Destructive resonance, electromagnetic waves, speed of light

Examples of resonance:

- traffic lights blowing in wind.
- cars making noise at a speed
- Breaking glass in oprah...
- Tacoma bridge collapse

DEMO: Break wine glass w/ loud speaker

$\omega_0 \approx 448$ Hz

turn up volume to break it

Maxwell's Equations

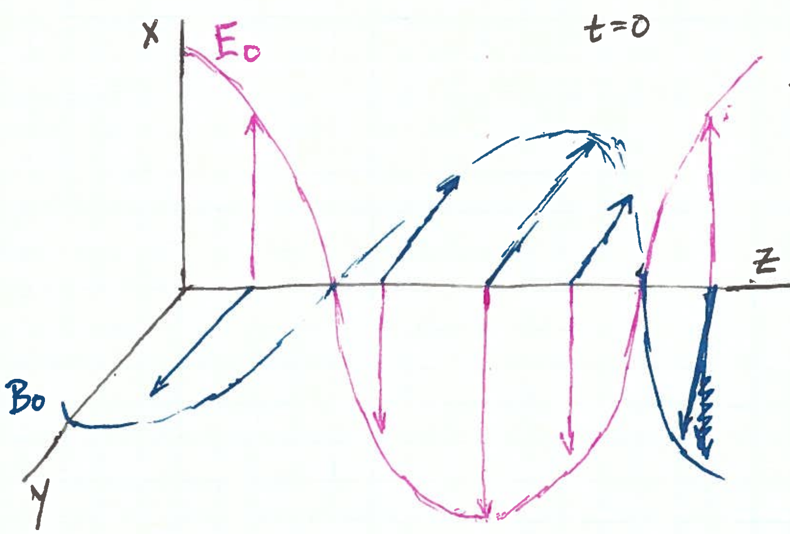
Gauss

$$\oint \vec{E} \cdot d\vec{A} = \frac{Q_{free}}{\varepsilon_0 K}$$

$$\oint \vec{B} \cdot d\vec{A} = 0$$

Faraday $\oint \vec{E} \cdot d\vec{l} = -\frac{d\Phi_B}{dt}$

Ampère $\oint \vec{B} \cdot d\vec{l} = \mu_0 K_m \left(I + \underbrace{\varepsilon_0 K \frac{d\Phi_E}{dt}}_{\text{displacement current}}\right)$



$\longrightarrow$ $v_0 = \frac{\omega}{k} = c$

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

$\vec{E} = E_0 \hat{x} \cos(-\omega t + kz)$

$\vec{B} = B_0 \hat{y} \cos(-\omega t + kz)$

$\hat{x} \times \hat{y} = \hat{z}$ (right-hand)

Consider Solution to Maxwell's Eqn's

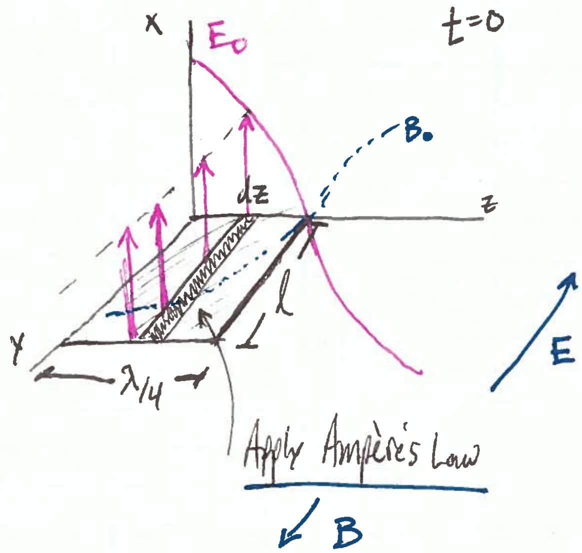
$$\vec{E} = E_0 \hat{x} \cos(kz - \omega t)$$

$$\vec{B} = B_0 \hat{y} \cos(kz - \omega t)$$

Works under conditions:

[1] $B_0 = \frac{E_0}{c}$

[2] $c = \frac{1}{\sqrt{\mu_0 \varepsilon_0}}$.



$$\oint \vec{B} \cdot d\vec{\ell} = \varepsilon_0 \mu_0 \frac{d\Phi_E}{dt}$$

$$\Phi_E = \iint E \cdot dA = [illegible]$$

$$= \int_0^{\lambda/4} \ell\, dz \cdot E_0 \cos(kz - \omega t)$$

$$\frac{d\Phi_E}{dt} = \ell E_0 (+\omega) \int_0^{\lambda/4} \sin(kz - \omega t)\, dz \quad (t=0)$$

$$= \ell E_0 \omega \left(-\cos kz\right)\Big|_0^{\lambda/4}$$

$$\frac{d\Phi_E}{dt} = \ell E_0 \omega / k = \ell E_0 c$$

$$B_0 \ell = \varepsilon_0 \mu_0 \left(\frac{d\Phi_E}{dt}\right)$$

$$B_0 = \frac{\varepsilon_0 \mu_0}{\ell} \cdot \ell E_0 c$$

$$B_0 = \varepsilon_0 \mu_0 c E_0$$

Now apply Faraday's Law and solve for speed of light (c)

Corner reflectors on moon allow us to measure distance to moon by transmitting / receiving pulse

Radio waves can be generated by oscillating charges...
aka current on a wire (antenna)

WEEI 850 kHz , $\lambda = 353$ m

DEMO: transmit 1 kHz audio signal at 802 kHz
jam WEEI by transmitting 1kHz tone at 850 kHz
transmits his own audio at 850 kHz on radio speaker