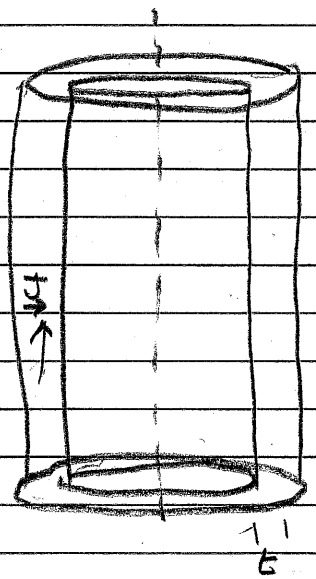
Test Questions - Exam III - 1st Dust.

1. State Ampere's laws in your own words.

2. Shown is the end face of a wide sheet of thickness t. The sheet is placed parallel to the xz-plane at y=0 and carries a uniform current of density $J\hat{z}$. Show that the $\vec{B}$-field is $\frac{\mu_0 J t}{2}\hat{x}$ at $y<0$ $-\frac{\mu_0 J t}{2}\hat{x}$ at $y>0$.



3. Next, fold the sheet to make a cylinder of radius $R \gg t$. Show that the $\vec{B}$-field jumps by $\mu_0 J t$ as you cross the current sheet.

4. Currents $I_1 = 2$ amp and $I_2 = -5$ amp flow through long straight wires (along y-axis)

What are the forces, per meter, acting on the wires if they are separated by 1cm. Why?

5. A $\vec{B}$ field can be generated by a current or a bar magnet. Why is the total flux of $\vec{B}$ equal to zero through any closed surface always equal to zero?

5a 8-15.

6. What is a bar magnet? Discuss the various steps that take us from a single electron [$\mu_e = 9.27 \times 10^{-24}$ N-m/T] to a store bought bar magnet.

7. 9-2

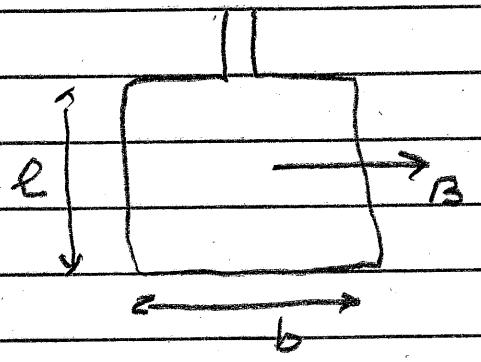
8 9-3

9 9-5

10 9-6

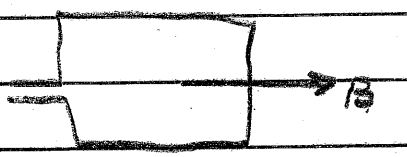
11 If the energy density of an $\underline{E}$-field ($\eta_E = \frac{1}{2}\epsilon_0 E^2$) is equal to the energy density of a $\underline{B}$-field, what is the relationship between the magnitudes of $\underline{E}$ and $\underline{B}$

12 Shown is a coil of width b and length ℓ suspended vertically in a $\vec{B} = B\hat{x}$ field. How would you make it work like the motor in a generator?



12a For generator show that Emf is maximum when flux is 0!

13 Will the device of problem 6 work if the coil was mounted horizontally? why?



14 What is wrong with the equation

$$\sum_C \vec{E}_{enc} \cdot \Delta\vec{\ell} = \frac{\Delta\Phi_B}{\Delta t} \; ?$$

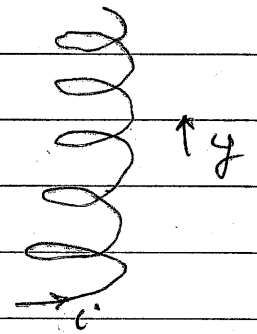
where $\frac{\Delta\Phi_B}{\Delta t}$ is the time rate of change of the flux of $\vec{B}$

14a Why in writing Gauss's law we use "total flux ... through a closed surface," while in Ampere's law and Faraday-Lenz's law we say "total circulation around a closed loop"?

15. A battery and an ac generator both produce E-fields. What is the difference? why?

16. Explain clearly the difference between the three devices capacitor, Resistor, Inductor

16. A solenoid has n turns per meter and radius R. The current i is increasing slowly as a function of time. Show that at a distance r from the axis of the solenoid, the non-Coulomb $\vec{E}_{NC}$ is

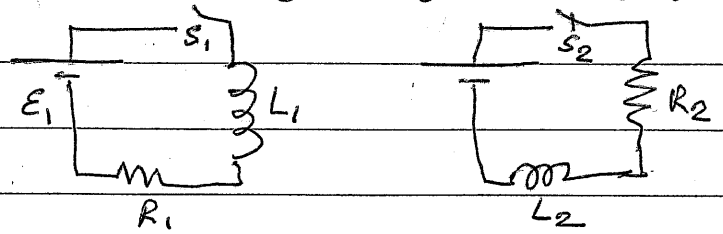


$$\vec{E}_{NC} = -\frac{\mu_0 n r}{2}\frac{\Delta i}{\Delta t}\hat{\phi} \quad r < R.$$

$$= -\frac{\mu_0 n R^2}{2r}\frac{\Delta i}{\Delta t}\hat{\phi} \quad r > R.$$

17. In Prob 16, what is the variation of the Emf in a loop if i) $r < R$ ii) $r > R$? Why?

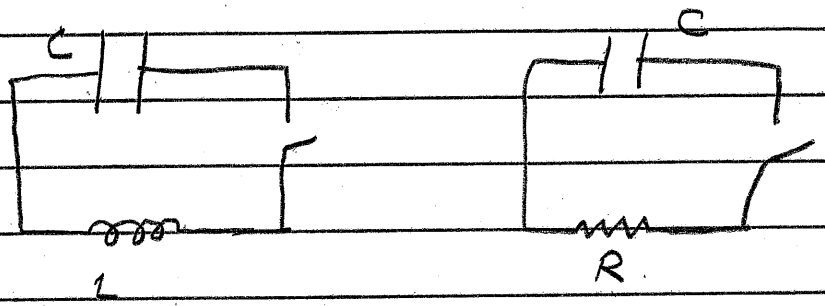
18. Shown are two circuits



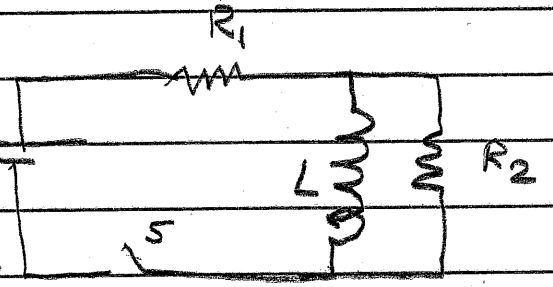
$L_1 = 10mH$, $L_2 = 20mH$
$R_1 = 1k\Omega$, $R_2 = 2k\Omega$.

If both switches are closed at $t=0$, in which circuit will the current reach 1mA first if i) $\varepsilon_1 = \varepsilon_2 = 10V$, ii) $\varepsilon_1 = 20V$, $\varepsilon_2 = 15V$? Why?

19. Shown are two circuits. In either case the capacitor is charged to $\pm Q$ and then the switch is closed. What is the subsequent variation of the charge on the capacitor-plates? why?



20. In the circuit shown S is closed at $t=0$. What is the potential across inductor L (i) immediately after S is closed, (ii) a long time later? why? (Compare to prob 9-16)



21. Explain why when you connect R to an ac generator it absorbs power but if you connect C or L there is no absorption on the average.

22 9-2

23-24 9-11, 9-12