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③ opthamologist → retina → attachment (Stapler heat)
④ Burn fat & → cordiologist Block
⑤ Cancer → kill infrared

———— x ————

Laser & FD	9m	cm
20	200 mks	10mM

ED

ELECTRODYNAMICS

(1) Differential form — Integral form

(1) $\vec{\nabla}\cdot\vec{E} = \frac{\rho}{\varepsilon_0}$ — $\oint \vec{E}\cdot\vec{da} = \frac{q}{\varepsilon_0}$

$\vec{da}$ ↓ area element

(2) $\vec{\nabla}\times\vec{E} = 0$ — $\oint \vec{E}\cdot\vec{dl} = 0$

$\vec{\nabla}\times\vec{E} = -\frac{\partial B}{\partial t}$ — $\oint \vec{E}\cdot\vec{dl} = -\frac{\partial(\phi_B)}{\partial t}$

(3) $\vec{\nabla}\cdot\vec{B} = 0$ — $\oint \vec{B}\cdot\vec{da} = 0$

(4) $\vec{\nabla}\times\vec{B} = \mu_0 J$ — $\oint \vec{B}\cdot\vec{dl} = \mu_0 I_{enclosed}$

$\vec{\nabla}\times\vec{B} = \mu_0 J + \mu_0\varepsilon_0\frac{\partial E}{\partial t}$ — $\oint \vec{E}\cdot dl = \mu_0 I + \frac{1}{c^2}\int\frac{\partial E}{\partial t}d_a$

$dF = \frac{dF}{dx} dx$

$T(x, y, z)$ $\quad dT = \frac{\partial T}{\partial x} dx + \frac{\partial T}{\partial y} dy + \frac{\partial T}{\partial z} dz$

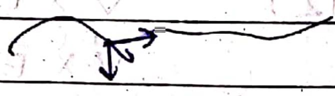
$= \left(\frac{\partial T}{\partial x} i + \frac{\partial T}{\partial y} j + \frac{\partial T}{\partial z} k\right) \left(dx\, i + dy\, j + dz\, k\right)$

$dT = \nabla T \cdot dl$ → line element

① $\nabla \rightarrow$ Del → $\left(i \frac{\partial}{\partial x} + j \frac{\partial}{\partial y} + k \frac{\partial}{\partial z}\right)$

$\Delta \Rightarrow$ operator → does not simplify multiply
→ ordering to differentiate

② Max^m value $(\theta = 0)$



to differential along line element

① $\Delta T = 0 \longrightarrow$ at max^m / minima

operator → on → [scalar qty]

① ∇T = "Gradient" ← called result (vector)

② $\nabla \cdot v$ = "Divergence" resulted into scalar
vector via dot product.

Eg: $\left(i \frac{\partial}{\partial x} + j \frac{\partial}{\partial y} + k \frac{\partial}{\partial z}\right) \cdot (i V_x + j V_y + k V_z)$

	∇ (·)		∇ (×)
operated on	Scalar	vector	(vector)
Result	vector	Scalar	(vector)

$$= \frac{\partial V_x}{\partial x} + \frac{\partial V_y}{\partial y} + \frac{\partial V_z}{\partial z} \Big\} \text{ Scalar qty}$$

③ $\nabla \times v \longrightarrow$ "curl" result into vector

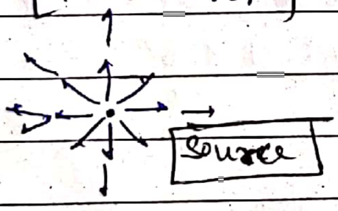
Operator · vector via cross product

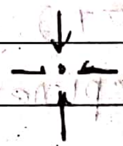
$$\begin{vmatrix} i & j & k \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ V_x & V_y & V_z \end{vmatrix}$$

असल में है क्या ?

① Divergence = How the fx is spreading out in space (Vectorial 3D effect)

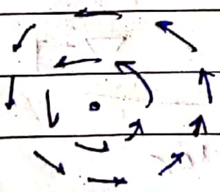
[+ve vector] [vector negative]





sink

② Curl = How the vector is squirreling about a point (Planner effect)



Gradient

$$\nabla(\underbrace{\nabla T}_{\text{vector}})$$

Not possible

(A) Divergence of a Gradient

$$\nabla\cdot(\nabla T) = \nabla^2 T$$ {Laplacian operator}

$$\left(i\frac{\partial}{\partial x} + j\frac{\partial}{\partial y} + k\frac{\partial}{\partial z}\right)\cdot\left(i\frac{\partial T}{\partial x} + j\frac{\partial T}{\partial y} + k\frac{\partial T}{\partial x}\right)$$

$$= \frac{\partial^2 T}{\partial x^2} + \frac{\partial^2 T}{\partial y^2} + \frac{\partial^2 T}{\partial z^2}$$

(2) Curl of a Gradient

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

(planar)

(3) Gradient of Divergence

$$\underbrace{\nabla(\nabla\cdot v)}_{\text{Vector}} \neq \underbrace{\nabla\cdot(\nabla T)}_{\text{Scalar}} = \nabla^2 T$$

[Electrodynamics by Griffith]

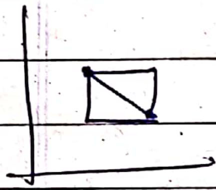
Curl

① $\nabla \cdot (\nabla \times v) = 0$

② $\nabla \times (\nabla \times v) = \nabla(\nabla \cdot v) - (\nabla \cdot \nabla) v$

$= \nabla(\nabla \cdot v) - \nabla^2 (v)$

ordinary integral $\int_a^b dF\,dx \neq F(b) - F(a)$ depends on path.



$\oint F \cdot dl \neq 0$ } Non-conservative

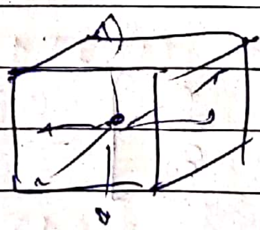
(A) depends on initial & final points & Not path dependent

$\int_a^b \nabla T \cdot dl = T(b) - T(a)$

(ii) $\oint \nabla T \cdot dl = 0$

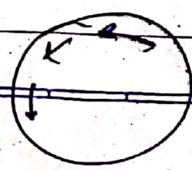
*** [V. Imp] $\int (\nabla \cdot v)\, d\tau = \oint v \cdot da$

Greens theorem / Gauss theorem



** $\int (\nabla \times v)\, da = \oint v \cdot dl$

[Stokes theorem]



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$$\int (\nabla \cdot v)\, d\tau = \oint v \cdot d_a$$

$$\int (\nabla \times v)\, d_a = \oint v \cdot dl$$

$$F = \frac{1}{4\pi\varepsilon_0} \frac{qQ}{r^2}$$

$$E = \sum \frac{q_i}{4\pi\varepsilon_0 r_i^2} = \frac{1}{4\pi\varepsilon_0} \frac{\hat{r}}{r^2} dq$$

$\lambda\, dl$

$\sigma\, dA$

$\rho\, d\tau$, V

Spherical coordinate

$$\oint \vec{E} \cdot \vec{dA} = \frac{1}{4\pi\varepsilon_0 \cancel{r^2}} \int dq \cdot \cancel{r^2} \sin\theta\, d\theta\, d\phi$$

$$\oint E \cdot dA = \frac{q}{\varepsilon_0}$$

$$\int (\nabla \cdot E)\, d\tau = \frac{1}{\varepsilon_0} \int \rho\, d\tau$$

$$\boxed{\nabla \cdot E = \frac{\rho}{\varepsilon_0}}$$

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$$\oint \vec{E}\cdot\vec{dl} = 0$$

loop

$$\frac{q}{4\pi\varepsilon_0}\int \frac{1}{r^2}\,dl = \frac{q}{4\pi\varepsilon_0}\,\frac{1}{r}\Bigg|_{r_a}^{r_b} = (0)$$

Earlier
↓
Now

$$\oint \vec{E}\cdot\vec{dl} = \text{emf} = -\frac{\partial(\phi_B)}{\partial t}$$

$$\boxed{\oint \vec{E}\cdot\vec{dl} = -\frac{\partial(\phi_B)}{\partial t}}$$

↓
Stokes

$$\int(\nabla\times E)\,dA = -\frac{\partial}{\partial t}\int B\cdot da$$

$$\boxed{\vec{\nabla}\times\vec{E} = -\frac{\partial B}{\partial t}}$$

$$\boxed{\oint B \cdot d_a = 0}$$ integral form

$$\int (\nabla \cdot B)\, d\tau = 0$$

$$\boxed{\nabla \cdot B = 0}$$ Differential form

$$\oint B \cdot dl = \mu_0 I$$ [$\int$ form] (Steady current)

$$\int (\nabla \times B)\, d_a = \mu_0 \int \vec{J} \cdot \vec{d_a}$$

$$\boxed{\nabla \times B = \mu_0 J}$$ Diff

☆

$$\nabla \cdot (\nabla \times E) = 0 = \nabla \cdot \left(\frac{-\partial B}{\partial t} \right) = -\frac{\partial}{\partial t} (\nabla \cdot B)$$

$$\nabla \cdot (\nabla \times B) = 0 = \nabla \cdot (\mu_0 J) = \mu_0 (\nabla \cdot J)$$

$$\frac{dq}{dt} = I = \int J \cdot d_a$$

$$\frac{d}{dt} \int \rho\, d\tau = \int (\nabla \cdot J)\, d\tau$$

$$\int \nabla \cdot J\, d\tau = -\frac{d}{dt} \int \rho\, d\tau = -\frac{d}{dt} (\varepsilon_0\, \nabla \cdot E)\, d\tau$$

see → continuity Eqn

cost of charge made

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$$\nabla . J = - \nabla . \left(\varepsilon_0 \frac{\partial E}{\partial t} \right)$$

$$\left[\nabla \times B = \mu_0 J + \underbrace{\mu_0 \varepsilon_0 \frac{\partial E}{\partial t}}_{\text{additional term}} \right]$$

$$\left[\oint B . dl = \mu_0 I + \frac{1}{C^2} \int \frac{d\varepsilon}{dt} da \right]$$

* Fiber optics = ~~Ed~~ Rodeh collen
(Electronic communication)

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