week 8:

1. microteaching : Divergence Theorem $\longrightarrow$ 2. Gauss' Law

3. STokes' Theorem $\longrightarrow$ 4. Ampere's Law

5. HW 8

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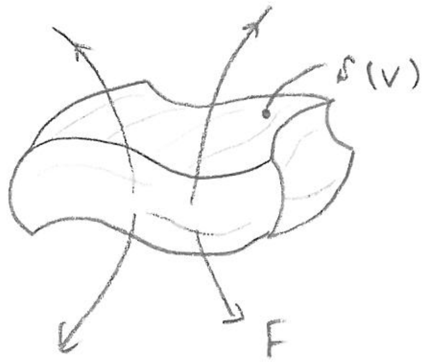
1. Divergence Theorem

Surface Integral $\longrightarrow$ Volume Integral

$$\oint_S \vec{F} \cdot d\vec{s} = \int_V (\vec{\nabla} \cdot \vec{F})\, dV$$



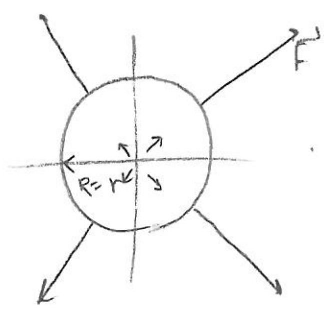
2. Gauss Law:

$$\oint_S \vec{E}\, d\vec{s} = \frac{1}{\varepsilon_0} \int_V \rho\, dV$$

$$= \int_V (\vec{\nabla} \cdot \vec{E})\, dV$$

$$\vec{\nabla} \cdot \vec{E} = \frac{1}{\varepsilon_0} \cdot \rho$$

Task: $\vec{F} = \langle x, y, z \rangle$; over sphere of $r = R$



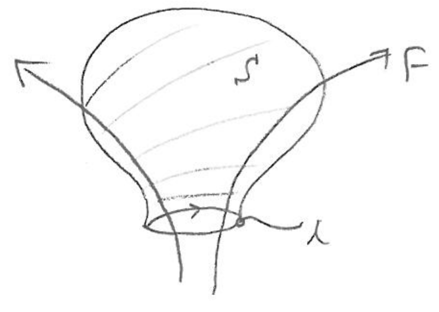
$$\int_S \vec{F} \cdot d\vec{s} = |F| \cdot 4\pi R^2 = \sqrt{x^2+y^2+z^2} \cdot 4\pi R^2 = 4\pi R^3$$

$$\int_V (\vec{\nabla} \cdot \vec{F})\, dV = 3 \cdot \int_V dV = 3 \cdot \frac{4}{3}\pi R^3 = 4\pi R^3$$

3. Stokes Theorem :

Line Integral $\longrightarrow$ Surface Integral

$$\oint_L \vec{F}\cdot d\vec{r} = \int_S (\vec{\nabla}\times\vec{F})\cdot d\vec{s}$$

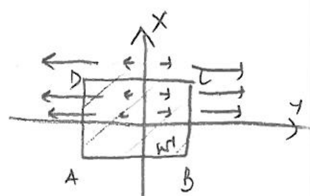


4. Ampere's Law : $\oint \vec{B}\cdot d\vec{l} = \mu_0 \int_S \vec{J}\cdot d\vec{s}$

$$= \int_S (\vec{\nabla}\times\vec{B})\cdot d\vec{s}$$

$$\vec{\nabla}\times\vec{B} = \mu_0 \vec{J}$$

Task : $\vec{F} = \langle 0, X, 0 \rangle$; l : circle of square '$2R$'



$$\oint_L \vec{F}\cdot d\vec{r} = \int_A^B \vec{F}_y\cdot d\vec{y} + \int_C^D \vec{F}_y\cdot d\vec{y} = \left[X\cdot\int dy\right] = \begin{array}{l} +R^2+R^2 \\ -(-R^2-R^2) \end{array} = 4R^2$$

$\odot\, d_s$

$$\int_S (\vec{\nabla}\times\vec{F})\cdot ds = \int_{4R^2} \langle 0, 0, 1\rangle\cdot ds = 4R^2$$

$\odot$ out $\qquad \otimes$ in

Use Ampere Right hand Law $\otimes$ $\odot$ while Choosing Surface

Vector - Identities:

$$\nabla \times (\nabla \Phi) = 0$$

(gradients are curl free)
$\because$ non zero growth along one axis)

$$\nabla \cdot (\vec{\nabla} \times \vec{A}) = 0$$

(Curls are divergence free

$\because$ Curl conserves magnitude
$\Rightarrow$ no sink or source $\therefore$
divergence free)

5. HW 8

1. define $t_0 = \frac{L_0}{v}$

Time taken for these signals to reach spacecraft $= t_0 + \frac{L_0}{c}$

$$= t_0 + \frac{v}{c} t_0$$

$$= t_0(1+\beta)$$

Going away: $\# N_L = f_0 \sqrt{\frac{1-\beta}{1+\beta}} \cdot T = f_0 t_0 (1+\beta) \sqrt{\frac{1-\beta}{1+\beta}}$

Coming back: $\# N_H = f_0 \sqrt{\frac{1+\beta}{1-\beta}} \, T = \, ?$

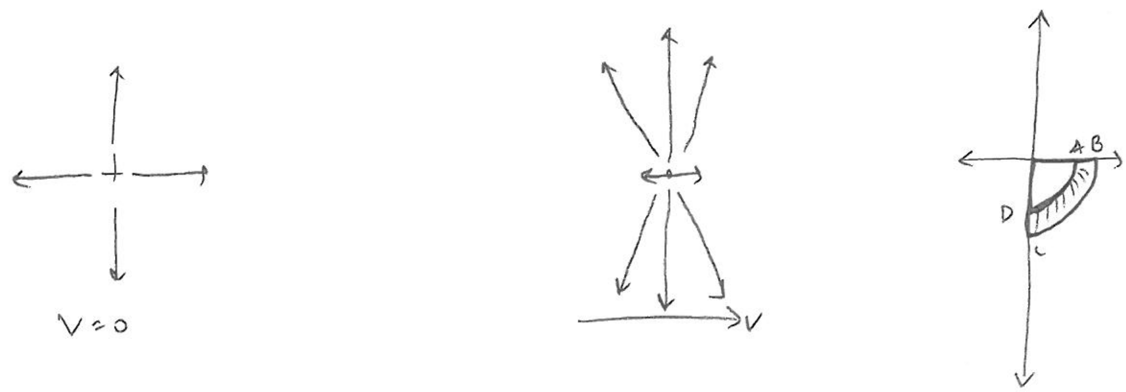
2. Let momentum be $dP = F dt \Rightarrow P = F t_0$

$$P = \gamma m v$$

$$\vdots$$

Try to express everything in terms of $\frac{v}{c}$

3. a.

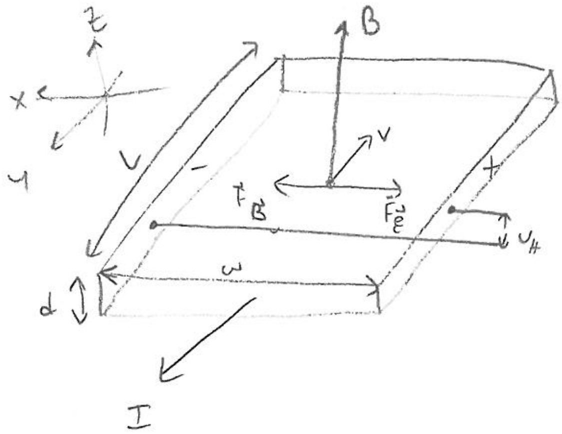


b. If conserved: $\oint \vec{E} \cdot d\ell = 0$

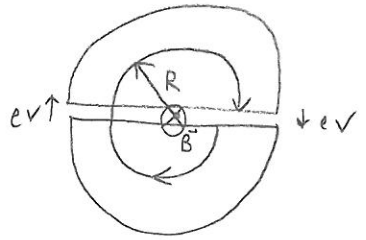
c. $\vec{B} = \frac{1}{c^2}(\vec{V} \times \vec{E})$

let V be in 'z' direction 'θ' to $\vec{E}_r$

4. $\vec{F} = ((\vec{V} \times \vec{B}) + \vec{E})q \quad \ldots$



5.



$\Rightarrow \Delta E = 2eV$ in each N =)

a. Balance forces : $\frac{mv^2}{R} = qBv$; Calc for $R = d/2$

b. $f = \frac{1}{t} = \frac{v}{R} = ?$

c. $\# N = \frac{\frac{1}{2}mv^2}{2eV} = ?$ as $\Delta E = 2eV$