**Answer key for Atkins**
**List B problems**
**Up to End of Chapter 8**
**Version 1.4 - Dec. 8, 2002**

***Keep looking for updated versions of this file - further chapters will be included***

## Chapter 1

1.1 146 kPa
1.2 (a) 10.5 bar (b) 10.4 bar
1.3 (a) 8.04 x $10^2$ Torr (b) 1.07 bar
1.4 92.4 K
1.5 120 kPa
1.6 2.67 x $10^3$ kg
1.7 0.0820615 L atm $K^{-1}$ $mol^{-1}$, $M$ = 31.9987 g $mol^{-1}$
1.8 $P_4$
1.9 2.61 kg
1.10 (a) 3.14 L (b) 212 Torr
1.11 16.4 g $mol^{-1}$
1.13 (a) 7.079 (b) 1
1.14 (a) 4.75 x $10^2$ m $s^{-1}$ (b) 4 x $10^4$ m (c) 1 x $10^{-2}$ $s^{-1}$
1.15 2.4 x $10^7$ Pa
1.16 4.1 x $10^{-7}$ m
1.17 9.9 x $10^8$ $s^{-1}$
1.18 (a) 3.7 x $10^{-9}$ m (b) 5.5 x $10^{-8}$ m (c) 4.1 x $10^{-5}$ m
1.19 9.6 x $10^{-2}$
1.22 (a) 1.12 (b) 2.7 L $mol^{-1}$
1.23 (a) 0.124 L $mol^{-1}$ (b) $x$ = 0.108 or $V_m$ = 0.108 L $mol^{-1}$
1.24 (a) 0.9963 (b) 0.9954
1.25 (a) 8.7 mL (b) -0.15 L $mol^{-1}$
1.26 (a) $x_N$ = 0.63, $x_H$ = 0.37 (c) 4.0 atm (b) $p_N$ = 2.5 atm, $p_H$ = 1.5 atm
1.27 (a) 0.0493 L $mol^{-1}$ (b) 3.16 $L^2$ atm $mol^{-2}$ (c) 231 K
1.29 $H_2S$: 2.6 atm, 881 K; $CO_2$: 2.2 atm, 718 K; Ar: 1.4 atm, 356 K

## Chapter 2

2.1 (a) 4.9 x $10^3$ J (b) 1.9 x $10^3$ J
2.2 59 J
2.3 -91 J
2.4 (a) $w$ = -1.62 x $10^3$ J, $q$ = 1.62 x $10^3$ J (b) $w$ = -1.38 x $10^3$ J, $q$ = 1.38 x $10^3$ J
(c) $w = q = 0$
2.5 $q$ = 3.28 x $10^3$ J, $\Delta U$ = 3.28 x $10^3$ J
2.6 -52.8 J
2.7 +6.01 J
2.9 -188 J

2.11 (a) $\Delta H = 14.9 \times 10^3$, $w = -831$ J, $\Delta U = 14.1$ kJ (b) $w = 0$, $q = +14.1$ kJ
2.13 -325 J
2.14 8.5 Torr
2.15 $p_i = 1.9$ atm, $p_f = 0.46$ atm
2.17 $C_{p,m} = 53$ J K$^{-1}$ mol$^{-1}$, $C_{V,m} = 45$ J K$^{-1}$ mol$^{-1}$
2.18 $\Delta H = -2.3$ kJ, $C = 0.18$ kJ K$^{-1}$
2.20 $q = 0$, $w = -3.5 \times 10^3$ J, $\Delta U = -3.5 \times 10^3$ J, $\Delta T = -24$ K, $\Delta H = -4.5 \times 10^3$ J
2.21 $q = 0$, $w = 2.4 \times 10^3$ J, $\Delta U = = 2.4 \times 10^3$ J, $\Delta H = 3.1 \times 10^3$ J,
$V_f = 14$ L, $p_f = 3.8 \times 10^5$ Pa
2.22 $V_f = 0.0201$ m$^3$, $T_f = 275$ K, $w = -7.5 \times 10^2$ J
2.23 $1.8 \times 10^{-3}$ cm$^3$
2.25 (a) $T_f = 164$ K (b) $T_f = 171$ K
2.26 $q = 24.0$ kJ, $w = -1.6$ kJ, $\Delta U = 22.4$ kJ
2.27 -3053.6 kJ mol$^{-1}$
2.28 -126 kJ mol$^{-1}$
2.32 $C = 69.3$ J K$^{-1}$, $\Delta T = +63.1$ K
2.34 +84.40 kJ mol$^{-1}$
2.38 (a) $\nu$(gr) = 1, $\nu$(dia) = -1, exothermic
(b) $\nu$(FeO,s) = 3, $\nu$($CO_2$, g) = 1, $\nu$($Fe_3O_4$,s) = -1, $\nu$(CO, g) = -1, endothermic
(c) $\nu$($Fe_3O_4$,s) = 1, $\nu$(CO, g) = 1, $\nu$(FeO,s) = -3, $\nu$($CO_2$, g) = -1, exothermic
2.44 (a) -175 & -173 kJ mol$^{-1}$, (b) -176 kJ mol$^{-1}$

**Chapter 3** - numerical answers provided below
3.10 0.48 K atm$^{-1}$
3.11 $q = +7.7469$ kJ mol$^{-1}$, $w = -7.62$ kJ mol$^{-1}$
3.12 $1.27 \times 10^3$ K$^{-1}$
3.13 $3.6 \times 10^2$ atm
3.14 $\mu_T = -41.2$ J atm$^{-1}$ mol$^{-1}$, $\Delta H = 27.2 \times 10^3$ J
3.15 $-3.4 \times 10^2$ kPa

**Chapter 4**
4.1 (a) $1.8 \times 10^2$ J K$^{-1}$ (b) $1.5 \times 10^2$ J K$^{-1}$
4.2 $S = 152.65$ J K$^{-1}$ mol$^{-1}$
4.3 9.08 J K$^{-1}$
4.4 -7.3 J K$^{-1}$
4.5 $q = 0$, $\Delta S = 0$, $\Delta U = w = +2.75$ kJ, $\Delta H = 3.58$ kJ
4.6 76.9 J K$^{-1}$
4.7 $q \neq q_{rev}$, process is not reversible
4.8 (a) $-58.2 \times 10^3$ J (b) -193 J K$^{-1}$
4.9 17 J K$^{-1}$
4.10 6.00 L
4.11 0.2 J K$^{-1}$
4.12 $\Delta H_{tot} = 0$, $\Delta S_{tot} = 24$ J K$^{-1}$
4.13 (a) $q = 0$ (b) $w = -230$ J (c) $\Delta U = -230$ J (d) $\Delta T = -5.3$ K (e) $\Delta S = 3.2$ J K$^{-1}$
4.14 (a) 104.6 J K$^{-1}$ (b) -104.6 J K$^{-1}$
4.15 (a) -21.0 J K$^{-1}$ (b) +512.0 J K$^{-1}$ mol$^{-1}$

4.16 (a) -212.40 kJ $mol^{-1}$ (b) -5798 kJ $mol^{-1}$
4.17 (a) -212.55 kJ $mol^{-1}$ (b) -5798 kJ $mol^{-1}$
4.18 -86.2 kJ $mol^{-1}$
4.19 -197 kJ $mol^{-1}$
4.20 (a) $\Delta S$ = 3.0 J $K^{-1}$, $\Delta S_{sur}$ = -3.0 J $K^{-1}$, $\Delta S_{tot}$ = 0
(b) $\Delta S$ = 3.0 J $K^{-1}$, $\Delta S_{sur}$ = 0, $\Delta S_{tot}$ = -3.0 J $K^{-1}$
(c) All = 0
4.21 (3/2) $nR$ ln 3
4.22 2108.11 kJ $mol^{-1}$
4.23 (a) 0.500 (b) 0.50 kJ (c) 0.5 kJ

**Chapter 5** - numerical answers provided below
5.1 -$\alpha V$
5.2 -2.0 J
5.3 -42.8 J $K^{-1}$
5.4 3.2 kJ
5.5 (a) 274 kPa (b) 3.45 kJ
5.6 2.71 kJ $mol^{-1}$
5.7 -0.93 kJ $mol^{-1}$
5.8 -1.924 x $10^{-7}$ $Pa^{-1}$
5.9 200 J
5.10 +2.88 kJ $mol^{-1}$

**Chapter 6** - numerical answers provided below
6.1 23ºC
6.2 $\Delta_{fus}S$ = 5.5 J $K^{-1}$ $mol^{-1}$, $\Delta_{fus}H$ = 2.4 kJ $mol^{-1}$
6.3 25.25 kJ $mol^{-1}$
6.4 (a) 31.11 kJ $mol^{-1}$ (b) 276.9 K
6.5 272 K
6.6 3.6 kg $s^{-1}$
6.7 Partial pressure of 3 Torr required to make sure frost remains
6.9 (a) 29.1 kJ $mol^{-1}$ (b) 0.22 atm, 0.76 atm
6.10 272.41 K
6.11 6.73%
6.12 5.92 kPa
6.13 7.12 x $10^{-2}$ N $m^{-1}$
6.14 2.04 x $10^{5}$ Pa

**Chapter 7**
7.1 843.5 $cm^3$
7.2 18 $cm^3$
7.3 8.2 x $10^3$ kPa
7.4 1.5 x $10^2$ kPa
7.5 7.1 K kg $mol^{-1}$, 4.99 K kg $mol^{-1}$
7.6 270 g $mol^{-1}$
7.7 178 g $mol^{-1}$

7.8 -0.077°C
7.9 $6.34 \times 10^{-2}$ J $K^{-1}$
7.10 +11.5 J $K^{-1}$ , 0
7.11 $n_B/n_E = 1$, $m_B/m_E = 0.7358$
7.12 0.51 mmol $kg^{-1}$, 0.27 mmol $kg^{-1}$
7.13 0.067 mol $L^{-1}$
7.14 -0.52°C
7.15 11 kg
7.16 $M = 14.0$ kg $mol^{-1}$
7.17 0.980
7.18 -3536 J $mol^{-1}$, 212 Torr
7.19 0.436, 0.755

**Chapter 8**

8.1 0.5 and 0.5
8.2 0.653, 0.347, $p = 73.4$ kPa
8.3 (a) Raoult's law predicts pressure of boiling liquid. Solution is ideal
(b) 0.4582, 0.5418
8.4 (a) 48 Torr
(b) 0.77, 0.23
(c) 0.5, 0.5, 34 Torr
8.5 See. Fig. 8.1, (a) $y_A = 0.81$, (b) $x_A = 0.67$, $y_A = 0.925$
8.6 Three equilibria, One condition of electrical neutrality, $C = 7 - (3 + 1) = 3$
8.7 (a) $C = 1$, $P = 2$ (b) $C = 2$, $P = 2$ ($NH_4Cl$ and $NH_3$ now independent)
8.8 (a) $C = 2$, $P = 2$ (b) $F = 2 - 2 + 2 = 2$
8.9 See Figs. 8.2a, b
8.10 See Fig. 8.3
8.11 See Fig. 8.4
8.12 See Fig. 8.5. N.B., figs. in text and solution do not match exactly
8.13 See Fig. 8.6. $x_B = 0.53$, $T = T_2$; $x_B = 0.82$, $T = T_3$
8.14 See Fig. 8.7
8.15 (a) $x_B = 0.75$, (b) $x_{AB2} = 0.8$, (c) $x_{AB2} = 0.6$
8.16 See Fig. 8.8. Solid soln $x(ZrF_4) = 0.24$ at 855°C. Solid solution continues to form and $ZrF_4$ content increases until $x(ZrF_4) = 0.4$ at 820°C. At this temp, entire sample is solid.
8.17 Fig. 8.9.
8.18 Refer to 8.17(a) student solutions manual. Cooling curves in Fig. 8.10.
8.19 (a) $x_A = 0.47$, second liquid phase appears. Amt of new phase increases as $x_A$ falls and the amt of the original phase decreases until at $x_A = 0.314$, only one liquid remains.
(b) Single liquid phase at all compositions. See Fig. 8.11.

**Chapter 8 B-List Phase Diagrams are below:**

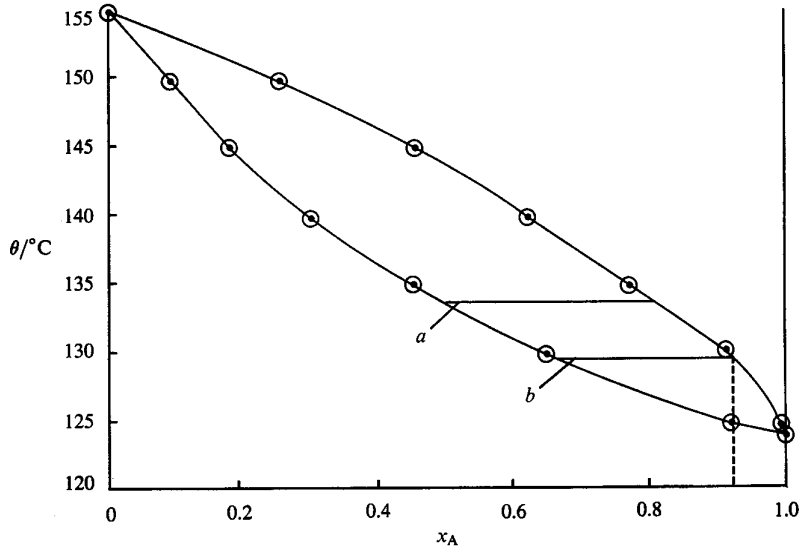


**Figure 8.1**

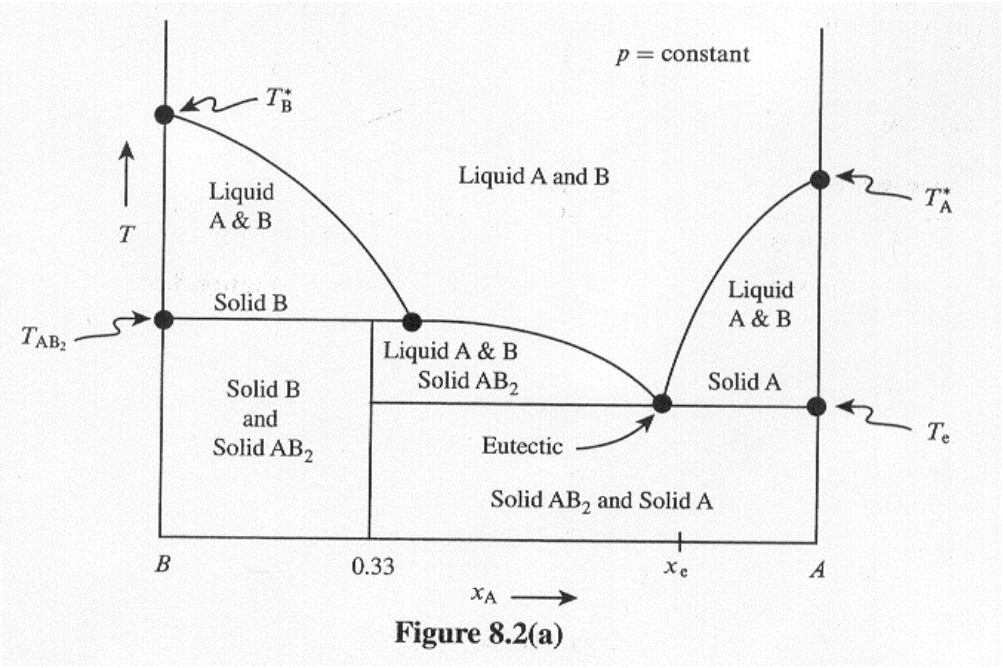


**Figure 8.2(a)**

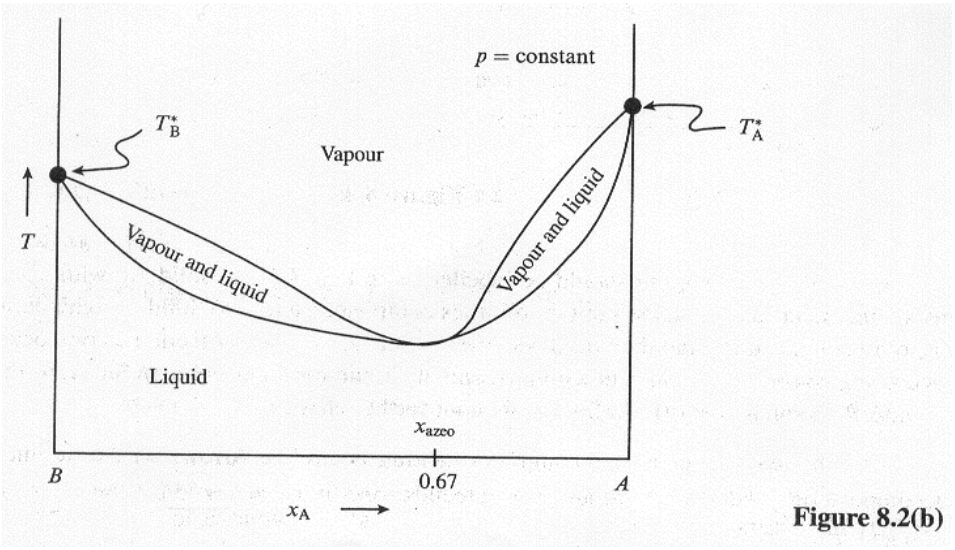


**Figure 8.2(b)**

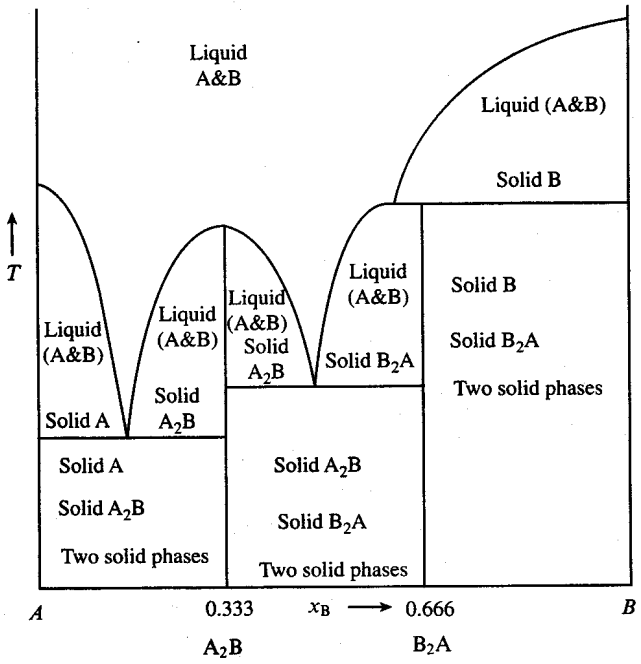


**Figure 8.3**

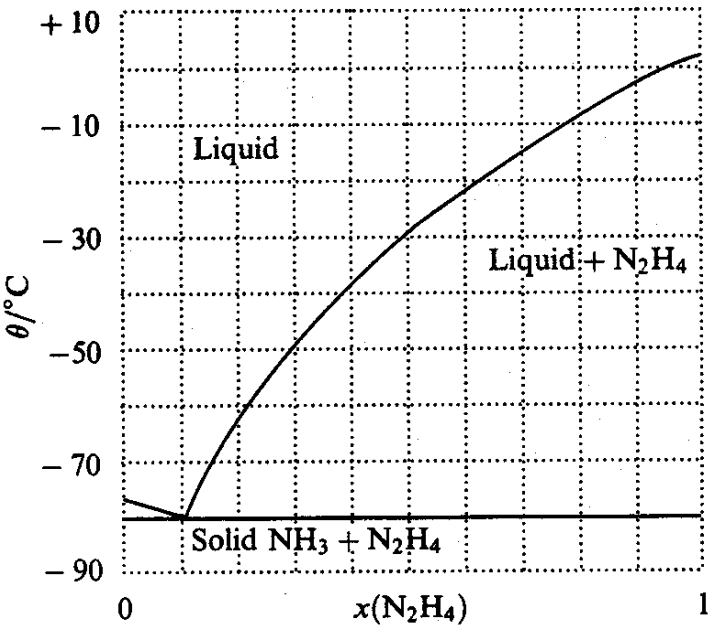


**Figure 8.4**

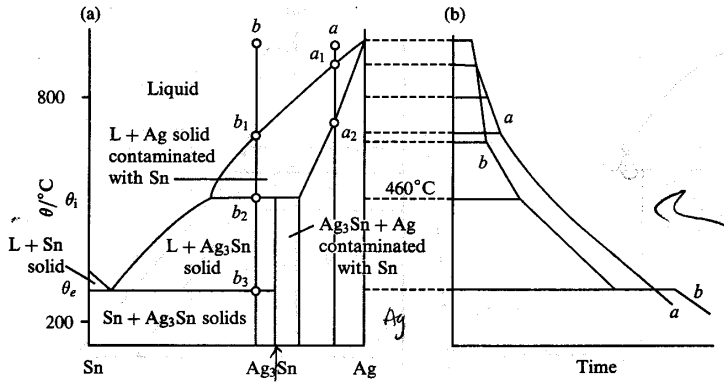


**Figure 8.5**

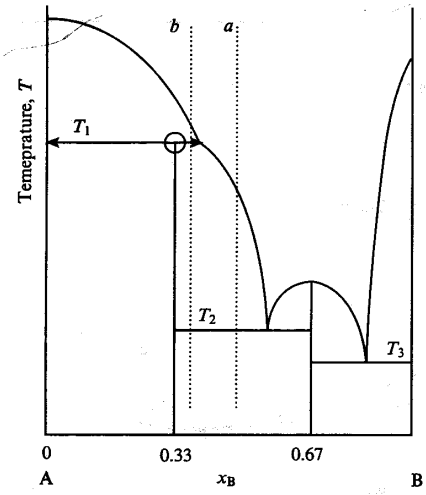


**Figure 8.6**

Does not match figure in book precisely

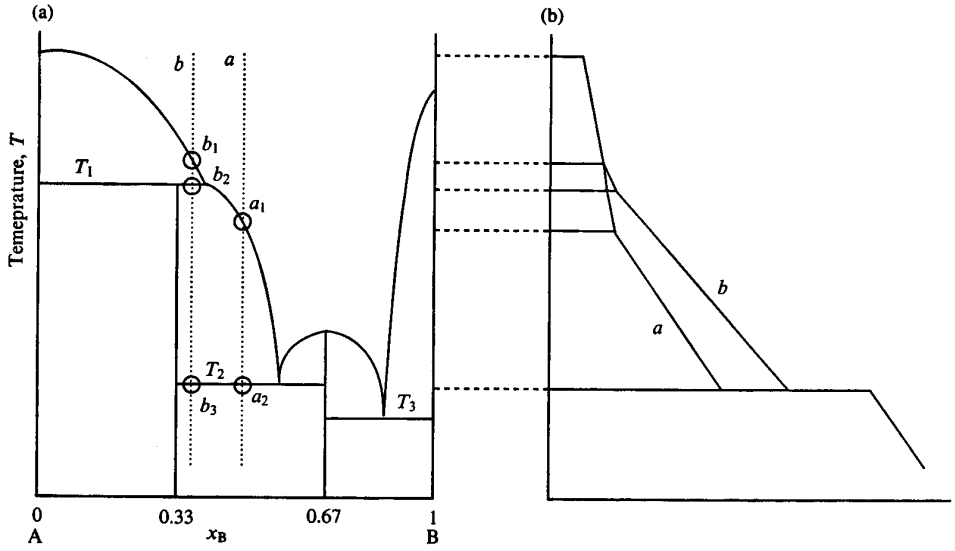


**Figure 8.7**

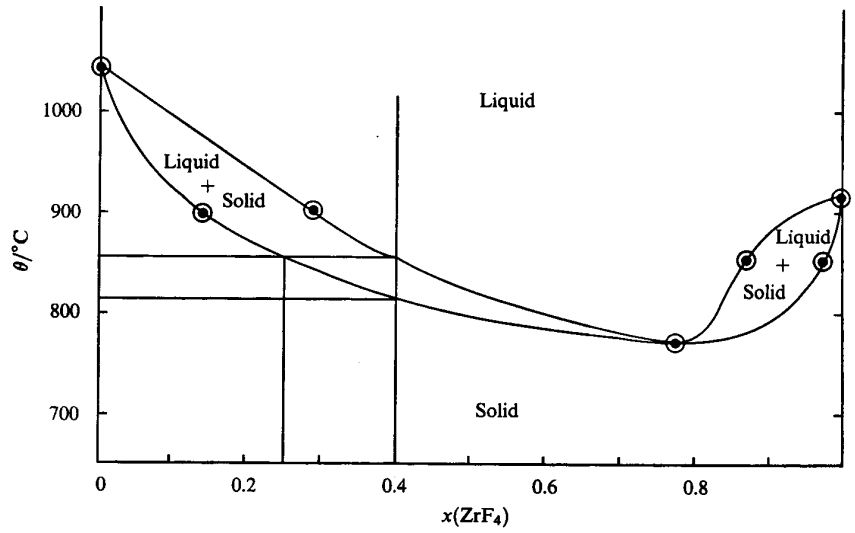


**Figure 8.8**

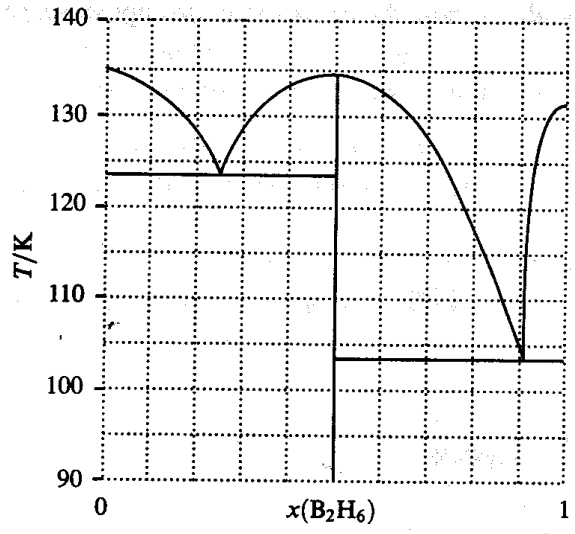


**Figure 8.9**

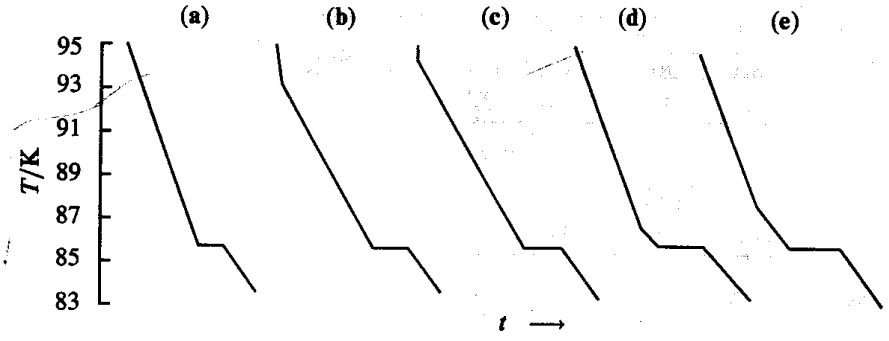


**Figure 8.10**

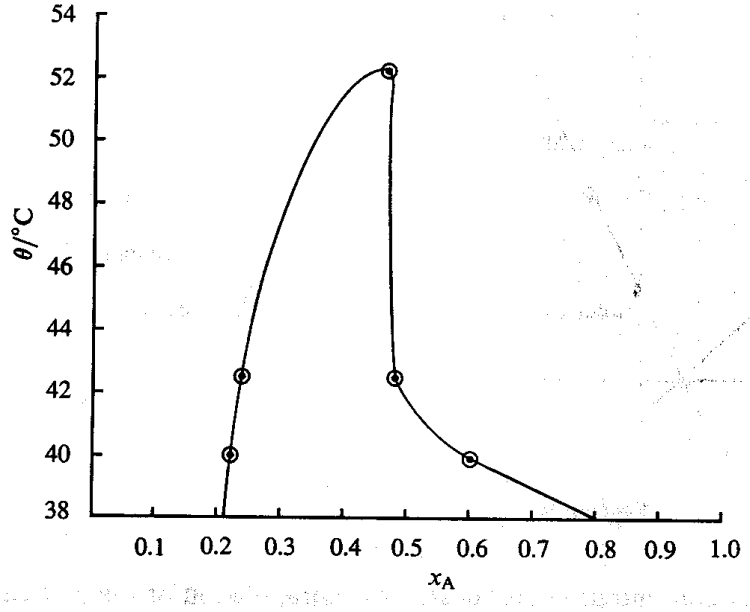


**Figure 8.11**