MSE200-002, Chapter 8

Homework solutions

8.2. a) ice and water; b) water and vapor; 3) water, ice and vapor.

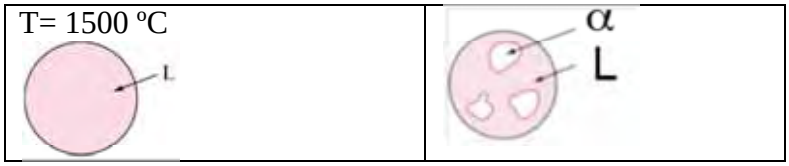
8.3. There are 3 triple point lines.
The lower one: vapor + α Fe + γ Fe
The middle one: vapor + γ Fe + δ Fe
The upper one: vapor + δ Fe + λιθυιδ

8.4. Gibbs phase rule: P + F = C+2, with varying pressure; P+F = C+1, with constant pressure

8.5. a) F= 0, b) F=2

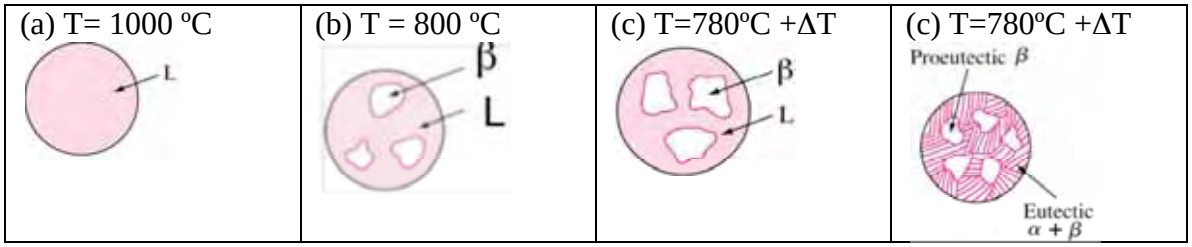
8.6. A system with two components (elements) with unlimited solubility in each other.

8.10. a) at 1350 ºC. i) L + α; ii) C_L: 59% Ni, C_α = 72% Ni;
iii) C_0 = 70% Ni. Fraction of L phase, $X_L = (C_\alpha - C_0)/(C_\alpha - C_L)$ = 15%
Fraction of a phase, $X_\alpha = 1 - X_L$ = 85%
b) at 1500 ºC, Only liquid phase exist, with a composition of 70%.
c)



8.15. C_0 =88%
(a) T= 1000 ºC, (i) L, (ii) C_L = 88% Ag, (iii) 100% L,

(b) T = 800ºC, (i) L+β, (ii) C_L = 78% Ag, C_β= 93% Ag,
(iii) $X_L = (93\%-88\%)/(93\%-78\%) = 33.3\%$, $X_\beta = 1 - X_L = 66.7\%$
(c) T=780ºC +ΔT, (i) L+β, (ii) C_L = 71.9% Ag, C_β= 91.2% Ag,
(iii) $X_L = (91.2\%-88\%)/(91.2\%-71.9\%) = 16.2\%$, $X_\beta = 1 - X_L = 83.4\%$
(d) T=780ºC -ΔT, (i) α+β, (ii) C_α = 7.9% Ag, C_β= 91.2% Ag,
(iii) $X_\alpha = (91.2\%-88\%)/(91.2\%-7.9\%) = 3.8\%$, $X_\beta = 1 - X_\alpha = 96.2\%$



8.16. C_0 =40%, W_0 =500g

(a) T = 850ºC, L+α, C_L = 55%, C_α= 7.8%,

X_L = (40%-7.8%)/(55%-7.8%) = 68.2%, X_β = 1-X_L = 31.8%

W_L = W_0 x X_L = 500g x68.2% = 341 g, W_α = W_0 x X_α = 500g x68.2% = 159 g

(b) T = 780ºC +ΔT, L+α, C_L = 71.9%, C_α= 7.9%,

X_L = (40%-7.9%)/(71.9%-7.9%) = 50.2%, X_β = 1-X_L = 49.8%

W_L = W_0 x X_L = 500g x50.2% = 251 g, W_α = W_0 x X_α = 500g x49.8% = 249 g

(c) T = 780ºC -ΔT, α+β, C_α= 7.9%, C_β= 91.2% Ag

X_α = (91.2%-40%)/(91.2%-7.9%) = 61.5%,

W_α = W_0 x X_α = 500g x61.5% = 307 g

(d) X_β = 1-X_α = 38.5%

W_β = W_0 x X_β = 500g x61.5% = 193 g

8.17. T = 183ºC –ΔT, $X_{proeutectic\ \beta}$ = 60%, $X_{eutectic}$ = 40% (Corrected), $C_{eutectic}$ = 61.9%, C_β= 97.5%, find C_0

$X_{proeutectic\ \beta}$ = 60% = (C_0- $C_{eutectic}$)/(C_β- $C_{eutectic}$) = (C_0-61.9%)/(97.5%-61.9%)

C_0 = 83.26%

8.18. T = 50ºC, X_β = 40%, X_α = 60%, C_α = 3%, C_β= 100%, find C_0

X_β = 40% = (C_0- C_α)/(C_β- C_α) = (C_0-3%)/(100%-3%)

C_0 = 41.8%

8.19. C_0= 70% Sn,

(a) hyper eutectic, (b) 98% Sn,

(c) at T = 183ºC +ΔT, C_L = 61.9%, C_β= 97.5%,

X_L = (97.5%-70%)/(97.5%-61.9%) = 77.2%, X_β = 1-X_L = 2.8%

(d) at T = 183ºC –ΔT, C_α= 19.2%, C_β= 97.5%,

X_α = (97.5%-70%)/(97.5%-19.2%) = 35.1%, X_β = 1-X_L = 64.9%

(e) C_α = 1%, C_β= 100%,

X_α = (100%-70%)/(100%-1%) = 30.3%, X_β = 1-X_L = 69.7%

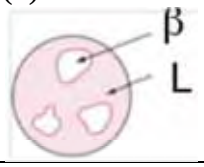
8.20. C_0 = 30 wt% Os

(a) at T = 2600ºC, (i) L + α, (ii) C_L = 17%, C_α= 39%,

(iii) X_L = (39%-30%)/(39%-17%) = 41.0%, X_α = 1-X_L = 59.0%

(b) at T = 2665ºC +ΔT, (i) L + β, (ii) C_L = 23.0%, C_β= 61.5%,
(iii) X_L = (61.5%-30%)/(61.5%-23%) = 81.8%, X_β = 1-X_L = 18.2%

(c) at T = 2665ºC -ΔT, (i) L + α, (ii) C_L = 23.0%, C_α= 43.0%,
(iii) X_L = (43%-30%)/(43%-23%) = 65%, X_β = 1-X_L = 35%

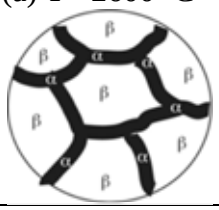
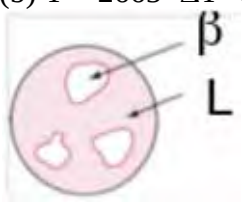
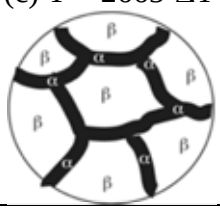
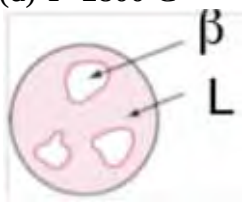
(a) T= 2600 ºC	(b) T = 2665+ΔT ºC	(c) T = 2665-ΔT ºC
		

8.21. C_0 = 60 wt% Os
(a) at T = 2600ºC, (i) α+β, (ii) C_α= 42.5%, C_β= 61.4%,
(iii) X_α = (61.4%-60%)/(61.4%-42.5%) = 7.4 %, X_β = 1-X_α = 92.6%

(b) at T = 2665ºC +ΔT, (i) L + β, (ii) C_L = 23.0%, C_β= 61.5%,
(iii) X_L = (61.5%-60%)/(61.5%-23%) = 3.9%, X_β = 1-X_L = 96.1%

(c) at T = 2665ºC -ΔT, (i) α+β, (ii) C_α= 43.0%, C_β= 61.5%,
(iii) X_α = (61.5%-60%)/(61.5%-43.0%) = 8.1 %, X_β = 1-X_α = 91.9%

(d) T = 2800ºC +ΔT, (i) L + β, (ii) C_L = 45%, C_β= 87%,
(iii) X_L = (87%-60%)/(87%-45%) = 40.5%, X_β = 1-X_L = 59.5%

(a) T= 2600 ºC	(b) T = 2665+ΔT ºC	(c) T = 2665-ΔT ºC	(d) T=2800ºC
			

8.24. C_0 =4.2%. C_α = 4.0%, C_L = 5.4%. At the peritectic temperature (1517°C), the weight% of alloy solidifies equals the L% left just before the peritectic reaction.
X_L = (4.2%-4.0%)/(5.4%-4.0%) = 14%

8.26. C_0 =4.2%. C_α = 4.0%, C_L = 5.4%. At the 1517°C + ΔT, there are two phases: α +L.
From 8.24: X_L = 14%, X_α = 1-X_L =86%

8.29. C_0 = 10% Pb,
(a) at T=100℃, two phases: pure Cu, C_{Cu} = 0% Pb, and Pb: C_{Pb}=100% Pb,
X_{Pb} = (10%-0)/(100%-0) = 10%, X_{Cu} = 1-X_{Pb} = 90%

(b) (a) at T=955 + ΔT℃, two phases: $\alpha + L_1$, C_α = 0% Pb, and Pb: C_{L1}=36% Pb,
X_{L1} = (10%-0)/(36%-0) = 27.8%, X_α = 1-X_{L1} = 72.2%

(c) (a) at T=955 - ΔT℃, two phases: $\alpha + L_2$, C_α = 0% Pb, and Pb: C_{L2}=87% Pb,
X_{L2} = (10%-0)/(87%-0) = 11.5%, X_α = 1-X_{L2} = 88.5%

(d) at T=200℃. The same as at T=100℃.

8.31. at T=955 + ΔT℃, two phases: $\alpha + L_1$, C_α = 0% Pb, and Pb: C_{L1}=36% Pb,
X_{L1} = 30%, find C_0

X_{L1} = (C_0-0)/(36%-0) = 30%, C_0 = 10.8%