

Quiz-4. Solution.

2) Grain spacing is given by;

$$\lambda^2 = 2D_0 \alpha \tau \exp\left(-\frac{Q}{RT}\right)$$

where,

$$\alpha = \sqrt[3]{\frac{RT}{Q}} = \sqrt[3]{\frac{8.314 \times 1550}{135 \times 10^3}} = 0.4570$$

Calculations for  $\tau$ ,

$$(5 \times 10^{-6})^2 = 2 \times 1 \times 10^{-5} \times 0.4570 \times \tau \times \exp\left(-\frac{135 \times 10^3}{8.314 \times 1550}\right)$$

$$\therefore \tau = 9.696 \times 10^{-12} \text{ sec.}$$

$$D \cdot t = D_0 \alpha \tau \exp\left(-\frac{Q}{RT}\right)$$

$$= 1 \times 10^{-5} \times 0.4570 \times 9.696 \times 10^{-12} \times \exp\left(-\frac{135000}{8.314 \times 1550}\right)$$

$$D \cdot t = 1.2499 \times 10^{-11}$$

Calculations for volume fraction of martensite,

$$b = 1 - (1 - f_i) \exp\left[-\frac{12 f_i^{2/3}}{\sqrt{\pi} \cdot g} \ln\left(\frac{C_e}{2C_0}\right) \sqrt{Dt}\right]$$

$$f_i = 0.5$$

$$\therefore f = 1 - (1 - 0.5) \exp \left[ - \frac{12 \times 0.5^{2/3}}{\sqrt{\pi} \times 10 \times 10^{-6}} \ln \left( \frac{0.8}{2 \times 0.05} \right) \sqrt{0.4} \right]$$

$$f = 0.9782$$

The hardness of the material is given by,

$$H = 1667C - 926 \frac{C^2}{B} + 150.$$

Here,  $C = 0.4$

$$\therefore H = 1667 \times 0.4 - 926 \times \frac{0.4^2}{0.939} + 150$$

$$\boxed{H = 665.33 \text{ HV.}}$$