PHY 2323 Cheat Sheet

1 Chapter 1, 2: Math Review

1.1 Coordinate Systems

2 Chapter 3: Electrostatics

2.1 Coulombs Law

$$\vec{E}(\vec{r}) = \frac{1}{4\pi\epsilon_0}\int_S \frac{\rho(\vec{r\prime})(\vec{r}-\vec{r\prime})}{|\vec{r}-\vec{r\prime}|^3}\mathrm{d}l$$

This can also be extended to a surface with ds and 2 integrals, or volume with dv

2.2 Gausses Law

Gausses Law can be used on a **closed surface** where we make a guassian surface (such as a sphere) at the point of interest.

$$\int_S \vec{E}\mathrm{d}\vec{s} = \frac{Q_{enc}}{\epsilon}$$

We also have the $\vec{D}$ field which is the *Electric Flux Density*.

$$\int_S \vec{D}\mathrm{d}\vec{s} = Q_{enc}$$

Finally, we have the flux ψ, a scalar.

$$\psi = \epsilon\int_s \vec{E}\mathrm{d}\vec{s} = \int \vec{D}\mathrm{d}\vec{s}$$

This is useful in 3 main cases.

1. Spherical Symmetry is present
2. Cylindrical symmetry is present (long line of charge with uniform ρ or cylander with no angular dependance)
3. Planar Symmetry (Long 2D surface of charge)

2.3 Electric Potential

This is the potential energy per unit charge. AKA the voltage. This is a **scalar field**. This is *independant of the path chosen*.

$$V(\vec{r}) = \frac{1}{4\pi\epsilon_0}\int_{l\prime}\frac{\rho_l \mathrm{d}l\prime}{|\vec{r}-\vec{r}\prime|}$$

This can be extended into 2d or 3d space by changing the $l\prime$ and $\mathrm{d}l\prime$ for $s\prime, \mathrm{d}s\prime$ or $v\prime, \mathrm{d}v\prime$.

Then we can say also at a higher level that:

$$\vec{E} = -\nabla V \qquad \nabla V = -\int \vec{E}\cdot \mathrm{d}\vec{l}$$

2.4 Electric Dipole

A **dipole** is a pair of equal and opposite charges that are very close to each other relative to the point of observation.

This means that at the point of observation, they seem as one charge.

2.5 Materials in Electric Fields

There are 3 types of materials:

1. Conductors
2. Insulators
3. Semiconductors

If we have 2 electric fields between 2 dielectric (insulators) surfaces, we have the following formulas for the D and E fields.