To get full credit: Show your work and EXPLAIN answers not based on calculation.

Exercises   3.14-16 from the 8ᵗʰ **or** 9ᵗʰ Edition

Exercise A.   Given one mole of an ideal gas with $C_v = 5R/2$, initially at 300. K and 30 bar. A process carries it to a final pressure of 1 bar. Calculate ΔG (in J) for the following familiar processes:

Part	Type of Expansion	Final T (K)	q (J)
B	adiabatic into an evacuated container	300 K	0
C	isothermal against a constant opposing pressure of one bar	300 K	+2400

Problem 1.a   As Exercise A, but for the following cases.

Part	Type of Expansion	Final T (K)	q (J)
D	isothermal and reversible	300 K	+8480
E	isothermal into an evacuated container	300 K	0

Problem 1.b   What would be challenging about computing ΔG for the process in part F of this set (adiabatic against a constant opposing pressure of 1.00 bar with $T_2 = 217$ K)?

Exercise B.   For each of the following cases for 1.00 moles of gas starting at 298 K, is $\Delta S_{universe}$ positive, negative, zero, or is there insufficient information given? EXPLAIN!

a) An isothermal reversible ideal gas compression from $P_i = 1.0$ bar to $P_f = 2.0$ bar

b) Adiabatic expansion of a real gas from $P_i = 10$ bar to $P_f = 2$ bar against $P_{opp} = 2$ bar.

c) Adiabatic compression of 1.0 moles of argon gas from $V_i = 22.4$ L bar to $V_f = 10.$ L

d) An isothermal reversible expansion of a real gas

Problem 2 For which of the processes in Exercise B is ΔG a valid criteria of spontaneity?

Exercise C. Exercises 3.10-11 from the 8ᵗʰ **or** 9ᵗʰ Edition
**Problem 3.**   At 298.15 K, n-pentane has the following properties
S_m° (liq) = 263.47 J/mole S_m° (gas) = 347.8 J/(mole K)
$C_{P,m}$ (liq) = 168.6 J/(mole K)
        Compute $C_{P,m}$ (g) if ΔS_{vap}° of n-pentane = 80.5 J/(mole K) at 323.15 K

Exercises 3.18-3.22 from the 8th **or** 9th Edition

Problem 4.   Use the data in Table 2.8 in the back of the book to compute the equilibrium vapor pressure (P*) for the following:

   C$_6$H$_6$ (liquid, 298.15 K, P$_{ext}$ =1 bar) $\leftrightarrows$ C$_6$H$_6$ (gas, 298.15 K, P*)
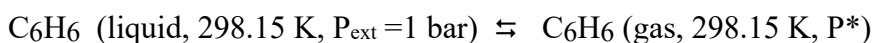
Exercises 4.9-4.11 from the 9th edition **or** 4.1, 4.3, 4.4 from the 8th edition.

Problem 5.a   Given the temperature at which the vapor pressure of solid tungsten is 1 Torr 3477 K) and 10 Torr (3773 K), compute the equilibrium vapor pressure of solid tungsten at 298 K. NOTE: the correct answer may seem unreasonably small!

Problem 5.b Given your answer to 5.a, what volume would be occupied by 1 atom of gas phase tungsten in equilibrium with the solid at 298 K? NOTE: the correct answer may seem unreasonably large!

Exercises 4.12, 4.15-16 from the 9th edition **or** 4.5, 4.8-4.9 from the 8th edition.

Exercise D   Given this phase diagram of water and assuming
   • ideal gas behavior
   • density of liquid water = 1.00 g/mL and ice is 0.934 g/mL
What is ΔS_m (not ΔS_m°) of vaporization at 273 K?

Problem 6: Using the graph and assumptions of Exercises ??
a)   What is ΔS_m (not ΔS_m°) of sublimation at 273 K? ?
b)   What is ΔS_m (not ΔS_m°) of vaporization at 293 K?

Exercise E
a) In class you were shown that under certain conditions, dG < 0 means the same thing as dS$_{universe}$ > 0. Use the same approach to determine the conditions under which dA < 0 means the same thing as dS$_{universe}$ > 0. Note that "A" stands for the Helmholtz Free Energy: $A \equiv U - TS$

b) Starting from dH = TdS + VdP derive $\left(\dfrac{\partial T}{\partial P}\right)_S = \left(\dfrac{\partial V}{\partial S}\right)_P$

Problem 7: Starting from dA = -PdV - SdT derive $\left(\dfrac{\partial P}{\partial T}\right)_V = \left(\dfrac{\partial S}{\partial V}\right)_T$