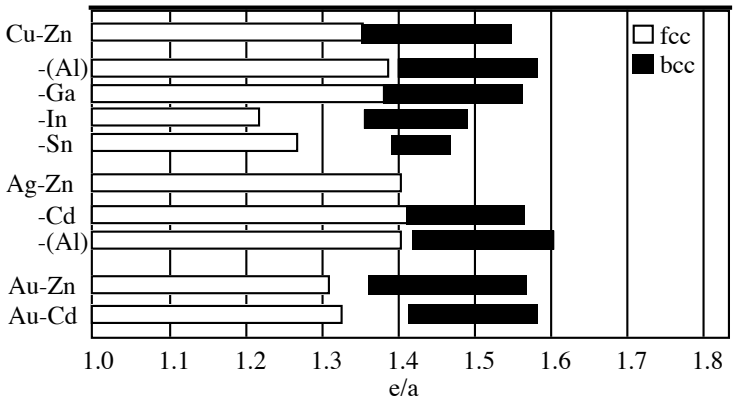
Supplemental Problems for Chapter 8

1) Consider a solid solution (alloy) with the face centered cubic structure containing one metal (A) with a single valence electron per atom and a second metal (B) with two valence electrons per atom. Within the framework of the free electron model, at what alloy composition (A_xB_{1-x}) will the Fermi wave vector of the alloy just reach the boundary of the first Brillouin zone?

2) The data in the Figure below illustrates that at a critical electron concentration, these fcc solutions transform to the bcc structure. Explain why this happens and justify the numerical value of the critical electron concentration.



3) Hume-Rothery's third rule regarding the relationship between electron concentration and the structure of an alloy phase has been rationalized in terms of the nearly-free electron theory. Explain the following points, using the appropriate equations and prose explanations:
(i) Explain why the magnitude of the electron density makes some crystal structures more stable than others,
(ii) Explain why the free electron theory is not able to explain this phenomenon.