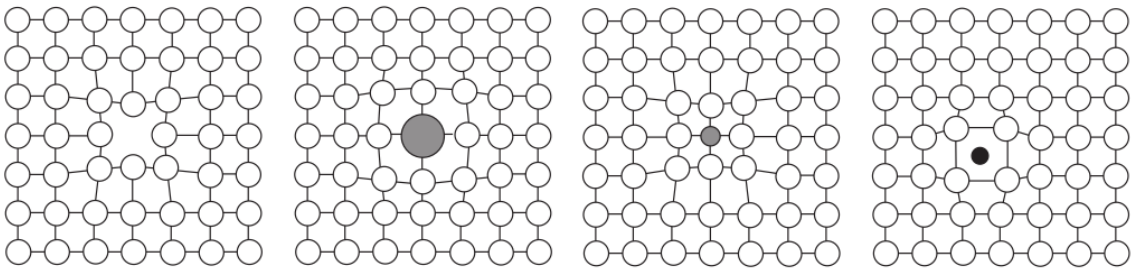
1. Briefly answer the following questions:
    a. Describe the substitutional and interstitial diffusion mechanisms in solid metals
    b. Provide two reasons why interstitial diffusion is normally more rapid than vacancy diffusion

2. What is the composition, in atom percent, of an alloy that consists of 4.5 wt% Pb and 95.5 wt% Sn? The atomic weights for Pb and Sn are 207.19 g/mol and 118.71 g/mol, respectively.

3. What kind of defects are shown in the four figures below? Comment on the specific defect type for each picture.



4. A sheet of steel 1.5 mm thick has nitrogen atmospheres on both sides at 1200°C and is permitted to achieve a steady-state diffusion condition. The diffusion coefficient for nitrogen in steel at this temperature is 6×10^{-11} m2/s, and the diffusion flux is found to be 1.2×10^{-7} kg/m^2·s. Also, it is known that the concentration of nitrogen in the steel at the high-pressure surface is 4 kg/m^3. How far into the sheet from this high-pressure side will the concentration be 2.0 kg/m^2? Assume a linear concentration profile.

5. Nitrogen from a gaseous phase is to be diffused into pure iron at 700°C. If the surface concentration is maintained at 0.2 wt% N, what will be the concentration 1 mm from the surface after 10 h? The diffusion coefficient for nitrogen in iron at 700°C is $2.5 \times 10–11$ m^2/s. Use the following erf (z) information below.

z	erf (*z*)
0.5	0.5205
0.527	*y*
0.55	0.5633

Additional Problems (Solutions posted next week)

1. The energy of vacancy formation in the Ge crystal is about 2.2 eV. Calculate the fractional concentration (nv/N) of vacancies in Ge at 938 °C, just below its melting temperature. What is the vacancy concentration (nv) given that the atomic mass and density ρ of Ge are 72.64 g mol−1 and 5.32 g cm−3, respectively.

2.
   a. What is the composition, in atom percent, of an alloy that consists of 92.5 wt% Ag and 7.5 wt% Cu?

   b. What is the composition, in weight percent, of an alloy that consists of 5 at% Cu and 95 at% Pt?

3. The diffusion coefficients for iron in nickel are given at two temperatures
   a. Determine the values of D_0 and the activation energy Q_d.
   b. What is the magnitude of D at 1100ºC (1373 K)?

T (K)	D (m^2/s)
1273	9.4×10^{-16}
1473	2.4×10^{-14}

4. An FCC iron–carbon alloy initially containing 0.35 wt% C is exposed to an oxygen-rich and virtually carbon-free atmosphere at 1400 K (1127°C). Under these circumstances the carbon diffuses from the alloy and reacts at the surface with the oxygen in the atmosphere; that is, the carbon concentration at the surface position is maintained essentially at 0 wt% C. (This process of carbon depletion is termed decarburization.) At what position will the carbon concentration be 0.15 wt% after a 10-h treatment? The value of D at 1400 K is 6.9 × 10-11 m2 /s.

z	erf (z)
0.40	0.4284
z	0.4286
0.45	0.4755