

Problem Session # 7

- 1) Calculate ΔS°_r for the reaction $\text{H}_2(\text{g}) + \text{Cl}_2(\text{g}) \rightarrow 2\text{HCl}(\text{g})$ at 725 K. Omit terms in the temperature-dependent heat capacities higher than T^2 / K^2 .

$$C^{\circ}_p(\text{H}_2, \text{g}) = 22.66 + 4.38 \times 10^{-2} T / \text{K} - 1.0835 \times 10^{-4} T^2 / \text{K}^2 \quad (\text{JK}^{-1} \text{mol}^{-1})$$

$$C^{\circ}_p(\text{Cl}_2, \text{g}) = 22.85 + 6.543 \times 10^{-2} T / \text{K} - 1.2517 \times 10^{-4} T^2 / \text{K}^2 \quad (\text{JK}^{-1} \text{mol}^{-1})$$

$$C^{\circ}_p(\text{HCl}, \text{g}) = 29.81 - 4.12 \times 10^{-3} T / \text{K} + 6.2231 \times 10^{-6} T^2 / \text{K}^2 \quad (\text{JK}^{-1} \text{mol}^{-1})$$

$$S^{\circ}_{298}(\text{HCl}, \text{g}) = 186.9 \text{ J.K}^{-1} \cdot \text{mol}^{-1} \quad S^{\circ}_{298}(\text{Cl}_2, \text{g}) = 223.1 \text{ J.K}^{-1} \cdot \text{mol}^{-1} \quad S^{\circ}_{298}(\text{H}_2, \text{g}) = 223.1 \text{ J.K}^{-1} \cdot \text{mol}^{-1}$$

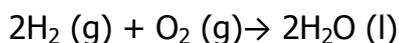
- 2) The amino acid glycine dimerizes to form dipeptide glycyglycine according to the reaction



Calculate ΔS at T 298 K. Useful thermodynamic data are:

| | Glycine | Glycyglycine | Water |
|--|---------|--------------|-------|
| $S^{\circ} (\text{JK}^{-1} \text{mol}^{-1})$ | 103.5 | 190.0 | 70.0 |

- 3) Determine the change in the entropy the following chemical reaction occurring at standard pressure and the stated temperature.



$$S^{\circ} [\text{H}_2(\text{g})] = 130.7 \text{ (J/mol.K)}, \quad S^{\circ} [\text{O}_2(\text{g})] = 205.1 \text{ (J/mol.K)}, \quad S^{\circ} [\text{H}_2\text{O}(\text{l})] = 69.91 \text{ (J/mol.K)}$$

- 4) Calculate ΔS if the temperature of 1.75 mol of an ideal gas with $C_{v,m} = (3/2)R$ is increased from 195 to 425 K under conditions of a) constant pressure b) constant volume.

- 5) What is the entropy change of the reaction $2\text{H}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{H}_2\text{O}(\text{l})$ at 99°C and standard pressure? Treat the heat capacities of H_2 , O_2 , H_2O as constant at 28.8, 29.4 and 75.3 J/mol.K,

respectively. Assume molar quantities based on the balanced chemical reaction and ideal gas behavior.

$$\Delta S_{298}^0 = -326.7 \text{ J.K}^{-1}.\text{mol}^{-1}$$

- 6)** If an isolated flask 200 g of gold at 120°C are added to 25 g of water at 10°C. 5g of ice at -10°C is added in to this isolated flask.

If heat capacities are $C_p(\text{H}_2\text{O}, \text{s}) = 0.5 \text{ cal.K/g}$, $C_p(\text{H}_2\text{O}, \text{l}) = 1.0 \text{ cal.K/g}$

$C_p(\text{Au}) = 0.0313 \text{ cal.K/g}$ $\Delta H_{\text{m,water}} = 80 \text{ cal/g}$

- a)** What is the final temperature of the system?
b) Calculate ΔS for the transformation.