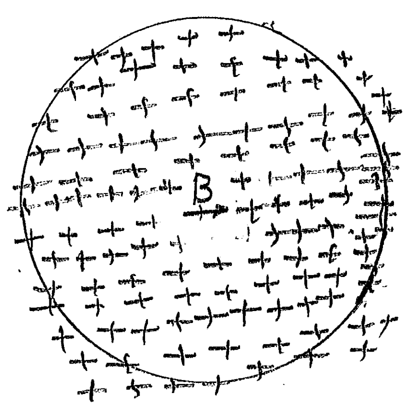
Problems: Week 9

9-1. We have learnt that the flux of $\underset{\rightarrow}{B}$ through any closed surface is always equal to <u>ZERO</u>, what does it tell you about (i) the elementary generators of $\underset{\rightarrow}{B}$ and (ii) the fundamental property of $\underset{\rightarrow}{B}$ field lines (in contrast to the field lines of a Coulomb $\underset{\rightarrow}{E}$).

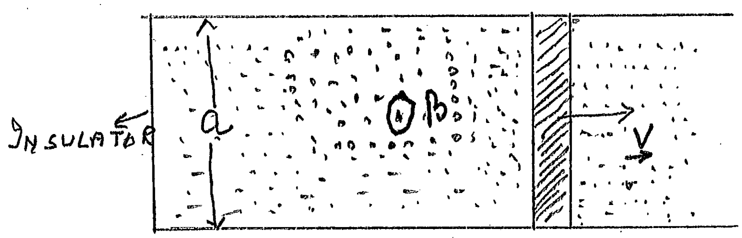
9-2. What is the difference between a Coulomb $\underset{\rightarrow}{E}$-field and a non-Coulomb $\underset{\rightarrow}{E}$-field?

9-3. What is the total flux of a non-Coulomb $\underset{\rightarrow}{E}$-field through a closed surface? Why?

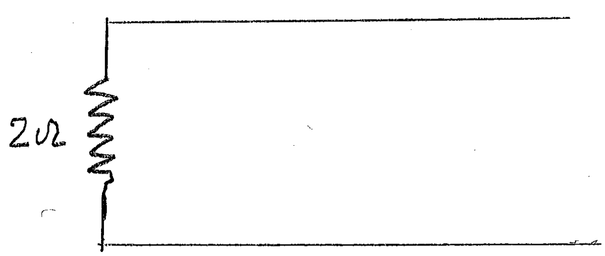
9-4. A uniform $\underset{\rightarrow}{B} = -B\hat{z}$ is normal to a conducting ring of diameter 10cm. If the resistance is 1Ω and you want to induce a clockwise current of 10Amps in the ring, at what rate must you change $\underset{\rightarrow}{B}$?



9-5. The figure shows a copper rod sliding on smooth conducting rails in the presence of a uniform $\underset{\rightarrow}{B} = 1T\hat{z}$. If $\underset{\rightarrow}{v} = 5m/s$ and a = 10cm, what is the induced *emf* in the rod and which end of it is positive? Incidentally, do you need to apply a force to move the rod?



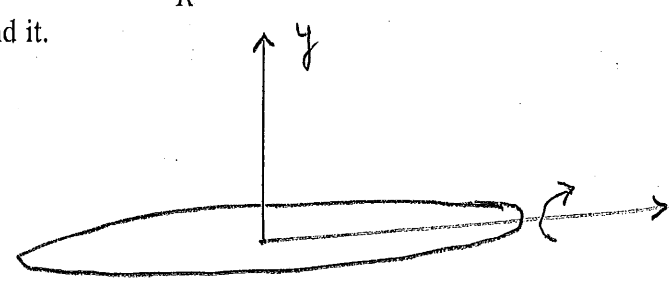
9-6. Same situation as in problem 9-5 but now there is a resistor $R = 2\Omega$ between the rails. (i) What is the current in the circuit? (ii) Now do you need a force to move the rod?



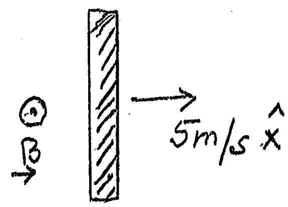
9-7. A circular coil of radius r and resistance R is lying in the xz-plane in a region where a uniform $\underset{\rightarrow}{B} = B\hat{y}$ is present. Show that if you flip the coil through 180° about the x-axis, a charge

$$Q = \frac{2B\Pi r^2}{R}$$

will flow around it.



9-8. The 0.1m long rod of problems 9-5 and 9-6 moves at $5 m/s\ \hat{x}$ in a uniform field of $1T\hat{z}$. What emf appears across the rod? Why?



9-9. How would you make the coil shown in problem 8-13 work like an a.c. generator?

9-10. In problem 9-9 show that the generated emf is maximum (zero) when the flux of the $\underset{\to}{B}$-field through the coil is zero (maximum).

9-11. Show that $\frac{L}{R}$ has the dimensions of time.

9-12. Why does the time constant of an L-R circuit depend on both L and R?

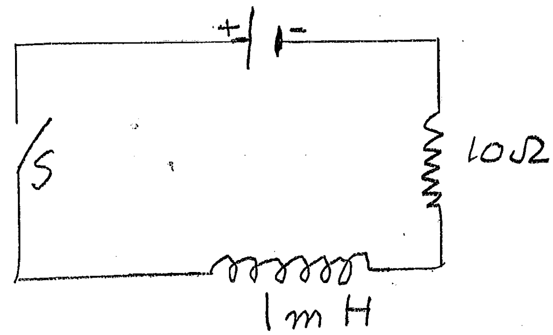
9-13. In order to establish a current I in an inductor L the battery must do $U_B = \frac{1}{2}LI^2$ Joules of work. Where does all this energy go? Why?

9-14. Apply the formula of the previous problem to a solenoid to show that $1m^3$ of a $\underset{\rightarrow}{B}$ field stores

$$\eta_B = \frac{B^2}{2\mu_0}$$

Joules of energy.

9-15. For the circuit shown, (i) what is the time constant? (ii) How long after closing the switch will the current reach 90 percent of its final value?



9-16. In the cicuit shown, what is the current (i) immediately after S is closed, (ii) a long time later? Why?