Solutions to Tutorial Problems

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ex. 2 (Knight ex. 34.4)

$P_{source} = 0.60\ W$ @ $1.9\ GHz$, $d = 10\ cm$

$$I = \frac{P_{source}}{4\pi r^2} = \frac{0.60\ W}{4\pi (0.10\ m)^2} = 4.78\ W/m^2$$

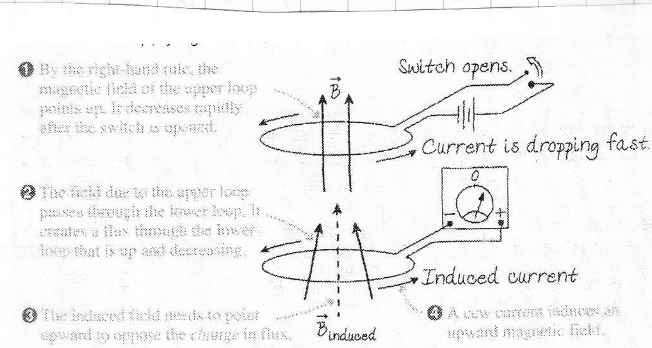
$$I = \frac{c\epsilon_0}{2} E_0^2 \rightarrow E_0 = \sqrt{\frac{2I}{c\epsilon_0}} = \sqrt{\frac{2(4.78\ W/m^2)}{(3.00\times10^8\ m/s)(8.85\times10^{-12}\ C^2/Nm^2)}}$$

$$= 60\ V/m$$

$$B_0 = \frac{E_0}{c} = \frac{60\ V/m}{3.00\times10^8\ m/s} = 2.0\times10^{-7}\ \frac{V\cdot s}{m^2} = 0.2\ \mu T$$

→ Note that since $E_0 \gg B_0$, the interaction of EM waves w/ respect to matter is due primarily to the electric field

ex. 1 (Knight ex. 33.6)



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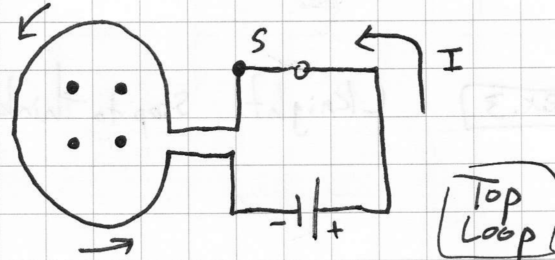
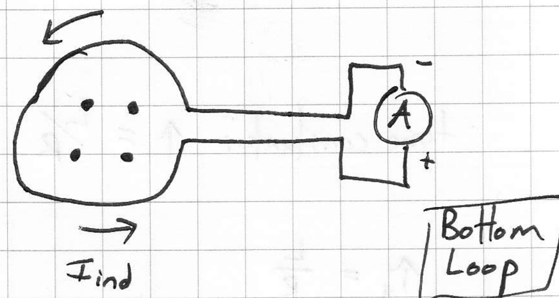
- Use RHR to show field in upper loop points up (or out of the page as drawn here)

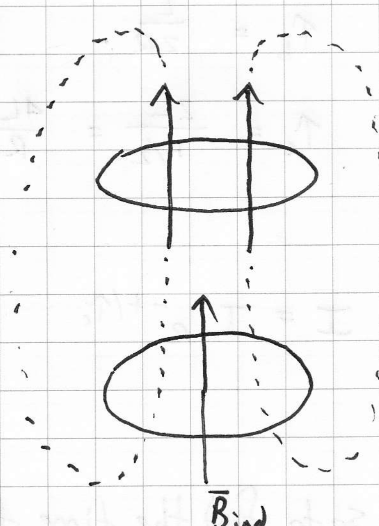


- opening switch cause rapid decrease in current and therefore a rapid decrease in the magnetic flux

- Such will also cause a decrease in the (upward) magnetic flux through the bottom loop



- Via Faraday's Law and Lenz's Law (i.e. $\mathcal{E} = -\frac{d\Phi_m}{dt}$), a current will be induced in the lower loop so to resist the change in the flux. To do such, that induced field must point upwards (so to **oppose** the change in flux)



- Seen from above, this is then a CCW current (or a positive one as shown by the way the ammeter is connected)

<u>NOTE</u>: If leads to ammeter were flipped, the sign ~~direction~~ of the current would also flip.

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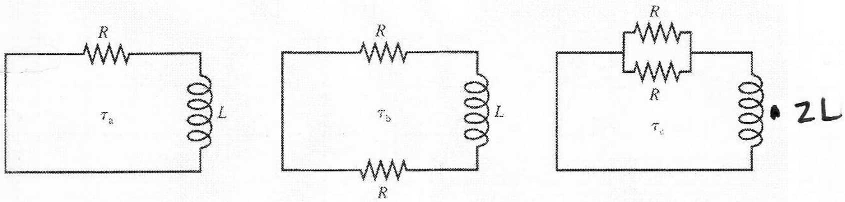
ex. 3 (Knight 'Stop to Think' 33.7 modified)



time constant: $\tau = L/R$

$\tau_a = \frac{L}{R}$

$\tau_b = \frac{L}{2R}$

$\tau_c = \frac{2L}{R/2} = \frac{4L}{R}$

So $\tau_c > \tau_a > \tau_b$

therefore circuit c will be the slowest

$I = I_0 e^{-t/\tau_c}$

NOTE: $I_0 = \frac{V_0}{R_{eq}} = \frac{2V_0}{R}$ (since $R_{eq} = \frac{R}{2}$ for circuit c)

So to find the time to reach 10%, we simply have

$t_{10} = -\tau_c \ln(0.1) = -\frac{4L}{R}\ln(0.1)$

$I(t_{10}) = \frac{2V_0}{R} e^{-t_{10}/\tau_c} = 0.2\frac{V_0}{R}$

($e^{-t_{10}/\tau_c} = 0.1$)