February 14 Recitation Notes and Review Questions for the Test
Ben Sauerwine

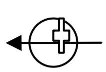
Two Notes: Stuff that appeared on the review sheet that I haven't covered:

"Much Greater Than" sign:
Suppose you have an expression, and are given some assumption $A >> B$. This is similar to taking the limit $\frac{B}{A} \to 0$. In sums where both A and B terms appear, you may exclude the B terms: e.g., $\frac{AB}{[A+B]^2[A-B]^2} \quad A >> B \approx \frac{AB}{[A]^2[A]^2}$, so I have dropped the B terms from the sum. I cannot, however, exclude the numerator since the A and B appear together.

First-Order Expansion:
This comes from the Taylor Series, something that you will do in Calculus 2: the Taylor expansion of a function is defined to be $f(x) \approx \sum_{n=0}^{\infty} \frac{f^n(x_0)}{n!}(x-x_0)^n$ near a point x_0, where the up-n after the f indicates that the derivative has been taken. In the first order, you may take the first two terms of this, which are $f(x_0) + f'(x_0)(x-x_0)$. Here's an example, the "small angle" formula that you may remember from Astronomy: suppose I want the sine of a very small angle theta: using this formula near theta = 0, I have $\sin(\theta) \approx \frac{\sin(0)}{0!} + \frac{\cos 0}{1!}(x-0) = x$, which should be approximately the sine for a very small x.

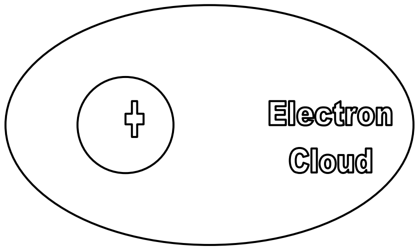
Questions:
`From lecture and the powerpoints, we were shown the graph involving 1/r^3 and 1/r^2. We discussed something about like forces being able to attract (?) if they are VERY close. I can see 1/r^2 < 1/r^3 if r < 1, but I just don't clearly see the concept of why this occurs. I don't know if you follow what I'm saying...`

Suppose I had an ideal dipole and a charge overlaid on each other, like this:



where the arrow indicates the direction of the dipole (this way this models your tape lab, at least if you had a positively charged brand of tape). Certainly, you see that at some point $\frac{1}{r^2} < \frac{1}{r^3}$, and indeed this is all that matters since this is an ideal dipole but what, conceptually, is happening here?

Suppose I made a non-ideal but microscopic picture to portray what's "really" going on:



Even though a net positive charge exists since the atom has become ionized, at a sufficiently small distance the electron cloud has shifted far enough that the fact that the average negative charge is closer to my object than the average positive charge and enough so that $\frac{q_{positive}}{4\pi r_{average,positive}^{2}} < \frac{q_{negative}}{4\pi r_{average,negative}^{2}}$. The difference between these resembles r-cubed, and so the justification for the $\frac{1}{r^2} < \frac{1}{r^3}$ model. I have done more, including a proof of the $\frac{1}{r^5}$ relationship in the January 27 recitation notes.