PHYS 4 Exam 5 Cheat Sheet (with LaTeX)

Angular Kinematics

$$\theta = \frac{S}{r}; \omega = \frac{d\theta}{dt}; \alpha = \frac{d^2\theta}{dt^2}; (1)\ \omega(t) = \omega_0 + \alpha t$$
$$(2)\ \theta = \theta_0 + \omega_0 t + \frac{1}{2}\alpha t^2; (3)\ \omega^2 = \omega_0^2 + 2\alpha\Delta\theta$$
$$v_t = \omega r; a_t = \alpha r; a_c = \omega r^2; T = \frac{2\pi}{\omega}$$

Electric Fields and Forces

$$e = 1.602 \times 10^{-19}\mathrm{C}; \varepsilon_0 = 8.85 \times 10^{-12}\frac{\mathrm{C}^2}{\mathrm{Nm}^2}$$
$$k = 8.99 \times 10^9 \frac{\mathrm{Nm}^2}{\mathrm{C}^2} = \frac{1}{4\pi\epsilon_0}$$
$$\vec{F} = \frac{kq_1q_2}{r^2}\hat{r} = \frac{kq_1q_2}{r^3}\vec{r}; \vec{E} = \frac{kq}{r^2}\hat{r} = \frac{kq}{r^3}\vec{r}; F = qE$$

In a diagram, the direction of an electric field is represented by the direction of its arrows, while the strength of the field is represented by the proxmity of the lines.

$$\lambda = \frac{Q}{r}; \sigma = \frac{Q}{A}; \rho = \frac{Q}{V}$$
$$E = \int dE = \int \frac{k\ dq}{r^3}\vec{r} = \int \frac{k\lambda}{r^3}\vec{r}dr$$
$$\vec{E}_{ring}(z) = \frac{kqz}{(z^2 + R^2)^{3/2}}\hat{k}$$

For a rod of length L, measured at a distance d from the close end from the rod of charge Q.

$$\vec{E}_{rod;axis}(d) = -\frac{kQ}{d(d-L)}\hat{i}$$

For a rod of length L, measured perpendicular to the rod at a distance d from the close end from the rod of charge Q.

$$\vec{E} = k\lambda\left[\frac{1}{z} - \frac{1}{L^2 + z^2}\right]\hat{i} + \frac{k\lambda L}{z\sqrt{L^2 + z^2}}\hat{j}$$

$$\vec{E}_{arc} = \frac{k\lambda}{r}\begin{pmatrix} 2\sin(\frac{\theta}{2}) \\ 0 \end{pmatrix}$$
$$\vec{E}_{disc} = \frac{\sigma}{2\epsilon_0}\left(1 - \frac{z}{\sqrt{z^2 + R^2}}\right)$$

Gauss' Law

$$\Phi = \frac{q_{enc}}{\varepsilon_0}; \Phi = \oint \vec{E} \cdot d\vec{A}$$

A must be a Gaussian surface. If $\vec{E}$ is constant on the surface, it can be simplified to $\Phi = E * A$. Conductors in an electric field have $\vec{E} = 0$ inside. Electrons move to ensure this. Inside, $\Phi = 0$.

Electrical Potential Difference

Path independent. For $\vec{E}(x, y, z)$:

$$\Delta V = \frac{\Delta U}{q} = -\int_i^f \vec{E} \cdot d\vec{x} = \int_i^f dV$$

Electric field lines go from more positive to more negative voltage.

Equipotential surface (ES): Surface with same V.

$$V = \frac{kq}{r}$$

Electric Dipoles

$$\begin{aligned}\vec{E} &= \begin{cases} < 0 \text{ if } -\frac{d}{2} < z < \frac{d}{2} \\ > 0 \text{ otherwise} \end{cases} \\ &= \frac{2kQd}{z^3\left(1 - \frac{d^2}{4z^2}\right)^2}\hat{d}\end{aligned}$$

In an electric field:

$$\vec{p} = Q\vec{d}$$
$$\vec{\tau} = \vec{p} \times \vec{E}$$
$$U = -\vec{p} \cdot \vec{E}$$

ESs are $\perp$ to $\vec{p}$.

Current

$$I = \frac{dq}{dt}$$