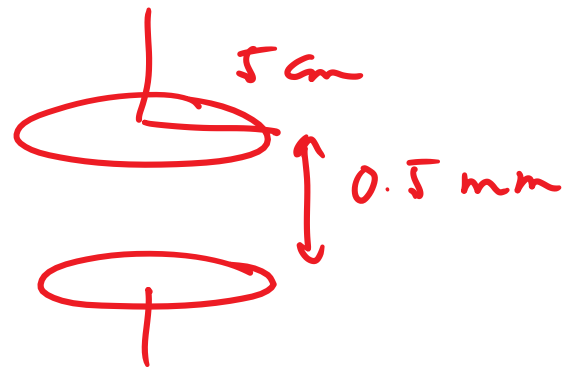
Everything that has a beginning has an end. Make peace with that

Gautama Buddha

Q2



$$V_0 = 20\,V$$

$$V = V_0 \sin 2\pi f t$$

$$f = 10\,MHz = 10 \times 10^6\,Hz$$

$$E = \frac{V}{d}$$

$$J_D = \epsilon_0 \frac{\partial E}{\partial t} = \frac{\epsilon_0}{d} \frac{dV}{dt}$$

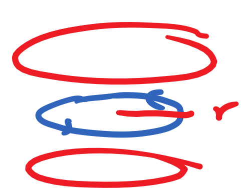
$$= \frac{\epsilon_0}{d} \cdot 2\pi f V_0 \cos 2\pi f t$$

$$J_D \Big|_{peak} = \frac{2\pi f V_0 \epsilon_0}{d}$$

$$\nabla \times \vec{B} = \mu_0 \epsilon_0 \underbrace{\frac{\partial E}{\partial t}}$$

$$\oint \vec{B} \cdot \vec{dl} = \mu_0 \epsilon_0 \frac{d}{dt} \Phi_E$$

$$\oint \vec{B} \cdot \vec{dl} = \epsilon_0 \mu_0 \frac{\partial \Phi_E}{\partial t}$$



$$\oint \vec{B} \cdot \vec{dl} = 2\pi r B$$

$$\Phi_E = \pi r^2 \cdot \frac{V}{d}$$

$$2\pi r\, B = \epsilon_0 \mu_0 \frac{\pi r^2}{d} \frac{dV}{dt} = \epsilon_0 \mu_0 \frac{\pi r^2}{d} \cdot V_0 . 2\pi f \cos(2\pi f t)$$

$$B = \frac{\epsilon_0 \mu_0 \cancel{\pi} r\, V_0 \cos(2\pi f t)}{\cancel{2} d}$$

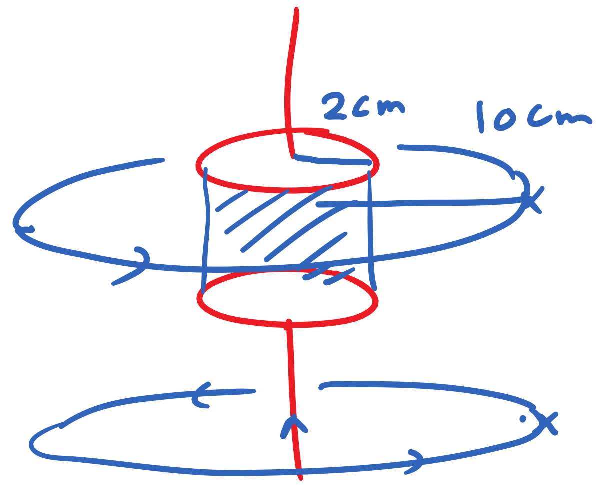
$$\oint \vec{B} \cdot \vec{dl} = \mu_0 J_D \cdot \pi r^2$$

$r = 10\,cm$

$$\oint \vec{B}\, \vec{dl} = \mu_0 J_D \cdot \pi R^2$$

$$2\pi r\, B = \mu_0 J_D \pi R^2$$

$$B = \frac{\mu_0 J_D R^2}{2}$$



$$\vec{J}_D = \epsilon_0 \frac{\partial \vec{E}}{\partial t} \quad \text{free space}$$

$$= \epsilon \frac{\partial \vec{E}}{\partial t} \quad \text{in medium}$$

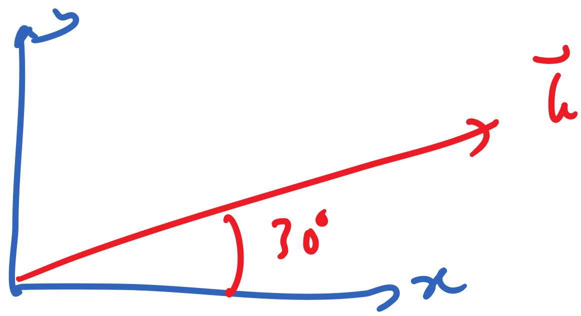
$$\vec{E} = \vec{E}_0 \sin(kz - \omega t)$$

$$\vec{E} = \vec{E}_0 \sin(\vec{k} \cdot \vec{r} - \omega t)$$

$$= \vec{E}_0 \sin(k_x x + k_y y + k_z z - \omega t)$$

$$\vec{k} = \hat{x}\,k_x + \hat{y}\,k_y + \hat{z}\,k_z$$

$\vec{k}$: direction of propagation of the wave



$$|\vec{k}| = k = \frac{2\pi}{\lambda}$$

$$k_x = k\cos 30^\circ$$
$$k_y = k\sin 30^\circ$$
$$k_z = 0$$

$$k_x^2 + k_y^2 + k_z^2 = k^2 = \left(\frac{2\pi}{\lambda}\right)^2 = \frac{\omega^2}{c^2}$$

$$\vec{E} = \vec{E}_0 \sin(k\cos 30^\circ x + k\sin 30^\circ y - \omega t)$$

GEROLAMO CARDANO

(1501–1576)

$$xy = 40$$
$$x + y = 10$$

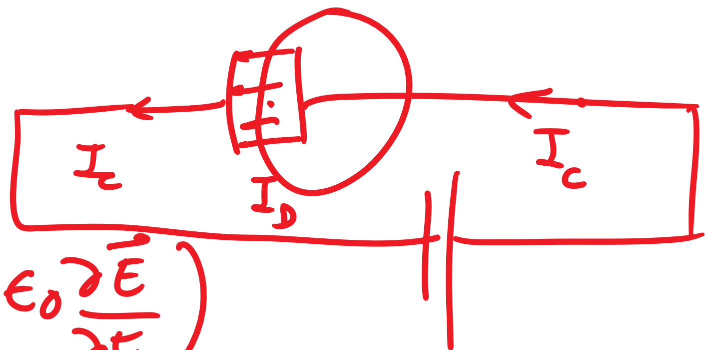
$$x = 5 + i\sqrt{15} = 5 + \sqrt{-15}$$
$$y = 5 - i\sqrt{15} = 5 - \sqrt{-15}$$

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

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

$$0 = \mu_0 \nabla \cdot \vec{J}$$

$$\nabla \cdot \vec{J} + \frac{\partial \rho}{\partial t} = 0$$ Continuity equation



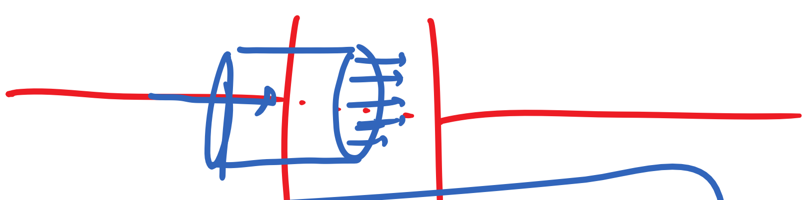
$$\nabla \times \vec{B} = \mu_0 \left(\vec{J} + \underbrace{\epsilon_0 \frac{\partial \vec{E}}{\partial t}}_{} \right)$$

displacement Current density

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

$$\oint \vec{E} \cdot d\vec{l} = -\frac{d}{dt}\left(\int \vec{B} \cdot d\vec{a} \right)$$

$$\boxed{\oint \vec{B} \cdot d\vec{l} = \mu_0 I + \mu_0 \epsilon_0 \frac{d}{dt} \int \vec{E} \cdot d\vec{a}}$$



$$\boxed{\int \nabla \cdot \vec{F}\, dV = \oint \vec{F} \cdot d\vec{a}}$$