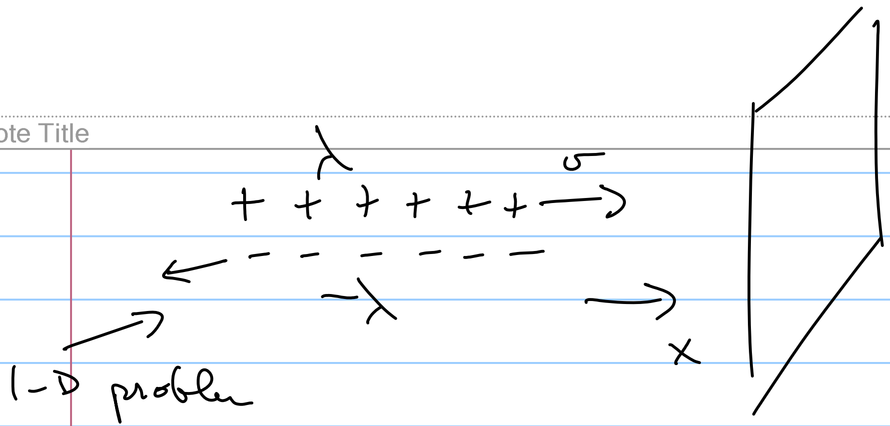
Note Title 3/20/2009



current through plane ?

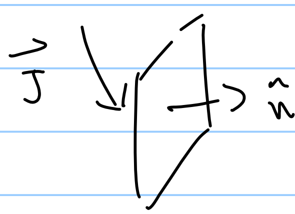
$$I \equiv \frac{dQ}{dt} = \int \vec{J} \cdot d\vec{a} \qquad \frac{\text{Coul}}{s}\,\frac{1}{m^2} \text{ or } \frac{\text{Amps}}{m^2}$$

$$\text{Given } \vec{J} = \rho \vec{v} \qquad \frac{\text{Coul}}{m^3}\,\frac{m}{s}$$

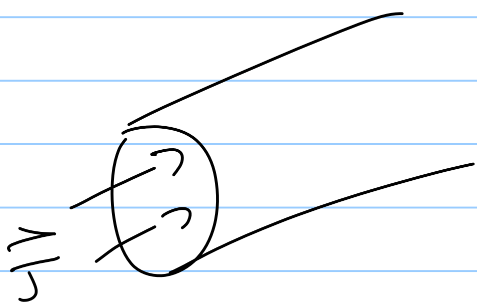
$\vec{J} = \rho \vec{v}$ in 3-D

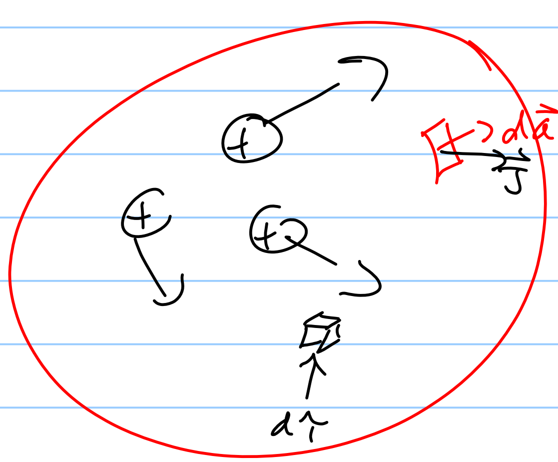
$\vec{K} = \sigma \vec{v}$ 2-D

$\vec{I} = \lambda \vec{v}$ 1-D



$$\vec{I} = \lambda \vec{v}_+ - \lambda \vec{v}_- = \lambda v \hat{x} - \lambda v(-\hat{x}) = 2\lambda v \hat{x}$$





$$\vec{J} = \rho \vec{v}$$

$$\underbrace{\oint \vec{J} \cdot d\vec{a}}_{\text{current}} = \int \vec{\nabla} \cdot \vec{J}\, d\tau \qquad \frac{\text{Coul}}{s}$$

$$\oint \vec{J}\cdot d\vec{a} = -\frac{d}{dt} Q_{enclosed} = -\frac{d}{dt}\int \rho \, d\tau$$

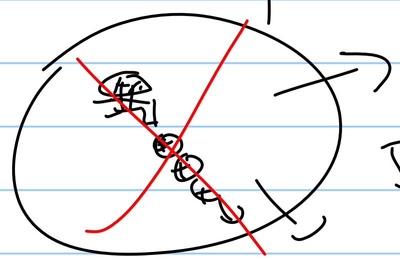
Coul/s

$$\int \vec{\nabla}\cdot\vec{J}\, d\tau = \int -\frac{\partial \rho}{\partial t}\, d\tau$$

1st order PDE

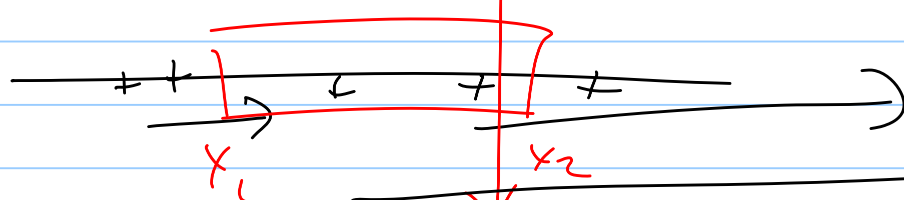
$$\boxed{\vec{\nabla}\cdot\vec{J} = -\frac{\partial \rho}{\partial t}} \; \cancel{+ A_{\text{source}}}$$

Cons of charge



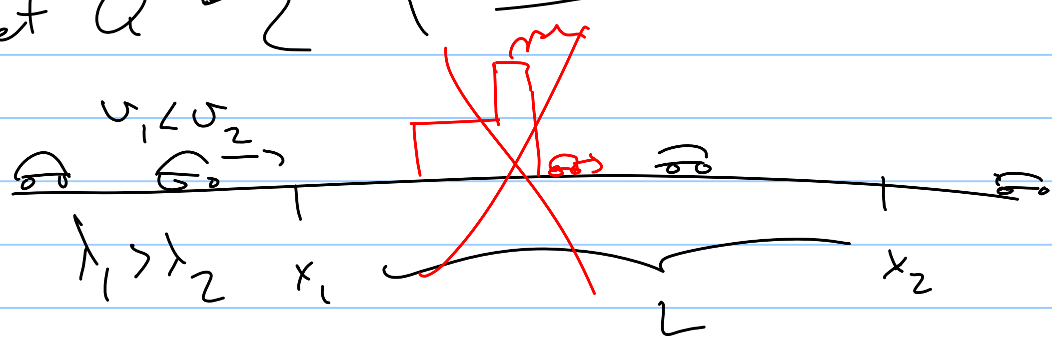
$$\frac{\partial}{\partial x}\underbrace{\lambda v}_{J_x} = -\frac{\partial \lambda}{\partial t}$$

$$\int \frac{\partial}{\partial x}(\lambda v)\, dx = -\int \frac{\partial \lambda}{\partial t}\, dx$$



$$\boxed{\lambda v \Big|_{x_1}^{x_2} = -\frac{\partial}{\partial t}\underbrace{\int_{x_1}^{x_2} \lambda \, dx}_{\text{charge enclosed}}}$$

Tablet Q #2



steady state $\frac{\partial}{\partial t} \to 0$ $\lambda_1 v_1 - \lambda_2 v_2 = 0$

$$\lambda_1 = \frac{\lambda_2 v_2}{v_1}$$

$\vec{J} = \rho \vec{v}$

$$\vec{J} \propto \psi \, v \, \psi \to \psi \psi k \qquad \psi = e^{i(kx - \omega t)}$$

$k = \frac{mv}{\hbar}$

$\rho \propto \psi^* \psi \qquad p = mv = \hbar k \qquad \frac{\partial}{\partial x} e^{i(kx - \omega t)}$

$\underbrace{\psi \psi^*}_{\rho} v \to \rho v$