Review for exam II

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Muddiest points:

1.) can't read text boxes on wiki:
web page will ask if you want to open with a different view. Do that.

2.) Make sure you can do Gauss's and Ampere's law problems from PH200.
Go to you old text book and look at examples of these types of problems.

3.) Why are Ampere's (Stokes theorem) and Gauss's (divergence theorem) laws useful?

They give you a easy way to understand these theorems.

4.) Why does curl E determine electrostatics (isn't it no time dependence)?

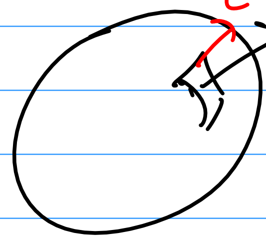
$$\vec{\nabla} \times \vec{E} = \vec{\nabla} \times \frac{1}{4\pi\epsilon_0} \int \frac{dQ}{r^2}\hat{r} = 0$$

5.) When do unit vectors have to be in cartesian coordinates?

$$\vec{E} = \int \frac{k\,dQ}{r^2}\hat{r} \rightarrow \int \frac{dx'dy'}{\quad}\hat{x} + \underline{\quad}\,\hat{y} + $$

$$\frac{dr'd\theta'}{\quad}\hat{r} + \underline{\quad}\,\hat{\theta} +$$

$$\int \vec{E}\cdot d\vec{a}$$



$\vec{E} = E_0\hat{r}$

$d\vec{a} = r^2 \sin\theta\, d\theta\, d\phi\, \hat{r}$

In calculating a vector such as E the cartesian unit vectors come outside the integral.
In integrating over scalar quantities such as flux it is often best to keep unit vectors which show the symmetry of the problem.

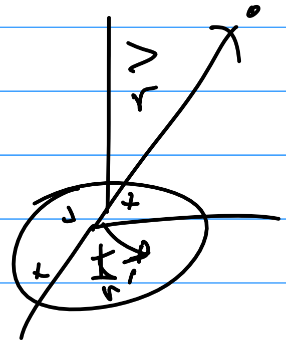
Triangle diagrams: electrostatics

$$\begin{tikzcd}
 & Q \arrow[dl, "V=\int \frac{k\,dQ}{r}"'] \arrow[dr, "\vec E = \int \frac{k\,dQ}{r^2}\hat r"] & \\
V \arrow[rr, bend left, "\vec E = -\vec\nabla V"] & & \vec E \arrow[ll, "\Delta V = -\int \vec E\cdot d\vec r"]
\end{tikzcd}$$

Gauss law $\oint \vec E\cdot d\vec a = \int \frac{\rho\, d\text{Volume}}{\epsilon_0}$

$\vec F = q\vec E$

ex: find V from charge on a disk



differential form

Coul/m^3

$$\oint \vec E\cdot d\vec a = \int \frac{\rho\, d\text{vol}}{\epsilon_0}$$

$$\|$$

$$\int \vec\nabla\cdot\vec E\, d\text{vol} = \int \rho\frac{d\text{vol}}{\epsilon_0}$$

in surface

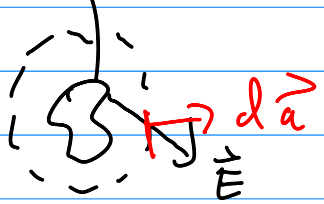
$$\boxed{\vec\nabla\cdot\vec E = \rho/\epsilon_0}$$

Similar to conservation of charge

$$\vec\nabla\cdot\vec J = -\frac{\partial\rho}{\partial t}$$

$\vec J = \rho\vec v$

Gauss's law not useful here



Gauss's law give a good approx to E way out here

$$\vec E \simeq \frac{kQ}{r^2}\hat r$$

$$\underbrace{\rho\, dv\, \vec{v}}_{\vec{J}} \times B = \vec{J} \times \vec{B}\, dv$$

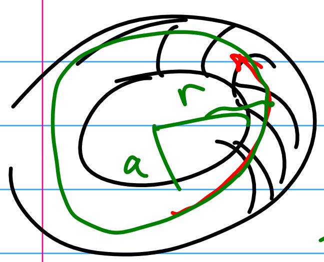
$$\vec{F} = q\vec{v} \times \vec{B}$$

$$\underbrace{\sigma\, da\, \vec{v}}_{\vec{K}} \times B = \int \vec{K} \times \vec{B}\, da$$

$$\vec{J} \longrightarrow \vec{B}$$

Ampere's law $\oint \vec{B}\cdot d\vec{r} = \mu_0 \int \vec{J}\cdot d\vec{a}$

Biot Savart $\vec{B} = \frac{\mu_0}{4\pi}\int \frac{\vec{J}\times\hat{r}}{r^2}$

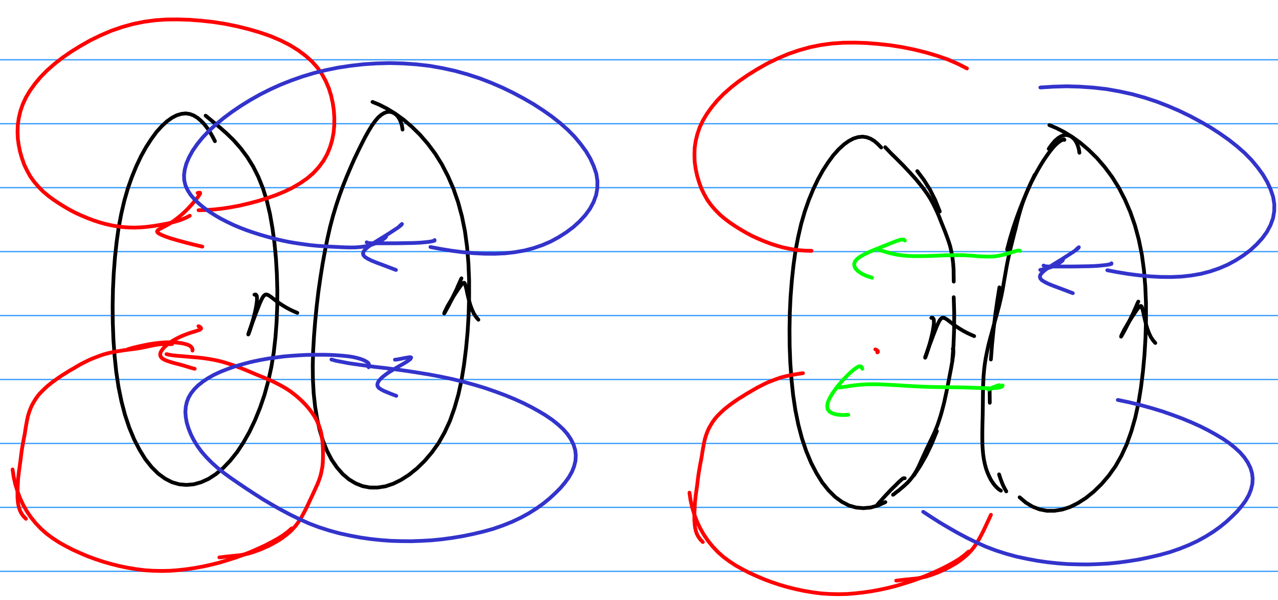


$$\oint \vec{B}\cdot d\vec{r} = \oint |\vec{B}||d\vec{r}| \cos\phi = B \overbrace{\oint dr}^{2\pi r} = B\, 2\pi r$$

$$= \mu_0 I_{enc} = \mu_0\, \underbrace{n}_{\text{turns/length}}\, 2\pi a\, \underbrace{I_0}_{\text{current wire}}$$

Examples:

-Helmholtz coils



$$q\vec{v}\times\vec{B} + q\vec{E} = m\vec{a}$$

-charges in space