Three important conclusions that popped up into today's lecture:

1. Martin's question about why the velocity of the EM wave in the material is different from the velocity in vacuum: note that the EM-wave moving through a material will set charges into oscillation. Those oscillating charges will itself generate an EM-wave with of course the same frequency as the incident EM-wave, but a different phase. The original wave and the secondary waves created by the oscillating charges will interfere with each other to create a new EM wave with the same frequency but with a different wavelength and speed. There is beautiful interference physics associated with this principle that we will discuss in more detail in Optics.
2. When an EM wave moves from a less dense to a more dense optical material part of the EM-wave will reflect and part of the EM-wave will transmit. For a non-absorbing medium, the E-field of the reflected wave is 180 degrees out of phase with the E-field of the incident wave. This phase shift was also discussed in PHYS2435. Note that the sign of the phase shift depends on the definition of the axis. Check Fig. 9.13 which shows the definition of the axis. The incident plane wave approaches the material by propagating along the z-axis in the positive direction. For the calculation on page 403 and 404 we assume that the incident wave is polarized in the x-direction. The magnetic field of the wave is polarization along the y-direction. The positive x and y-axis are in such way so the cross product of E and B points in the positive z-direction for the incident wave. This should be as for the incident wave energy is transported in the positive z-direction. Now the wave reflected from the material is moving in the negative z-direction. So the Poynting vector of the reflected wave should point in the negative z-direction. So if the E-field point in the positive x-direction, the B-field should point in the negative y-direction, so flipped from the incident wave. So the y-coordinate axis of the reflected wave is flipped. So when doing the boundary conditions of the B-field we get an extra negative sign into equation 9.79. Note that no extra negative sign was introduced when doing the boundary conditions for the E-field (equation 9.78) as our incident wave is only polarized in the x-direction, and that axis does not flip upon reflection. Another way to see this is to realize that the relation between B and E in vector notation is given by equation 9.46:
$$\vec{B}_o = \frac{\vec{k}}{\omega} \times \vec{E}_o$$
As k flips direction, also its cross product with E flips direction, introducing an extra minus sign for the reflected wave. This is kind of what Aureliano explained on the white board in class.
3. The amplitude coefficients at perpendicular incidence for reflection and transmission of electromagnetic waves are given by:

$$\frac{\tilde{\vec{E}}_{oR}}{\tilde{\vec{E}}_{oI}} = \frac{n_1 - n_2}{n_1 + n_2}$$
$$\frac{\tilde{\vec{E}}_{oT}}{\tilde{\vec{E}}_{oI}} = \frac{2n_1}{n_1 + n_2}$$

Looking to those equations you can see the reflected and incident wave are indeed 180 degrees out of phase if n2>n1. If n2>n2, i.e. you are moving from a dense to a less dens material, the phase shift is 0 degrees. It is also clear from the equations that the transmitted wave can have a larger amplitude than the incident wave if n1> n2. We saw this in the normal incidence tutorial last week. This does not violate the conservation of energy as a wave with a larger amplitude in a less dense medium could have a lower intensity. Note that the intensity of a wave is given by:

$$Intensity = \frac{1}{2}\varepsilon v E_o^2 = \frac{1}{2}\sqrt{\frac{\varepsilon}{\mu}} E_o^2$$

So if a EM wave moves out of a dense material into vacuum the amplitude can go up as long as the intensity does not go up. So the increase of its amplitude square should be less than the decrease of refraction index (note that n is the square root of the relative dielectric constant).