

Chem 1104 - 2018 Summer Problem Set #6

1. For each of the following, specify which has the higher entropy:

- A sample of dry ice(solid CO_2) at -78°C or CO_2 vapor at 0°C .
- Sugar as a solid or after being dissolved in a cup of coffee.
- A chunk of metallic sodium or a flask of argon at room temperature.
- $\text{NH}_4\text{Cl}(\text{s})$ or $\text{NH}_4\text{Cl}(\text{aq})$.

2. The enthalpy of vaporization of liquid diethyl ether is 26.0 kJ/mol at the boiling point of 35.0°C . Calculate ΔS for a) liquid to vapor and b) vapor to liquid at 35.0°C .

3. Calculate the standard entropy change for each of the following reactions at 25°C :

- $\text{Mg}(\text{s}) + 1/2\text{O}_2(\text{g}) \rightarrow \text{MgO}(\text{s})$
- $\text{Pb}(\text{s}) + \text{Cl}_2(\text{g}) \rightarrow \text{PbCl}_2(\text{s})$
- $2\text{ICl}(\text{g}) \rightarrow \text{I}_2(\text{s}) + \text{Cl}_2(\text{g})$
- $\text{C}_2\text{H}_5\text{OH}(\text{l}) + 3\text{O}_2(\text{g}) \rightarrow 2\text{CO}_2(\text{g}) + 3\text{H}_2\text{O}(\text{l})$
- $\text{NaCl}(\text{s}) \rightarrow \text{NaCl}(\text{aq})$

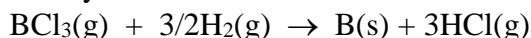
4. Using values of ΔH_f° and ΔS° , calculate ΔG° for the following reactions:

- $\text{Pb}(\text{s}) + \text{Cl}_2(\text{g}) \rightarrow \text{PbCl}_2(\text{s})$
- $\text{Mg}(\text{s}) + 1/2\text{O}_2(\text{g}) \rightarrow \text{MgO}(\text{s})$
- $\text{NH}_3(\text{g}) + \text{HCl}(\text{g}) \rightarrow \text{NH}_4\text{Cl}(\text{s})$
- $\text{Br}_2(\text{l}) + 3\text{F}_2(\text{g}) \rightarrow 2\text{BrF}_3(\text{g})$

5. Calculate ΔG° for the following reactions using ΔG_f° values listed in the appendix of your textbook.

- $4\text{NH}_3(\text{g}) + 5\text{O}_2(\text{g}) \rightarrow 4\text{NO}(\text{g}) + 6\text{H}_2\text{O}(\text{l})$
- $2\text{H}_2\text{S}(\text{g}) + 3\text{O}_2(\text{g}) \rightarrow 2\text{H}_2\text{O}(\text{g}) + 2\text{SO}_2(\text{g})$

6. Elemental boron can be made by the reduction of boron halide with H_2 :



Given the following data:

Substance	ΔH_f°	ΔS°
$\text{BCl}_3(\text{g})$	-403.8 kJ/mol	$290 \text{ J/K}\cdot\text{mol}$
$\text{H}_2(\text{g})$	0 kJ/mol	$130.684 \text{ J/K}\cdot\text{mol}$
$\text{B}(\text{s})$	0 kJ/mol	$5.86 \text{ J/K}\cdot\text{mol}$
$\text{HCl}(\text{g})$	-92.307 kJ/mol	$186.908 \text{ J/K}\cdot\text{mol}$

calculate ΔH° , ΔS° , and ΔG° for this reaction. Is it predicted to be spontaneous under standard conditions? If spontaneous, is it enthalpy driven or entropy driven? If not spontaneous, in your view why is it not?

7. The dissociation of gaseous chlorine to Cl atoms has an equilibrium constant of 0.106 at 1800 K. Calculate the free energy change for this reaction. $\text{Cl}_2(\text{g}) \rightleftharpoons 2\text{Cl}$

Answer Set for Chem 1104-2018 Summer Problem Set #6

Note: Values may vary slightly depending on literature source used.

1.a) CO₂ vapor; b) dissolved sugar; c) argon; d) NH₄Cl(aq)

2.a) +84.4 J/K; b) -84.4 J/K

3.a) -108.31 J/K; b) -151.9 J/K; c) -155.89 J/K; d) -138.9 J/K; e) 43.4 J/K

4.

	ΔH°	ΔS°	ΔG°
a)	-359.41 kJ	-151.9 J/K	-314.1 kJ
b)	-601.70 kJ	-108.31 J/K	-569.42 kJ
c)	-176.01 kJ	-284.8 J/K	-91.15 kJ
d)	-511.20 kJ	-175.51 J/K	-459.8 kJ

5.a) -1010.8 kJ; b) -990.41 kJ

6. $\Delta H^\circ = 126.9$ kJ, $\Delta S^\circ = 81$ J/K, $\Delta G^\circ = +102.8$ kJ. The reaction is not spontaneous at room temperature; the enthalpy change is too positive to be outweighed by $-T\Delta S^\circ$.

7. $\Delta G^\circ = +33.6$ kJ