

# Physics 2321. Review for Exam I.

## 1. Chapter 23. Electric Potential.

- Electric Potential Energy.
  - Relative  $\Delta U = -W$
  - Absolute  $U = -W_\infty$
  - Units: J
- Electric Potential,  $V$ .
  - Relative  $\Delta V = -\frac{W}{q}$
  - Absolute  $V = -\frac{W_\infty}{q}$
  - Units: J/C or N·m/C
- Finding Potential from  $\vec{E}$ .
  - $\Delta V = V_f - V_i = - \int_i^f \vec{E} \cdot d\vec{s}$
- Finding  $\vec{E}$  from Potential.
  - $E_x = -\frac{\partial V}{\partial x}$ ;  $E_y = -\frac{\partial V}{\partial y}$ ;  $E_z = -\frac{\partial V}{\partial z}$
  - When  $\vec{E}$  is uniform,  $E = -\frac{\Delta V}{\Delta s}$
  - Examples: Example 23-12 and Prob. 51.
- Potential Due to Point Charges
  - $V = \frac{1}{4\pi\epsilon_0} \sum_{i=1}^n \frac{q_i}{r_i}$
  - Examples: Ch. 23 Prob 28.
- Potential Energy of an arrangement of Point Charges
  - $U_E = k \sum_{i=1, j>i}^n \frac{q_i q_j}{r_{ij}}$
  - Examples: Ch. 23 Test Bank 2.

## 2. Chapter 21. Electric Charge.

- Unit: Coulomb
- Unit: C/s=1 Amp (for current, I)
- Charges come in discrete pieces; electrons, protons.
- Coulomb's Law:  $F = \frac{1}{4\pi\epsilon_0} \frac{|q_1||q_2|}{r^2}$
- Shell theorems.

## 3. Chapter 21. Electric Fields.

- Definition:  $\vec{E} = \frac{\vec{F}}{q_0}$
- Rules of Electric field lines.
- Field due to point charge:  $\vec{E} = \frac{1}{4\pi\epsilon_0} \frac{|q|}{r^2}$
- Field above or below a Electric Dipole:  $E = \frac{1}{2\pi\epsilon_0} \frac{p}{z^3}$  [SKIP]
  - Dipole moment:  $\vec{p} = q\vec{a}$
  - Torque on Dipole:  $\vec{\tau} = \vec{p} \times \vec{E}$
- Field Due to Continuous Charge Distributions.
  - Line charge,  $\lambda$  C/m.
  - Surface charge,  $\sigma$  C/m<sup>2</sup>.
  - Volume charge,  $\rho$  C/m<sup>3</sup>.
  - Find  $dq = \lambda ds$  or  $\sigma dA$  or  $\rho dV$
  - Find  $dE$
  - Integrate  $E = \int_{allcharge} dE$

## 4. Chapter 22. Gauss' Law.

- $\oint \vec{E} \cdot d\vec{A} = \frac{q_{enc}}{\epsilon_0}$
- A Gaussian surface should be chosen to be parallel and/or perpendicular to the E-field. (But any surface obeys Gauss' Law.)
- Examples of E-fields we derived:
  - Near a uniformly charged sheet/plane:  $E = \frac{\sigma}{2\epsilon_0}$
  - Near a conducting plate with  $\sigma$  the charge density on *one* side:  $E = \frac{\sigma}{\epsilon_0}$
  - Electric field outside spherical shell of total charge q:  $E = \frac{1}{4\pi\epsilon_0} \frac{q}{r^2}$
  - Electric field near a line of charge:  $E = \frac{\lambda}{2\pi\epsilon_0 r}$