

**Answer Key for Atkins' - 7<sup>th</sup> Edition - "B" problems only  
Up to end of Lecture 17 - November 15, 2005**

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**Lecture 1**

- 1.4 830 kPa  
1.6 (a)  $8.04 \times 10^2$  Torr (b) 1.07 bar  
1.7 92.4 K  
1.9  $2.67 \times 10^3$  kg  
1.10  $0.0820414 \text{ L atm K}^{-1} \text{ mol}^{-1}$ ,  $M = 31.9987 \text{ g mol}^{-1}$

**Lecture 2**

- 1.11  $\text{P}_4$   
1.13 (a) 3.14 L (b) 212 Torr  
1.14  $16.4 \text{ g mol}^{-1}$   
1.22 (a)  $x_{\text{N}_2} = 0.63$ ,  $x_{\text{H}_2} = 0.37$  (b)  $p_{\text{N}_2} = 2.5 \text{ atm}$ ,  $p_{\text{H}_2} = 1.5 \text{ atm}$  (c) 4.0 atm

**Lecture 3**

- 24.4 (a) 7.079 (b) 1  
24.5 (a)  $4.75 \times 10^2 \text{ m s}^{-1}$  (b)  $4.4 \times 10^4 \text{ m}$  (c)  $1 \times 10^{-2} \text{ s}^{-1}$   
24.6  $2.4 \times 10^7 \text{ Pa}$   
24.7  $4.1 \times 10^{-7} \text{ m}$   
24.8  $9.9 \times 10^8 \text{ s}^{-1}$   
24.9 (a)  $3.7 \times 10^{-9} \text{ m}$  (b)  $5.5 \times 10^{-8} \text{ m}$  (c)  $4.1 \times 10^{-5} \text{ m}$   
24.10 0.092

**Lecture 4**

- 1.16 (a-i) 1.0 atm (a-ii) 270 atm (b-i) 0.99 atm (b-ii) 190 atm  
1.18 (a) 1.12 (b)  $2.7 \text{ L mol}^{-1}$  - repulsive forces dominate  
1.19 (a)  $0.124 \text{ L mol}^{-1}$  (b)  $x = 0.112$  or  $V_m = 0.112 \text{ L mol}^{-1}$   
1.21 (a) 8.7 mL (b)  $-0.15 \text{ L mol}^{-1}$   
1.23  $a = 0.0493 \text{ L mol}^{-1}$ ,  $b = 3.16 \text{ L}^2 \text{ atm mol}^{-1}$ ,  $r = 2.69 \text{ \AA}$   
1.25 (a)  $p = 2.6 \text{ atm}$ ,  $T = 881 \text{ K}$  (b)  $p = 2.2 \text{ atm}$ ,  $T = 718 \text{ K}$  (c)  $p = 1.4 \text{ atm}$ ,  $T = 356 \text{ K}$

**Lecture 5**

No questions assigned

**Lecture 6**

- 2.4 (a)  $4.9 \times 10^3 \text{ J}$  (b)  $1.9 \times 10^3 \text{ J}$

- 2.5 59 J  
 2.6 -91 J  
 2.8  $p_2 = 1.41 \text{ atm}$ ,  $\Delta U = 3.28 \times 10^3 \text{ J}$ ,  $q = 3.28 \times 10^3 \text{ J}$ ,  $w = 0 \text{ J}$   
 2.9 (a) -19 J (b) -53 J  
 2.10 6.01 J  
 2.12 -190 J

### Lecture 7 - Set I

- 2.7 (a)  $w = -1.62 \text{ kJ}$ ,  $q = 1.62 \text{ kJ}$  (b)  $w = -1.38 \text{ kJ}$ ,  $q = 1.38 \text{ kJ}$  (c)  $w = q = 0 \text{ J}$   
 2.14 (a)  $q = \Delta H = 14.9 \text{ kJ}$ ,  $w = -831 \text{ J}$ ,  $\Delta U = 14.1 \text{ kJ}$   
 (b)  $w = 0 \text{ J}$ ,  $q = \Delta U = 14.1 \text{ kJ}$ ,  $\Delta H = 14.9 \text{ kJ}$   
 2.16 -325 J  
 2.17 8.5 Torr  
 2.18 0.46 atm  
 2.20  $C_{p,m} = 53 \text{ J K}^{-1} \text{ mol}^{-1}$ ,  $C_{v,m} = 44 \text{ J K}^{-1} \text{ mol}^{-1}$

### Lecture 7 - Set II

- 2.21  $\Delta H = -2.3 \text{ kJ}$ ,  $q = -2.3 \text{ kJ}$ ,  $C_{p,m} = 5.8 \text{ J K}^{-1} \text{ mol}^{-1}$   
 2.23  $q = 0 \text{ J}$ ,  $w = \Delta U = -3.5 \text{ kJ}$ ,  $\Delta T = -24 \text{ K}$ ,  $\Delta H = -4.5 \text{ kJ}$   
 2.24  $q = 0 \text{ J}$ ,  $w = \Delta U = 2.4 \text{ kJ}$ ,  $\Delta H = 3.1 \text{ kJ}$ ,  $V_f = 14 \text{ L}$ ,  $p_f = 3.74 \text{ atm}$   
 2.25  $V_f = 20 \text{ L}$ ,  $T_f = 279 \text{ K}$ ,  $w = -670 \text{ J}$   
 2.27  $q = 0 \text{ J}$ ,  $w = \Delta U = -36 \text{ J}$ ,  $\Delta T = -0.58 \text{ K}$ ,  $\Delta H = -51 \text{ J}$   
 2.28 (a) 164 K (b) 171 K

### Lecture 8

- 2.29  $\Delta H = q = 24.0 \text{ kJ}$ ,  $w = -1.6 \text{ kJ}$ ,  $\Delta U = 22.4 \text{ kJ}$   
 2.30  $-3053.6 \text{ kJ mol}^{-1}$   
 2.31  $-126 \text{ kJ mol}^{-1}$   
 2.35  $C = 66.1 \text{ J K}^{-1}$ ,  $\Delta T = 66.2 \text{ K}$  (Using  $\Delta_f H^\circ(\text{C}_{14}\text{H}_{10}) = 125.5 \text{ kJ mol}^{-1}$ )  
 2.36  $84.4 \text{ kJ mol}^{-1}$   
 2.37  $1.9 \text{ kJ mol}^{-1}$   
 2.39 (a)  $-32.88 \text{ kJ mol}^{-1}$  (b)  $-55.84 \text{ kJ mol}^{-1}$   
 2.40 (a)  $\Delta_r H^\circ = -589.56 \text{ kJ mol}^{-1}$ ,  $\Delta_r U^\circ = -587.08 \text{ kJ mol}^{-1}$   
 (b)  $\Delta_r H^\circ(\text{HI}) = 26.48 \text{ kJ mol}^{-1}$ ,  $\Delta_r H^\circ(\text{H}_2\text{O}) = -241.82 \text{ kJ mol}^{-1}$   
 2.44 (a)  $\Delta_r H^\circ = -175 \text{ kJ mol}^{-1}$ ,  $\Delta_r U^\circ = -173 \text{ kJ mol}^{-1}$  (b)  $-176 \text{ kJ mol}^{-1}$   
 2.45  $-1587 \text{ kJ mol}^{-1}$

### Transition Lecture (selected answers)

- 3.4 see solution of 3.4(a)  
 3.5  $dz = [(1 + y)^{-2}]dx - [2x(1 + y)^{-3}]dy$

- 3.6  $dz = [3x^2 - 2y^2]dx - [4xy]dy$   
 3.7  $dz = [2xy + y^2]dx + [x^2 + 2xy]dy$   
 3.8 see solution of 3.8(a)

### Lecture 9

- 3.10  $d \ln p = (p\kappa_T)^{-1}(\alpha dT - dV/V)$   
 3.12  $\alpha = 1/T, \kappa_T = 1/p$   
 3.13  $0.48 \text{ K atm}^{-1}$   
 3.14  $\Delta U_m = 129 \text{ J mol}^{-1}, q = 7.75 \text{ kJ mol}^{-1}, w = -7.62 \text{ kJ mol}^{-1}$   
 3.15  $1.27 \times 10^{-3} \text{ K}^{-1}$   
 3.16  $360 \text{ atm}$   
 3.17  $\mu_T = -41.2 \text{ J mol}^{-1} \text{ atm}^{-1}, q = \Delta H = 27.2 \text{ kJ}$   
 3.18  $-3.3 \text{ atm}$

### Lecture 10

- 4.4 (a)  $180 \text{ J K}^{-1}$  (b)  $150 \text{ J K}^{-1}$   
 4.5  $152.65 \text{ J K}^{-1} \text{ mol}^{-1}$   
 4.6  $9.08 \text{ J K}^{-1}$   
 4.7  $-7.3 \text{ J K}^{-1}$   
 4.8  $q = \Delta S = 0, \Delta U = w = 2.75 \text{ kJ}, \Delta H = 3.58 \text{ kJ}$   
 4.9  $76.9 \text{ J K}^{-1}$   
 4.10 not reversible  
 4.11 (a)  $-58.2 \text{ kJ}$  (b)  $-193 \text{ J K}^{-1}$   
 4.12  $17 \text{ J K}^{-1}$   
 4.13  $6.0 \text{ L}$

### Lecture 11

- 4.14  $0.2 \text{ J K}^{-1}$  \*\*\*if proper  $T$  used, should be  $+12.8 \text{ J K}^{-1}$   
 4.15  $\Delta H_{\text{tot}} = 0 \text{ J}, \Delta S_{\text{tot}} = 24 \text{ J K}^{-1}$   
 4.18 (a)  $-21.0 \text{ J K}^{-1} \text{ mol}^{-1}$  (b)  $512.0 \text{ J K}^{-1} \text{ mol}^{-1}$   
 4.19 (a)  $-212.40 \text{ kJ mol}^{-1}$  (b)  $-5798 \text{ kJ mol}^{-1}$   
 4.20 (a)  $-212.55 \text{ kJ mol}^{-1}$  (b)  $-5798 \text{ kJ mol}^{-1}$   
 4.24  $(1.5nR)\ln(3)$   
 4.25  $2108.11 \text{ kJ mol}^{-1}$   
 4.26 (a)  $0.50$  (b)  $500 \text{ J}$  (c)  $500 \text{ J}$

### Lecture 12

- 4.16 (a)  $0 \text{ J}$  (b)  $-230 \text{ J}$  (c)  $-230 \text{ J}$  (d)  $-5.3 \text{ K}$  (e)  $3.2 \text{ J K}^{-1}$   
 4.17 (a)  $104.6 \text{ J K}^{-1} \text{ mol}^{-1}$  (b)  $-104.6 \text{ J K}^{-1} \text{ mol}^{-1}$  (assuming it is reversible)  
 4.21  $-86.2 \text{ kJ mol}^{-1}$

- 4.22  $-197 \text{ kJ mol}^{-1}$   
 4.23 (a)  $\Delta S_{\text{sys}} = 5.9 \text{ J K}^{-1}$ ,  $\Delta S_{\text{sur}} = -5.9 \text{ J K}^{-1}$ ,  $\Delta S_{\text{tot}} = 0 \text{ J K}^{-1}$   
 (b)  $\Delta S_{\text{sys}} = 5.9 \text{ J K}^{-1}$ ,  $\Delta S_{\text{sur}} = 0 \text{ J K}^{-1}$ ,  $\Delta S_{\text{tot}} = 5.9 \text{ J K}^{-1}$   
 (c)  $\Delta S_{\text{sys}} = \Delta S_{\text{sur}} = \Delta S_{\text{tot}} = 0 \text{ J K}^{-1}$

### Lecture 13 (selected answers)

- 5.4  $-\alpha V$   
 5.5  $-2.0 \text{ J}$   
 5.6  $-42.8 \text{ J K}^{-1}$   
 5.7  $2.8 \text{ kJ}$  (using  $\kappa_T = 116.5 \times 10^{-6} \text{ atm}^{-1}$ ) or  $3.2 \text{ kJ}$  (neglecting  $\kappa_T$ )  
 5.8 (a)  $274 \text{ kPa}$  (b)  $3.45 \text{ kJ}$   
 5.9  $2.71 \text{ kJ mol}^{-1}$   
 5.10  $-0.93 \text{ kJ mol}^{-1}$   
 5.12  $200 \text{ J}$   
 5.13  $2.88 \text{ kJ mol}^{-1}$   
 5.14  $V_m = RT^{-1} + B + Cp + Dp^2$

### Lecture 14

- 6.2 (a) *gas*  $\rightarrow$  *gas* (b) *gas*  $\rightarrow$  *supercritical fluid* (c) *supercritical fluid*  $\rightarrow$  *solid*  
 (d) *solid*  $\rightarrow$  *gas* (e) *gas*  $\rightarrow$  *gas*  
 6.4  $296 \text{ K}$   
 6.5  $\Delta_{\text{fus}}H = 2.4 \text{ kJ mol}^{-1}$ ,  $\Delta_{\text{fus}}S = 5.5 \text{ J K}^{-1} \text{ mol}^{-1}$   
 6.7 (a)  $31.11 \text{ kJ mol}^{-1}$  (b)  $276.9 \text{ K}$   
 6.8  $272 \text{ K}$  (assume liquid is ethanol)  
 6.9  $3.6 \text{ kg s}^{-1}$   
 6.10 The frost will sublime, need partial pressure of 2.92 Torr to ensure frost remains  
 6.11 (a)  $29.1 \text{ kJ mol}^{-1}$  (b)  $0.22 \text{ atm}$ ,  $0.76 \text{ atm}$   
 6.12  $272.41 \text{ K}$   
 6.13  $6.73 \%$

### Lecture 15

- 6.14  $5.92 \text{ kPa}$   
 6.15  $71.2 \text{ mN m}^{-1}$   
 6.16  $204 \text{ kPa}$

### Lecture 16

- 7.4  $843.5 \text{ cm}^3$   
 7.5  $18 \text{ cm}^3 \text{ mol}^{-1}$   
 7.6  $8200 \text{ kPa}$   
 7.7  $150 \text{ kPa}$

- 7.8  $K_b = 4.99 \text{ K Kg mol}^{-1}$ ,  $K_f = 7.10 \text{ K Kg mol}^{-1}$   
7.9  $270 \text{ g mol}^{-1}$   
7.10  $178 \text{ g mol}^{-1}$

### Lecture 17

- 7.11  $-0.077 \text{ }^\circ\text{C}$   
7.12  $\Delta_{\text{mix}}G = -17 \text{ J}$ ,  $\Delta_{\text{mix}}S = 0.064 \text{ J K}^{-1}$   
7.13  $\Delta_{\text{mix}}G = -3.43 \text{ kJ}$ ,  $\Delta_{\text{mix}}S = 11.5 \text{ J K}^{-1}$ ,  $\Delta_{\text{mix}}H = 0 \text{ J}$   
7.14  $n_B/n_E = 1$ ,  $m_B/m_E = 0.7358$   
7.15  $b_N = 0.51 \text{ mmol kg}^{-1}$ ,  $b_O = 0.27 \text{ mmol kg}^{-1}$   
7.16  $0.067 \text{ mol L}^{-1}$   
7.17  $-0.52 \text{ }^\circ\text{C}$   
7.18  $52 \text{ mol kg}^{-1}$   
7.19  $14 \text{ kg mol}^{-1}$