

Chemistry 230 -- Quiz 8
October 31, 2001 — Tellinghuisen

Pledge and signature:

Note: If you want your paper returned folded (*i.e.*, score concealed), please print your name on the back.

1. (4) Give the number of degrees of freedom f for each of the following systems: $f = C_{ind} - P + 2$
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|----------------------------------------------------------------------------------------------------------------------------|---|
| (a) An aqueous solution of sucrose in equilibrium with solid sucrose and water vapor: | 1 |
| (b) An aqueous solution of KBr and NaCl in equilibrium with water vapor: | 3 |
| (c) Liquid water and liquid benzene (mutually almost completely immiscible): | 2 |
| (d) $\text{CaCO}_3(s)$ in equilibrium with $\text{CaO}(s)$, $\text{CO}_2(g)$, $\text{CaCO}_3(g)$, and $\text{CaO}(g)$: | 1 |
2. (2) For each pair, state which substance has the greater $\Delta H_{m,vap}$ at its normal boiling point:
- | | | | | |
|--------------|----|--|--------------------------------------------------|----------------------|
| (a) Ne or Ar | Ar | | (b) H_2O or H_2S | H_2O |
|--------------|----|--|--------------------------------------------------|----------------------|
3. (2) For the H_2O phase diagram, state the number of degrees of freedom
- | | | | | |
|-------------------------|---|--|--------------------------------|---|
| (a) at the triple point | 0 | | (b) along the solid/vapor line | 1 |
|-------------------------|---|--|--------------------------------|---|
4. (4) True or False: (All of these concern ideal-gas chemical reactions.)
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|------------------------------------------------------------------------------------------------------------|---|
| (a) If $\Delta G^\circ > 0$, then no products can form when the reaction is run at constant T and P : | F |
| (b) In a closed system with P - V work only, G is always minimized at equilibrium: | F |
| (c) S of a closed system can decrease substantially in an irreversible process: | T |
| (d) ΔG° for an ideal-gas reaction is a function of T and P : | F |
5. (2) Suppose the standard state for ideal gases were changed from $P^\circ = 1.00$ bar to $P^\circ = 1000$ torr. Indicate (yes or no) whether K_P° would change as a result of this, for each of the following:
- | | | | | |
|---------------------------------------------------------------------------|----|--|---------------------------------------------------------------------|-----|
| (a) $\text{H}_2(g) + \text{Cl}_2(g) \rightleftharpoons 2 \text{HCl}(g)$: | no | | (b) $\text{N}_2\text{O}_4(g) \rightleftharpoons 2 \text{NO}_2(g)$: | yes |
|---------------------------------------------------------------------------|----|--|---------------------------------------------------------------------|-----|
6. (15) Equilibrium data for a certain gas-phase reaction are found to fit the following expression:

$$\ln K_P^\circ = a + b/T + c \ln T.$$

where a , b , and c are fitted parameters, and T is the temperature in K. Obtain expressions for ΔG° , ΔH° , and ΔC_P° for this reaction.

$$\Delta G^\circ = -RT \ln K_P^\circ = -R(aT + b + cT \ln T)$$

$$\frac{d \ln K_P^\circ}{dT} = \frac{\Delta H^\circ}{RT^2} = -\frac{b}{T^2} + \frac{c}{T} \rightarrow \Delta H^\circ = R(cT - b)$$

$$\Delta C_P^\circ = \frac{d \Delta H^\circ}{dT} = Rc$$