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

- Constants, definitions:
  \[ g = 9.8 \text{ m/s}^2 \]
  \[ R_{\text{Earth}} = 6.37 \times 10^6 \text{ m} \]
  \[ M_{\text{Earth}} = 5.98 \times 10^{24} \text{ kg} \]
  \[ G = 6.67 \times 10^{-11} \text{ m}^3 \text{kg}^{-1} \text{s}^{-2} \]
  \[ R_{\text{Moon}} = 1.74 \times 10^6 \text{ m} \]
  \[ M_{\text{Moon}} = 7.36 \times 10^{22} \text{ kg} \]
  \[ \varepsilon_0 = 8.85 \times 10^{-12} \text{ C}^2 \text{Nm}^{-2} \]
  \[ k = \frac{1}{4\pi\varepsilon_0} = 8.99 \times 10^9 \text{ Nm}^2 \text{C}^{-2} \]
  \[ \epsilon_0 = 8.85 \times 10^{-12} \text{ C}^2 \text{Nm}^{-2} \]
  \[ c = 3.00 \times 10^8 \text{ m/s} \]
  \[ e = 1.60 \times 10^{-19} \text{ C} \]
  \[ 1 \text{ eV} = e(1\text{V}) = 1.60 \times 10^{-19} \text{ J} \]
  \[ \text{dipole moment: } \vec{p} = q\vec{d} \]
  \[ \text{charge densities: } \lambda = \frac{Q}{L}, \sigma = \frac{Q}{A}, \rho = \frac{Q}{V} \]

- Area of a circle: \[ A = \pi r^2 \]
- Area of a sphere: \[ A = 4\pi r^2 \]
- Volume of a sphere: \[ V = \frac{4}{3}\pi r^3 \]
- Area of a cylinder: \[ A = 2\pi r\ell \]
- Volume of a cylinder: \[ V = \pi r^2\ell \]

- Units:
  \[ \text{Joule} = J = \text{N} \cdot \text{m} \]

- Kinematics (constant acceleration):
  \[ v = v_0 + at \]
  \[ x - x_0 = \frac{1}{2}(v_0 + v)t \]
  \[ x - x_0 = v_0t + \frac{1}{2}at^2 \]
  \[ v^2 = v_0^2 + 2a(x - x_0) \]

- 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):
  \[ K = \frac{1}{2}mv^2 \]
  \[ \vec{F}_{\text{net}} = m\vec{a} \]
  \[ E_{\text{mech}} = K + U \]
  \[ W = -\Delta U \text{ (by field)} \]
  \[ W_{\text{ext}} = \Delta U = -W \text{ (if objects are initially and finally at rest)} \]

- Gravity:
  Newton’s law: \[ |\vec{F}| = G\frac{m_1m_2}{r^2} \]
  Gravitational Field: \[ \vec{g} = -GM \frac{\vec{r}}{r^2} \]
  Gravitational acceleration (planet of mass \( M \)): \[ a_g = \frac{GM}{r^2} \]
  Law of periods: \[ T^2 = \left(\frac{4\pi^2}{GM}\right)r^3 \]
  Potential Energy: \[ U = -G\frac{m_1m_2}{r_1} + G\frac{m_1m_3}{r_2} + G\frac{m_2m_3}{r_3} + ... \]
  Gauss’ law for gravity: \[ \int_S \vec{g} \cdot d\vec{S} = -4\pi GM_{\text{ins}} \]

- Electrostatics:
  Coulomb’s law: \[ |\vec{F}| = k\frac{|q_1||q_2|}{r^2} \]
  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: \[ U = -\vec{p} \cdot \vec{E} \]