Note: Starting with Assignment 12 homework turned in after I get in the next day will be docked 10%. Homework turned in 24 hours later than that will be docked 50%, then 25% for another day late, etc.. The last homework assignment is due Tuesday June 13 at 5 PM since the final is just 14 hours away at that point.

Hints for Assignment 14

6.1 Answer:

$$N = -\frac{\mu_0}{4}\frac{(abI)^2}{r^3}$$

This answer is just the magnitude; you have to give the direction too.

6.3 Magnitude of the answer:

$$F = \frac{3\mu_0}{2\pi}\frac{m_1 m_2}{r^4}$$

6.6 The key to this almost correct analysis is the Pauli Exclusion Principle. Count the electrons and think about the way electron spins are arranged in the shells. Assume that the same pairing effect governs the orbital angular momentum as well. You should be able to state the answer to this question in about two sentences involving no mathematics.

6.7 Answer: $\mathbf{B} = \mu_0\mathbf{M}$.

6.8 Just compute $\mathbf{J}_b$ and $\mathbf{K}_b$ and use Ampere's law to find $\mathbf{B}$. Again you should find that $\mathbf{B} = \mu_0\mathbf{M}$.

6.10 By a square loop with reversed current he means to represent the gap as toroid current of the opposite direction from the original edge magnetization current. When you get the field inside the iron you will not get the usual toroidal magnetic field. The reason is that in a current driven toroid the current per length is larger in the bagel hole than it is on the outside of the bagel because the total current is the same both places (NI). But in this case M is the same on the inside and the outside both, so you will get a different answer. Hint: see the previous two problems. To find the field of the reversed square, use the answer to Problem 5.8. Final answer: $\mathbf{B} = \mu_0\mathbf{M}[1 - 2\sqrt{2}w/(\pi a)]$.

6.12 You are to do this one two ways to see that sometimes the $\mathbf{H}$ way is a lot quicker. Again you will find $\mathbf{B} = \mu_0\mathbf{M}$.

6.13 In this problem you are to assume that $\mathbf{B}_0$ and $\mathbf{M}$ are independently specified, i.e., treat them separately, i.e. **they don't point in the same directions.** You will need to remember that the magnetic field inside a magnetized sphere is $(2/3)\mu_0 M$. Partial answers: (a) $\mathbf{B} = \mathbf{B}_0 - (2/3)\mu_0\mathbf{M}$. (b) $\mathbf{H} = \mathbf{H}_0$. (c) $\mathbf{B} = \mathbf{B}_0$. (Note: you need to find both $\mathbf{B}$ and $\mathbf{H}$ in all three cases.)

6.14 This is just like the $\mathbf{P}$, $\mathbf{E}$, and $\mathbf{D}$ sketch you made in Chapter 4. If it makes it easier for you, set $\mu_0 = 1$.

Hints for Assignment 13

5.20 Use Ampere's law in differential form: $\nabla \times \mathbf{B} = \mu_0\mathbf{J}$. You will again encounter the continuity equation, this time discovering that our Maxwell's equations, as developed so far, are not quite right if the charge density is changing in time. This is the reason that Physics 442 exists.

5.22 Answer: if the wire extends along the x-axis from $x = x_1$ to $x = x_2$, and if r is the distance from the x-axis to the observation point and if $x = 0$ is directly under the observation point, then

$$A_x = \frac{\mu_0 I}{4\pi} \ln\left(\frac{x_2 + \sqrt{x_2^2 + r^2}}{x_1 + \sqrt{x_1^2 + r^2}}\right) \quad ; \quad A_y = A_z = 0$$

5.23 What he wants you to do is take this given **A** and find the **J** that goes with it. It is an invitation to find your way around the triangle diagram on page 233. You will be tempted to use the Laplacian relation, but remember that the Laplacian of a vector is weird in cylindrical and spherical coordinates, and he hasn't given you these formulas in the inside front cover of the book. So you will have to get around the triangle some way that involves operations that are found in the book. Or, if you are daring, you can use the vector Laplacian formula given on the review pages I give you for exams (web page).

5.29 By a uniformly charged sphere he means a solid sphere of charge with charge density $\rho = 3Q/(4\pi R^3)$. You can do this one by carefully integrating Eq. 5.67. By carefully, I mean that you have to keep the r's and R's straight. Make sure that you draw a good picture, keep the observation point fixed, and carefully distinguish between the R in 5.67 and the R given in the problem. Answer:

$$\mathbf{B} = \frac{\mu_0 \omega Q}{4\pi R}\left[(1 - \frac{3r^2}{5R^2})\cos\theta\hat{r} - (1 - \frac{6r^2}{5R^2})\sin\theta\hat{\theta}\right]$$

5.32 Follow his hint and it's not too hard.

5.33 You can either rewrite Eq. (5.86) into dot-product coordinate-free form, or you can use

$$\mathbf{B} = \nabla \times \mathbf{A} \quad \text{and} \quad \mathbf{A} = \frac{\mu_0}{4\pi}\frac{\mathbf{m} \times \mathbf{r}}{r^3}$$

and identities from the inside cover of the text.

5.36 You should find that $m = (4\pi/3)\sigma\omega R^4$. Then show that the vector potential formula in Example 11 for points outside the sphere is the potential of the appropriate dipole.

5.39 To find the potential difference in part (b), note that charge will build up on the edges until the magnetic force on a moving charge carrier is balanced by the electric force.