Answers to suggested problems in Chapter 5

5.1
Self-diffusion is atomic migration in "pure" metals (all atoms exchanging positions are of the same type). Interdiffusion is diffusion of atoms of one metal into another metal.

5.3
a. With vacancy diffusion, atomic motion is from lattice site to an adjacent vacancy. Both self-diffusion and diffusion of substitutional impurities proceed via this mechanism. For interstitial diffusion, atomic motion is from interstitial site to adjacent interstitial site.
b. (1) interstitial atoms are more mobile due to their smaller size and (2) there are a large number of empty interstitial sites than there are vacancies (for substitutional impurity atoms).

5.4
Steady-state diffusion is the situation wherein the rate of diffusion into a given system is just equal to the rate of diffusion out, such that there is no net accumulation or depletion of diffusion species (i.e. diffusion flux is independent of time).

5.5
a. The driving force is that which compels a reaction to occur.
b. The driving for steady-state diffusion is the concentration gradient.

5.6
4.1×10^{-3} kg/h

5.7
1.8 mm

5.11
31.3 h

5.12
1.06 mm

5.16
$D_\alpha = 1.69 \times 10^{-10}\ m^2/s$ (faster)
$D_\gamma = 5.86 \times 10^{-12}\ m^2/s$ (slower)

For <u>α-Fe (BCC)</u>, the atomic packing factor (APF) is 0.68 whereas for <u>γ-Fe (FCC)</u>, the APF is 0.74 (close-packed). Thus, *diffusion of carbon is greater in α-Fe* because there is slightly more interstitial void space in BCC Fe and thus the motion of the interstitial C atoms occurs more easily.

5.17
$8.1 \times 10^{-15}\ m^2/s$