

**Name:**

**Exam 2 Part 1 - Solid State Physics - Fall 2015**

December 4, 2015

Directions: Please clear your desk of everything except for pencils and pens. The exam is closed book, and you are not allowed a formula sheets, but you may use a calculator. Leave substantial space between you and your neighbor. Show your work in the space provided on the exam. I can provide additional scratch paper if needed.

The entire exam is out of 100 points. Each subquestion, (a), (b), (c), ... is worth 5 points. This part of the exam is out of 50 points.

1. **Short answer section**

(a) What is the Wiedemann-Franz law?

(b) What is the basis of Thomas-Fermi screening?

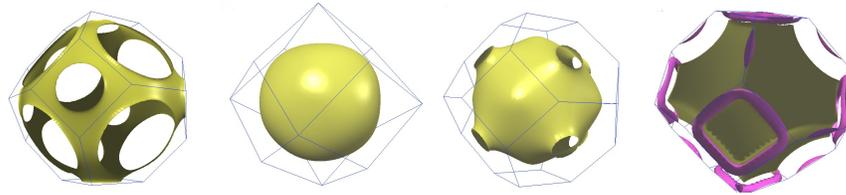
(c) What is the law of Dulong and Petit?

(d) Name three failures of the harmonic crystal

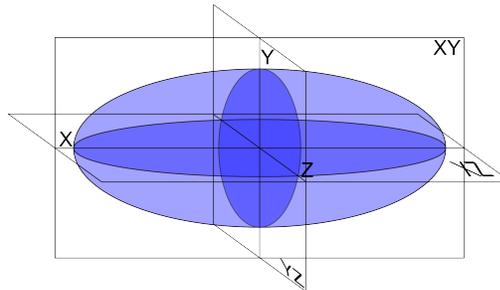
(e) Where is the Fermi energy of a semiconductor in relation to the conduction and valence band edges?

## 2. Qualitative Questions

- (a) Below is shown the Fermi surface of Na (Alkali metal), Ca (divalent metal), Cu (Noble metal), and Al (Trivalent). Label each of them.



- (b) A Fermi surface is show below. Sketch the response in the de Haas van Alphen effect to an applied field in (i) the x-direction and (ii) the z-yirection.



(c) Sketch the distribution of charge from the valence electrons and ionic core for a metal, a molecular crystal, a covalent crystal, and an ionic crystal.

(d) Compare and contrast source of the cohesive energy for metals and for covalent crystals. Based on this, which of these materials do you expect to be more malleable (able to bend and deform) and why?

- (e) Material 1 is placed in contact with material 2 with  $\mu_1 > \mu_2$  prior to contact. Sketch the charge density and also the potential at the material 1 - material 2 interface.