- 1. Show the following figures that will part of the basis of your poster and report:
- (a) A figure of the structure of a unit cell of your material and a verbal description
- (b) A figure of several unit cells
- (c) A figure of the band structure, with a brief comment
- (d) A figure of the density of states, with a brief comment.
- (e) What do you intend to explore further and how far have you progressed? A report like is intended to help your final project deliverables, not to create delay!
- 2. Plasma frequency and color.
- (a) Look up the crystal structure, atomic weight, the density, and the valence of Cu and Al.

Assume a free electron model with the effective mass of electrons equal to the ordinary rest mass.

- (b) From (a), calculate values for the Fermi energy, E_F , the Fermi temperature, T_F , the Fermi wave vector, k_F , the density of states at the Fermi energy, $D(E_F)$, and the Fermi velocity, v_F . Put these values in context of other well-known physical quantities of the same type.
- (c) Calculate the plasma frequency based on the free electron theory. Based on your result, what color would you expect Al to be? Cu? What colors are they?
- (d) The band structures of Cu (below, left) and Al (below, right) hold a clue to the colors. Can you come up with an explanation for the colors of Cu and Al based on this information?



Band structure of Cu reported in Stahrenberg et al., PRB 64 (2001) 115111. Aluminum from Marder's text.

3. Calculate the total energy of a free electron solid at zero temperature. Use the density of states $D_E(E)$ from your previous homework (but make sure you include spin).

The calculation at T>0 is a bit harder, but not too much. It is important that you are able to formulate the problem and understand how to do it numerically.

I will add more questions next week, so that you have a sense of what questions might be on the final exam.