Giridhar Kumar

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SEM-IV Unit-1 paper-06

CLASSMATE
Date :
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→ Equation of Continuity (Charge Conservation).

* **Fundamental Idea.**

→ Nature never creates or destroys electric charge.
→ If charge decreases inside a volume → It must flow outside.

* **Mathematical Derivation**

Consider a volume V enclosed by surface S. Total charge inside.

$$Q = \int_V \rho \, dv$$

Rate of decrease of charge

$$\frac{dQ}{dt} = \frac{d}{dt} \int_V \rho \, dv$$

Current flowing out of surface

$$I = \oint_S \vec{J} \cdot d\vec{S}$$

By conservation.

$$\frac{d}{dt} \int_V \rho \, dv = - \oint_S \vec{J} \cdot d\vec{S}$$

Using Divergence theorem.

$$\int_V \left\{ \left(\frac{\delta \rho}{\delta t} \right) + \nabla \cdot \vec{J} \right\} dv = 0$$

∵ Volume is arbitary

$$\therefore \quad \nabla \cdot \vec{J} + \frac{\delta \rho}{\delta t} = 0$$