Homework Quiz #8B
solution outline

(a) You have a single crystal of gold. For each of the following defects, state whether you expect it to be present at room temperature and justify your answer with a brief explanation

❶ grain boundaries

No. Grain boundaries, by definition, separate different grains each of which is a region possessing the atomic arrangement of a single crystal. Hence, grain boundaries necessarily are found only in polycrystalline specimens.

❷ vacancies

Yes. Vacancies are thermally activated, so even at room temperature there will be a fraction of unoccupied lattice sites.

(b) In a diffractometer experiment a specimen of cerium is irradiated with silver K_α radiation which has a wavelength, λ, of 0.573 Å. Calculate the angle, θ, of the 4th reflection. The lattice constant, a, for cerium is 5.16 Å.

cerium is FCC, $\therefore$ selection rule is (hkl) all even or all odd: (111), (200), (220), (311)…

use Bragg's Law, $\lambda = 2\,d_{hkl} \sin\theta$, to determine the angle of reflection of (311)

$$d_{311} = \frac{a}{\sqrt{3^2 + 1^2 + 1^2}} = \frac{5.16}{\sqrt{11}} = 1.56\,\mathring{A}$$

$$\lambda = 2\,d_{hkl} \sin\theta$$

$$\therefore \quad \theta = \sin^{-1}\left(\frac{\lambda}{2 \times d_{hkl}}\right) = \sin^{-1}\left(\frac{0.573}{2 \times 1.56}\right) = 10.6°$$