

Exam II
CH 353 Sumer 2007
Vanden Bout

Name: _____

You can use anything to answer the following except someone else.

Carefully read all the problems. The exam should have 4 questions on 6 pages. The first page has potentially useful information. The last page is for extra writing space.

$$R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1} \quad R = 8.314 \times 10^{-2} \text{ L bar K}^{-1} \text{ mol}^{-1} \quad R = 8.206 \times 10^{-2} \text{ L atm mol}^{-1} \text{ K}^{-1}$$

$$1 \text{ atm} = 1.01325 \text{ bar} \quad T/\text{K} = T/^{\circ}\text{C} + 273.15 \quad 1 \text{ atm-L} = 101.325 \text{ J} \quad 1 \text{ bar-L} = 100 \text{ J}$$

$$dS = \frac{C_v}{T} dT + \frac{\alpha}{\kappa} dV \quad dS = \frac{C_p}{T} dT - V\alpha dP$$

$$\text{for IG this is } dS = \frac{C_v}{T} dT + \frac{nR}{V} dV \quad \text{or } dS = \frac{C_p}{T} dT - \frac{nR}{P} dP$$

$$dH = \left(\frac{\partial H}{\partial T}\right)_P dT + \left(\frac{\partial H}{\partial P}\right)_T dP \quad \left(\frac{\partial H}{\partial T}\right)_P = C_p \quad \left(\frac{\partial H}{\partial P}\right)_T = V - T\left(\frac{\partial V}{\partial T}\right)_P = V(1 - \alpha T)$$

$$dU = \left(\frac{\partial U}{\partial T}\right)_V dT + \left(\frac{\partial U}{\partial V}\right)_T dV \quad \left(\frac{\partial U}{\partial T}\right)_V = C_v \quad \left(\frac{\partial U}{\partial V}\right)_T = T\left(\frac{\partial P}{\partial T}\right)_V - P = T\frac{\alpha}{\kappa} - P$$

$$\alpha \equiv \frac{1}{V} \left(\frac{\partial V}{\partial T}\right)_P \quad \kappa \equiv -\frac{1}{V} \left(\frac{\partial V}{\partial P}\right)_T \quad \text{For an IG } \alpha = \frac{1}{T} \quad \text{and } \kappa = \frac{1}{P}$$

$$\text{Virial Equation } PV = nRT(1 + B'P) \quad \text{van der Waals equation } \left(P + \frac{a}{V^2}\right)(V - b) = nRT$$

Please sign at the bottom to certify that you have worked on your own.
 I certify that I have worked the following exam without the help of others, and that the work I am turning in is my own.

Signed: _____
 Signature Date

1. True/False Circle either T or F for each statement (10 points each)

T F For an adiabatic process, ΔS_{SYS} can never decrease.

T F At constant T & P, $\Delta S_{\text{SURR}} = -\Delta H_{\text{SYS}}/T_{\text{SYS}}$ always.

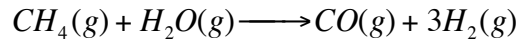
T F A spontaneous endothermic process can never decrease the entropy of the system.

T F For a reversible process $\Delta S_{\text{Total}} = 0$.

T F For an isothermal reversible expansion of an ideal gas $\Delta G = 0$.

2. Short Answer (25 points each)

What is the standard Gibb's energy for the following reaction at 298K and standard pressure



	$\Delta_f H^\circ$	$\Delta_f G^\circ$	S°	C_p
$\text{CH}_4(\text{g})$	-74.8	-50.7	186.3	35.3
$\text{H}_2\text{O}(\text{g})$	-241.8	-228.6	188.8	33.6
$\text{CO}(\text{g})$	-110.5	-137.2	197.7	29
$\text{H}_2(\text{g})$	0	0	130.7	28.8

Given that

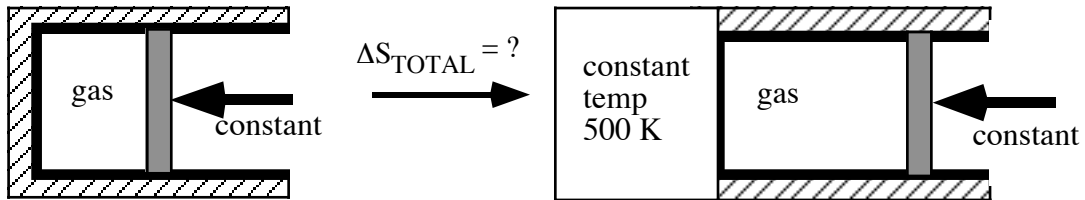
$$\left(\frac{\partial G}{\partial P}\right)_T = V$$

What is ΔG for a change in pressure for P_i to P_f for a gas that obeys the equation of state

$$P(V - nb) = nRT$$

3. (50 points)

3 moles of an ideal gas ($C_{V,M} = 3/2R$) are initially in an insulated piston at a constant pressure. The volume of the gas is initially 40 L and the temperature and pressure unknown. The piston is then placed in contact with a constant temperature bath at 500 K. Bringing the bath in contact with the piston causes 6.236 kJ of heat to transfer into the piston and causes the gas to expand. **Find ΔS_{TOTAL} for this process.**



4. (50 points)

You place 10 g of solid water on a sidewalk one afternoon when it is 30°C outside. The ice melts and the liquid heats up to 30°C. You can assume the ice cube is initially 0°C. What is the change in the entropy of the system, the surroundings, and the universe (total) for this process (ice melting + liquid heating)? (note: in reality this process would also involve some water evaporating. Ignore this effect).

$$C_{p,\text{solid}} = 36 \text{ J K}^{-1} \text{ mol}^{-1}$$

$$C_{p,\text{liquid}} = 75.3 \text{ J K}^{-1} \text{ mol}^{-1}$$

$$\Delta_{\text{FUS}}H^\circ = 6.02 \text{ kJ mol}^{-1}$$

$$S^\circ (\text{H}_2\text{O, liq, 298K}) = 70 \text{ J K}^{-1} \text{ mol}^{-1}$$