Nm^2}$
  - $c = 3.00 \times 10^8 \frac{m}{s}$
  - Dipole moment: $\vec{p} = q\vec{d}$
  - Area of a circle: $A = \pi r^2$
  - Area of a sphere: $A = 4\pi r^2$
  - Volume of a cylinder: $V = \pi r^2\ell$

- Units:
  - 1 eV = $\frac{e(1V)}{1} = 1.60 \times 10^{-19} \text{J}$
  - Charge densities: $\lambda = \frac{Q}{L}$, $\sigma = \frac{Q}{A}$, $\rho = \frac{Q}{V}$
  - Volume of a sphere: $V = \frac{4}{3}\pi r^3$

- $M_{Earth} = 5.98 \times 10^{24} \text{kg}$
- $R_{Earth} = 6.37 \times 10^6 \text{m}$
- Earth-Sun distance = $1.50 \times 10^{11} \text{m}$
- Earth-Moon distance = $3.82 \times 10^8 \text{m}$
- $e = 1.60 \times 10^{-19} \text{C}$
- $m_p = 1.67 \times 10^{-27} \text{kg}$
- $m_e = 9.11 \times 10^{-31} \text{kg}$
- $\text{Area of a cylinder: } A = 2\pi r\ell$
- $\text{Volume of a cylinder: } V = \pi r^2\ell$

- $\text{Joule} = J = \text{N} \cdot \text{m}$

- $\text{Energy of a dipole in } \vec{E} = k \frac{|q_1||q_2|}{r^2}$
- $\text{Force on a charge in an electric field: } \vec{F} = q\vec{E}$
- $\text{Electric field of a point charge: } |\vec{E}| = k \frac{|q|}{r^2}$
- $\text{Electric field of a dipole on axis, far away from dipole: } \vec{E} = \frac{2k\vec{p}}{r^3}$
- $\text{Electric field of an infinite line charge: } |\vec{E}| = \frac{2k\lambda}{z^3}$
- $\text{Torque on a dipole in an electric field: } \vec{\tau} = \vec{p} \times \vec{E}$
- $\text{Potential energy of a dipole in } \vec{E} \text{ field: } U = -\vec{p} \cdot \vec{E}$