1. The density of metal niobium is 8.57 g/cm^3; the atomic weight is 92.9. Its lattice parameter is 0.33 nm. Determine whether it has a simple cubic, face-centered cubic, or body-centered cubic crystal structures.

2. The metal copper has an FCC crystal structure. If the angle of diffraction (2θ) for the (111) set of planes occurs at 43.32° (first-order reflection) when monochromatic X-rays having a wavelength of 0.154 nm are used, calculate (a) the interplanar spacing of this set of planes, and (b) the lattice parameter of this structure.

3. The atomic weight and density for copper at 1000°C are 63.5 g/mol and 8.4 g/cm^3, respectively. Calculate the equilibrium number of vacancies per cubic centimeter for copper at 1000°C. The activation energy for vacancy formation is 0.9 eV/atom. The Boltzmann's constant is 8.62×10^{-5} eV/atom-K.

4. A plate of iron is exposed to a carbon-rich atmosphere on one side and a carbon-deficient atmosphere on the other side at 700°C. The carbon concentrations at the two faces are 1.2 and 0.8 Kg/m^3, respectively; the thickness of the plate is 5 mm. If the steady-state condition is achieved, calculate the diffusion flux through the place. Assume the diffusivity of carbon is 3×10^{-11} m^2/s at this temperature.

5. The diffusivity of iron in nickel at 1000°C and 1200°C are 9.4×10^{-16} and 2.4×10^{-14}, respectively. (a) Determine the values of D_0 and the activation energy (in eV) of diffusion. (b) What is the diffusivity at 1100°C?

6. The Young's modulus of copper is 1.1×10^5 MPa. A piece of copper rod originally 300 mm long is pulled axially in tension with a stress of 300 MPa. If the deformation is entirely elastic, what will be the resultant elongation?

7. Using the phase diagram, for a 40 wt% Sn-60 wt% Pb alloy at 150°C, (a) What phases are present? (b) What is the composition of each phase? (c) What is the mass fraction of each phase?

8. The microstructures of three Sn-Pb alloys are:
(a)   (b)   (c)
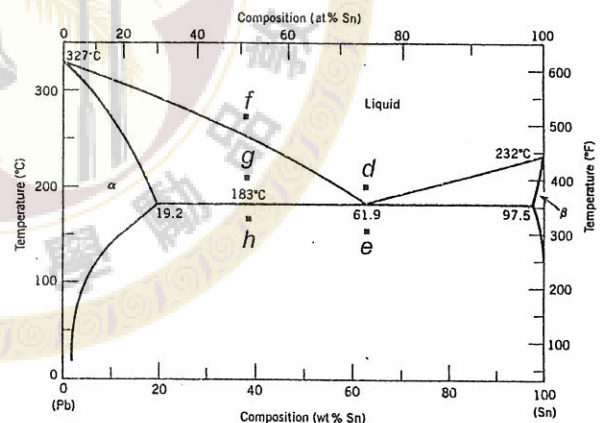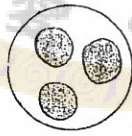
Which points in the phase diagram of problem 7 do the microstructures represent respectively?

9. Magnesium oxide has the rock salt crystal structure and a density of 3.58 g/cm^3. The atomic weights of magnesium and oxygen are 24.3 and 16, respectively. Determine the unit cell edge length.

10. The equilibrium electron and hole concentrations in silicon at room temperature are 1.33×10^{16}/m^3; the electron and hole mobilities are 0.14 and 0.048 m^2/V-s, respectively. What is the room temperature electrical conductivity?

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