※ 考生請注意：本試題不可使用計算機。　請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

1. Please derive the critical radius and activation energy for homogeneous nucleation. (10%)

2. Define and describe the differences between the reconstructive and displacive transformation. (10%)

3. Identify and draw the positions of the FCC octahedral and tetrahedral interstices and calculate the numbers of constitutional atoms, tetrahedral and octahedral sites. (10%)

4. Calculate the theoretical density of the $BaTiO_3$ (10%)
   (crystal system: cubic, a = 4.01Å)，Atomic weight: Ba= 137.32 g/mol, Ti= 47.86 g/mol, O= 16 g/mol
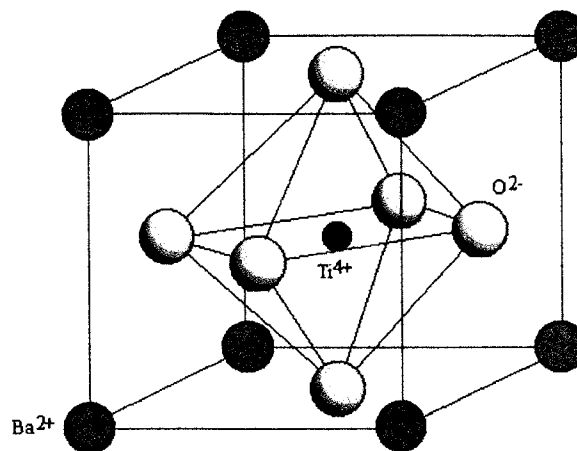
5. Calculate the equilibrium number of vacancies per cubic meter for copper at 1000°C. The energy for vacancy formation is 0.9 eV/atom; the atomic weight and density (at 1000°C) for copper are 63.5 g/mol and 8.40 g/cm^3, respectively. (10%)

6. If electroneutrality is to be preserved, what point defects are possible in NaCl when a Ca^{2+} substitutes for a Na^+ ion? How many of these defects exist for every Ca^{2+} ion? (10%)

7. Using and plotting the electron band structures to explain the insulators, conductors, n-type semiconductors and p-type semiconductors. (10%)

8. Packing density of a structure =fraction of volume in a crystal structure that is occupied by constituent particles. Please derive the packing densities for BCC and FCC structures. (10%)

9. (1) Calculate Miller Indices, given the following intercepts: a' = 3, b' = 2, c' = 4; (2) Sketch a cubic unit cell and in it indicate and label the following directions: [101] (10%)

10. When a solid solution becomes unstable due to a lower temperature, for example exsolution occurs and the two phases separate into distinct microscopic to megascopic lamellae. Use the thermodynamics (Gibbs free energy) to explain why ? (10%)