Asssignment-4 solution

Heat treatment and Surface hardening – II

Week-4

1) The critical radius of nucleus (r*) for homogeneous nucleation of one solid phase (precipitates, let us sayβ) from another solid phase (α) is given by: (where ΔG_v is the volume free energy change per unit volume, ΔG_s is the strain energy per unit volume and γ is the surface interfacial (α/β) energy.)

a) $\frac{2\gamma}{(\Delta G_v - \Delta G_s)}$

b) $\frac{2\gamma+1}{(\Delta G_v - \Delta G_s)}$

c) $\frac{2\gamma-1}{(\Delta G_v - \Delta G_s)}$

d) $\frac{2\gamma}{(\Delta G_v)}$

2) If Z is the co-ordination number, then numbers of atoms of A (N_A) and B (N_B) in mixed condition are related to the number of bonds as:

a) $N_AZ = 2P_{AA} + P_{AB}$ and $N_BZ = 2P_{BB} + P_{AB}$.

b) $N_AZ = 2P_{BB} + P_{AB}$ and $N_BZ = 2P_{AA} + P_{AB}$.

c) $N_AZ = 2P_{BB} - P_{AB}$ and $N_BZ = 2P_{AA} - P_{AB}$.

d) $N_AZ = 2P_{AA} - P_{AB}$ and $N_BZ = 2P_{BB} - P_{AB}$.

3) In the expression for $\Delta H_{mix} = P_{AB}(E_{AB} - (\frac{E_{AA}+E_{BB}}{2}))$, if $E_{AB} < \frac{E_{AA}+E_{BB}}{2}$ then

a) A-A or B-B bond formation is favourable compared to A-B types of bond.

b) A-B bond formation is favourable compared to A-A and B-B types of bond.

c) None of these.

d) Both (a) and (b).

4) The chemical potential of elements A and B in the real regular solution or non-ideal solution is given by:

a) $\mu_A = -G^0_A + \Omega(1-X_A)^2 + RT \ln X_A$ and $\mu_B = -G^0_B + \Omega(1-X_B)^2 + RT \ln X_B$.

b) $\mu_A = G^0_A - \Omega(1-X_A)^2 + RT \ln X_A$ and $\mu_B = G^0_B - \Omega(1-X_B)^2 + RT \ln X_B$.

c) $\mu_A = G^0_A + \Omega(1-X_A)^2 + RT \ln X_A$ and $\mu_B = G^0_B + \Omega(1-X_B)^2 + RT \ln X_B$.

d) $\mu_A = G^0_A + \Omega(1-X_A)^2 - RT \ln X_A$ and $\mu_B = -G^0_B + \Omega(1-X_B)^2 - RT \ln X_B$.

5) Which of the following expression is correct for molar entropy of mixing (ΔS_{mix}) and molar free energy of mixing (ΔG_{mix}) of binary **real (regular solution model) solution** of elements A and B, respectively:

a) $\Delta S_{mix} = -R (X_A \ln X_A + X_B \ln X_B)$ and $\Delta G_{mix} = \Omega X_A X_B + RT (X_A \ln X_A + X_B \ln X_B)$.

b) $\Delta S_{mix} = -R (X_B \ln X_A + X_A \ln X_B)$ and $\Delta G_{mix} = RT (X_B \ln X_A + X_A \ln X_B)$.

c) $\Delta S_{mix} = RT (X_B \ln X_A + X_A \ln X_B)$ and $\Delta G_{mix} = -R (X_B \ln X_A + X_A \ln X_B)$.

d) $\Delta S_{mix} = RT (X_A \ln X_A + X_B \ln X_B)$ and $\Delta G_{mix} = -R (X_A \ln X_A + X_B \ln X_B)$.

6) The molar configurational entropy (ΔS_{mix}) of mixing of elements A and B in case of ideal and non-ideal solution (based on QCM) is:

a) Same and is given by $\Delta S_{mix} = -R (X_A \ln X_A + X_B \ln X_B)$.

b) Different from each other, but **not** given by $\Delta S_{mix} = -R (X_A \ln X_A + X_B \ln X_B)$.

c) Same and is given by $\Delta S_{mix} = -R (X_B \ln X_A + X_A \ln X_B)$.

d) None of these.

7) The total number of A-A type bonds per unit cell per A atom for BCC unit cell considering all the lattice points are decorated with only A type of atoms:

a) 8

b) 2

c) 4

d) 6

8) In the equation $\Delta H_{mix} = \Omega X_A X_B$, if N_o is the Avogadro's number and Z is the co-ordination number, then the correct expression for Ω(omega) will be:

a) $\Omega = N_0 \times Z \times \left(E_{AB} - \left(\frac{E_{AA} + E_{BB}}{2}\right)\right)$

b) $\Omega = N_0 \times Z \times \left(E_{AB} + \left(\frac{E_{AA} + E_{BB}}{2}\right)\right)$

c) $\Omega = N_0 \times \left(E_{AB} - \left(\frac{E_{AA} + E_{BB}}{2}\right)\right)$

d) $\Omega = N_0 \times Z \times \left(E_{AB} - \left(\frac{E_{AA} - E_{BB}}{2}\right)\right)$

9) In Fig. 1, Schematic phase diagram of components A and B have been drawn from G-X plots at five different temperatures. Identify the correct combination of five G-X (a, b, c, d and e) plots, in the options, from which above phase diagram have been drawn. In all the plots including the options (answers) have pure A on left and pure B on right side. Only one option is fully correct, so no partial marking is allowed.

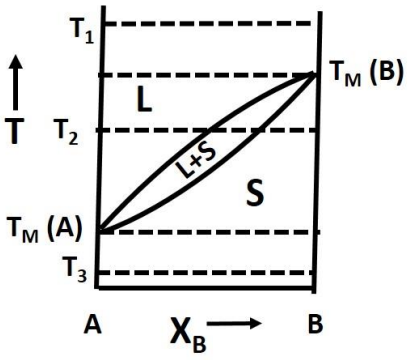
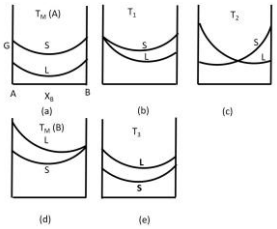


Fig. 1

L= liquid
S= solid
T_MA= Melting point of A
T_MB= Melting point of B

(a)



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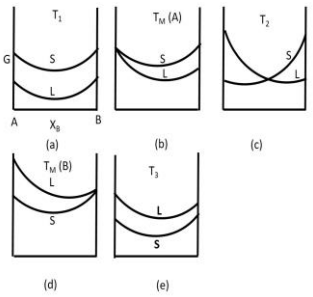

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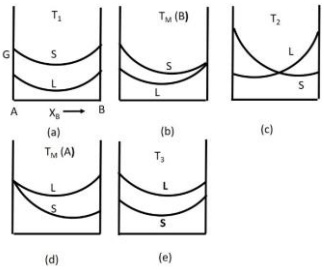
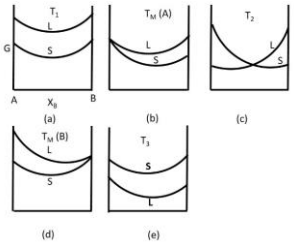


(d)



10) A binary alloy containing 60 atomic % A, 40 atomic % B, solidifies through a binary eutectic reaction to a mixture of α and β phases with following compositions:

α : 80 atomic % A, 20 atomic % B

β: 10 atomic % A, 90 atomic % B

What will be the mole fraction (X) of α, β in the microstructure? Please Mark closest matching answer

a) X_α=0.802, X_β= 0.198

b) X_α= 0.255, X_β= 0.745

c) X_α= 0.643, X_β= 0.357

d) X_α= 0.714, X_β= 0.286