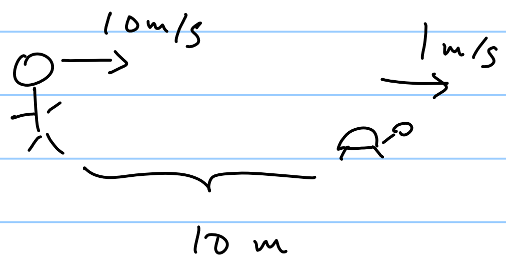
Drop 7.37 for this friday

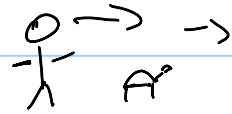
Note Title 4/8/2009

Zeno's Paradox:

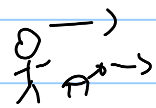


const

$t = 0$

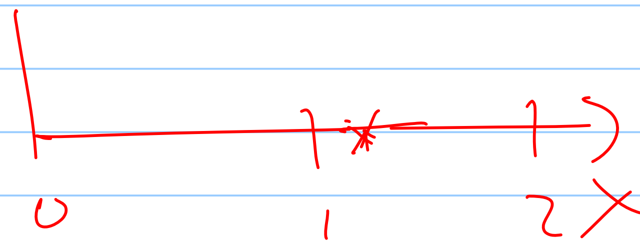


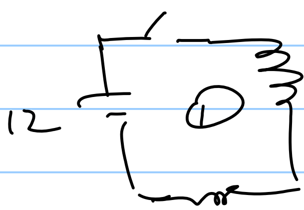
$t = 1$



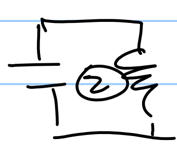
$t = .1$

$T = \sum t_i = 1 + .1 + .01 + \cdots = 1.1111\,1$





$V - L_1 \frac{di_1}{dt} - M \frac{di_2}{dt} = 0$

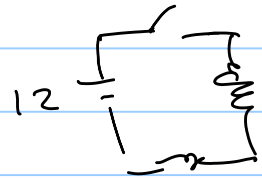


$V_c - L_2 \frac{di_2}{dt} - M \frac{di_1}{dt} = 0$

Perturbation:

Steps

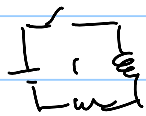
I



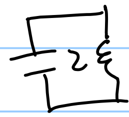
no 2^{nd} circuit

$i_1^{(0)}(t)$

II



assume $i_1^{(0)}(t)$



$$V_c - L_1 \frac{di_2^{(0)}}{dt} - M\frac{di_1^{(0)}}{dt} = 0$$

$i_2^{(0)}(t)$

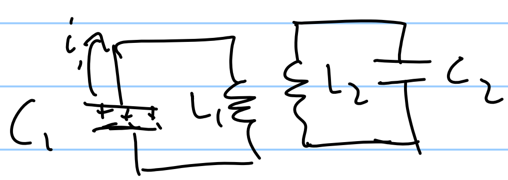
III

find effect of $i_2^{(0)}(t)$ on circuit (1)

which gives $i_1^{(1)}(t)$

⋮

$$i_1(t) = i_1^{(0)}(t) + i_1^{(1)}(t) + \cdots$$

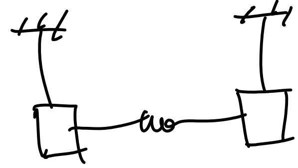


$$\frac{Q_1}{C_1} - L_1\frac{di_1}{dt} + M\frac{di_2}{dt} = 0$$

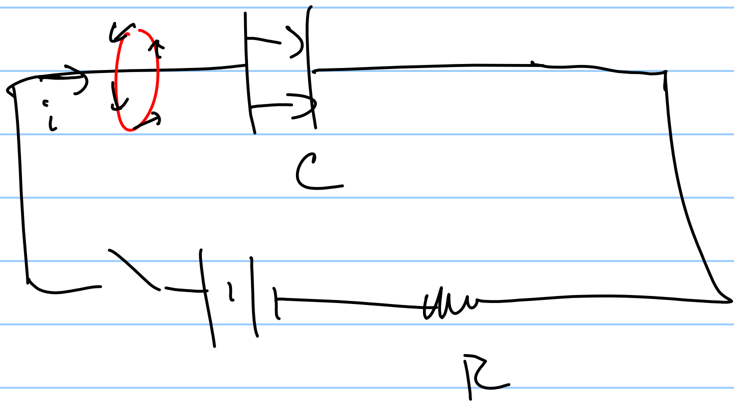
$$i_1 = -\frac{dQ_1}{dt}$$

$$\frac{Q_2}{C_2} - L_2\frac{di_2}{dt} + M\frac{di_1}{dt} = 0 \qquad i_2 = -\frac{dQ_2}{dt}$$

Same as



$$Q(t) = Q_{max}\left(1 - e^{-t/RC}\right)$$



$$i = \frac{dQ}{dt} \qquad i(t)$$

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

$$\underbrace{\vec{\nabla} \cdot (\vec{\nabla} \times \vec{B})}_{\equiv\, 0} = \mu_0 \underbrace{\vec{\nabla} \cdot \vec{J}}_{= -\frac{\partial \rho}{\partial t}} \neq 0$$ except in magnetostatics

$$\vec{\nabla} \cdot \vec{\nabla} \times \vec{B} = \mu_0 \vec{\nabla} \cdot \vec{J} + \vec{\nabla} \cdot ? = \emptyset$$

$$\vec{\nabla} \cdot \vec{E} = \frac{\rho}{\epsilon_0}$$ Gauss's form

$$\frac{\partial \rho}{\partial t} = \epsilon_0 \vec{\nabla} \cdot \frac{\partial \vec{E}}{\partial t}$$ is this the mystery term

$$\vec{J} = \vec{J}_{currents} + \underbrace{\vec{J}_{displacement}}_{= \epsilon_0 \frac{\partial \vec{E}}{\partial t}}$$

$$\vec{J}_d = \epsilon_0 \frac{\partial \vec{E}}{\partial t}$$

$$\vec{\nabla} \times \vec{B} = \mu_0 \vec{J} = \mu_0 \vec{J}_{current} + \mu_0 \epsilon_0 \frac{\partial \vec{E}}{\partial t}$$

$$\vec{\nabla} \cdot \vec{\nabla} \times \vec{B} = \mu_0 \vec{\nabla} \cdot \vec{J}_{current} + \mu_0 \vec{\nabla} \cdot \frac{\partial}{\partial t}(\epsilon_0 \vec{E}) = \mu_0 \underbrace{\vec{\nabla} \cdot \vec{J}_{curr}}_{= -\partial \rho / \partial t} + \mu_0 \frac{\partial \rho}{\partial t}$$

$$\vec{\nabla} \cdot \vec{E} = \frac{\rho}{\epsilon_0}$$

$$\frac{\partial}{\partial t} \mu_0 \epsilon_0 \underbrace{\vec{\nabla} \cdot \vec{E}}_{\rho / \epsilon_0} = \mu_0 \frac{\partial \rho}{\partial t}$$

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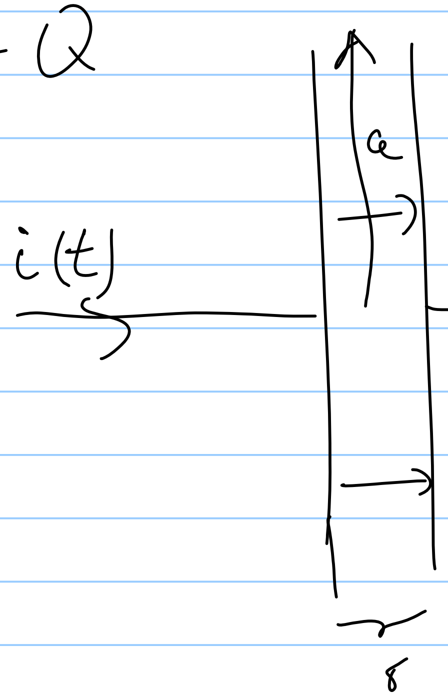
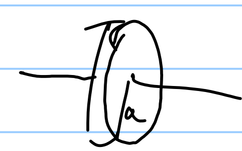
tablet Q

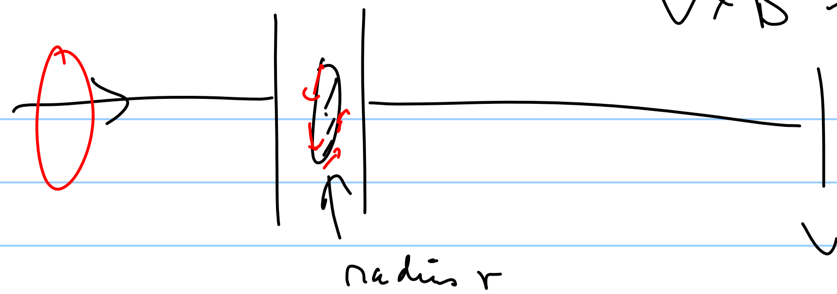




$$E = \frac{\sigma}{\epsilon_0} = \frac{Q(t)}{A \epsilon_0}$$

$$J_d = \epsilon_0 \frac{\partial E}{\partial t} = \epsilon_0 \frac{1}{A \epsilon_0} \frac{dQ}{dt} = \frac{1}{A} i \quad \text{const}$$

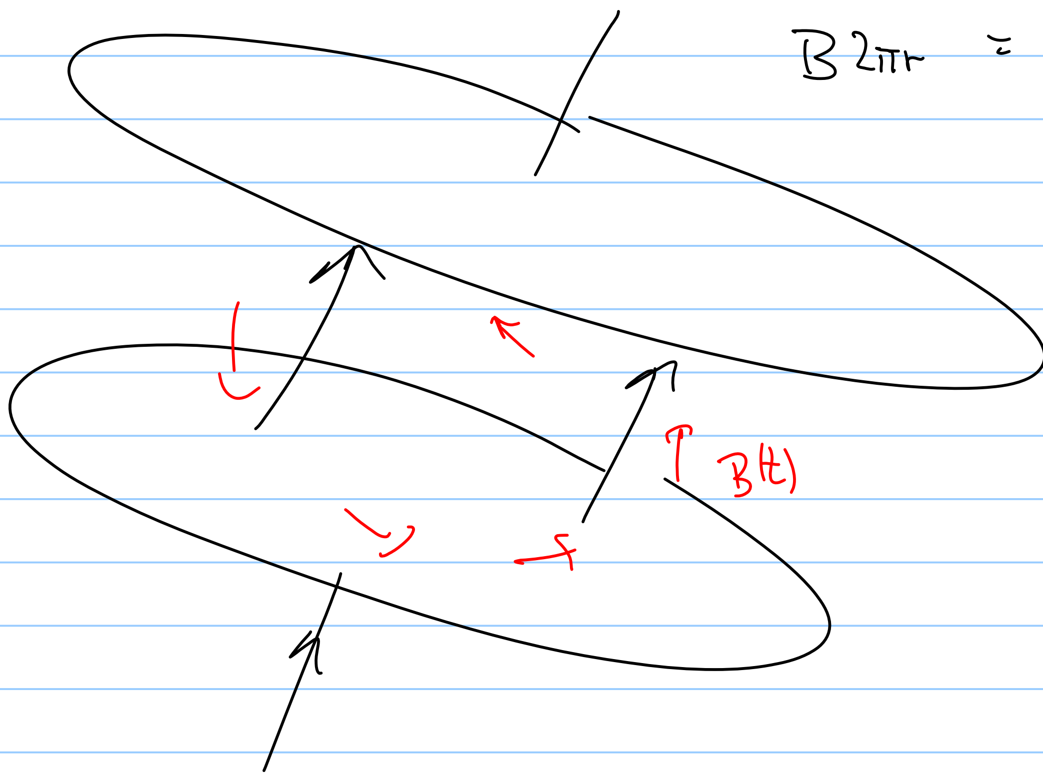
$$\vec{\nabla} \times \vec{B} = \mu_0 \vec{J}_{dispC}$$



$$\vec{J}_{current} = 0$$

$$\oint \vec{B} \cdot d\vec{l} = \mu_0 \int J_{disp}\, da$$

$$B\, 2\pi r = \mu_0 J_d \pi r^2$$



$E(t)$