Physics 489 S 04 Lecture 21
Electron Dynamics: Optical Properties of metals and insulators, A & M pages 293-299, 566-7; Kittel, first part of Ch. 8.

1. Insulators are not inert!
   - At low frequency the electrons in an insulator polarize
     Defines the dielectric constant ϵ
   - At high frequencies the electrons in an insulator can conduct, i.e., they can absorb energy just as well as a metal
2. Optical absorption in both metals and insulators can be understood in terms of interband transitions of electrons
   Key point: since the momentum of light is small compared to the Brillouin Zone of typical solids, light can cause transitions ONLY between states with approximately the same wavevector k.

   See hand-drawn figures in notes

3. Leads to the difference between "direct gap" and "indirect gap" insulators
4. Color of materials is determined by the frequency of light that is absorbed
   - Ag is "silver" - also Al, ...
     Recall the discussion of dynamics of electrons in the homogeneous electron gas
     Absorption at very low frequency leads to $\epsilon < 0$ for frequencies in the visible.
     Recall that $\epsilon < 0 \rightarrow$ index of refraction n is imaginary $\rightarrow$ perfect reflection.
     In these metals there is little interband absorption in the range of energies of visible photons, which implies they are good reflectors for visible light.
   - Cu and Au are "gold-colored" or yellow due to interband transitions in the blue - not good reflector in the blue
   - NaCl and diamond are transparent - large gap - they perfect crystal has no absorption in the visible - transparent except for effects of impurities