

1) How does the entropy of the following system change in the following cases (increases or decreases and also write the ΔS with the appropriate sign)

- a) Solid lead melts. *increases* $+\Delta S$
- b) A vapor converts to solid. *decreases* $-\Delta S$
- c) A liquid boils. *increases* $+\Delta S$
- d) A solid is dissolved in water. *increases* $+\Delta S$
- e) Water freezes to form ice. *decreases* $-\Delta S$
- f) Sugar crystallizes from a supersaturated solution. *decreases* $-\Delta S$

2) Predict whether the entropy change is positive or negative in the following reactions.

- a) $2\text{KClO}_4(\text{s}) \longrightarrow 2\text{KClO}_3(\text{s}) + \text{O}_2(\text{g})$ $+\Delta S$
- b) $\text{H}_2\text{O}(\text{g}) \longrightarrow \text{H}_2\text{O}(\text{l})$ $-\Delta S$
- c) $2\text{Na}(\text{s}) + 2\text{H}_2\text{O}(\text{l}) \longrightarrow 2\text{NaOH}(\text{aq}) + \text{H}_2(\text{g})$ $+\Delta S$
- d) $\text{PCl}_3(\text{l}) + \text{Cl}_2(\text{g}) \longrightarrow \text{PCl}_5(\text{s})$ $-\Delta S$
- e) $\text{H}_2(\text{g}) \longrightarrow 2\text{H}(\text{g})$ $+\Delta S$
- f) $\text{U}(\text{s}) + 3\text{F}_2(\text{g}) \longrightarrow \text{UF}_6(\text{s})$ $-\Delta S$

3) Which of the following has a larger standard entropy.

- a) $\text{Li}(\text{s})$ or $\text{Li}(\text{l})$
- b) $\text{C}_2\text{H}_5\text{OH}(\text{l})$ or $\text{CH}_3\text{OCH}_3(\text{l})$
- c) $\text{O}_2(\text{g})$ or $\text{O}_3(\text{g})$
- d) $\text{NO}_2(\text{g})$ or $\text{N}_2\text{O}_4(\text{g})$

4) Use the data tables to calculate the standard entropy changes of the following reactions.



$$\boxed{31.88} \quad \boxed{205} \quad \boxed{248.5}$$

$$\text{prod} - \text{react} = \boxed{11.6 \text{ J/K mol}}$$



$$\boxed{65.69} \quad \boxed{26.78} \quad \boxed{213.6}$$

$$\text{prod} - \text{react} = \boxed{174.75 \text{ J/K mol}}$$

5) Use the data tables to calculate the ΔG for the following reactions.



$$\boxed{0} \quad \boxed{0} \quad \boxed{2 \times 86.7}$$

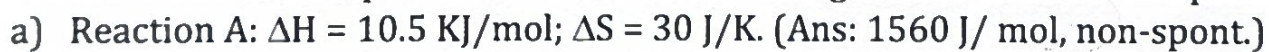
$$\text{prod} - \text{react} = \boxed{173.4 \text{ kJ/mol}}$$



$$\boxed{2(209.2)} \quad \boxed{5(0)} \quad \boxed{4(-394.4) + 2(-237.2)}$$

$$\text{prod} - \text{react} = \boxed{-2470 \text{ kJ/mol}}$$

6) From the ΔH and ΔS , predict which of the following reactions would be spontaneous at 25 °C.



$$\Delta G = \Delta H - T\Delta S$$

$$= 10500 \text{ J/mol} - (298 \times 30 \text{ J/K mol})$$

$$= \boxed{1560 \text{ J/mol (NON-SPONT)}}$$



$$\Delta G = \Delta H - T\Delta S$$

$$= 1800 - (298 \times 113)$$

$$= \boxed{35474 \text{ J/mol NON-SPONT}}$$

$$\Delta G = \Delta H - T\Delta S$$

7) Find the temperature at which both the following reactions will be spontaneous.

a) Reaction A: $\Delta H = -126 \text{ kJ/mol}$; $\Delta S = 84 \text{ J/K}$ (Ans: spont. at all temp.)

Keep ΔG as -1 for spont. reaction.

$$\frac{\Delta G - \Delta H}{\Delta S} = -T ; \frac{-1 - (-126 \times 10^3)}{84} = -1499.98 \text{ K}$$

Reaction is spont. at all temp above -1499.98 K .

(Note: when ΔH is $-ve$ & ΔS is $+ve$ reaction is spont at all temp.)

b) Reaction B: $\Delta H = -11.7 \text{ kJ/mol}$; $\Delta S = -105 \text{ J/K}$. (Ans: spont. above 111 K)

$$\frac{\Delta G - \Delta H}{\Delta S} = -T ; \frac{-1 - (-11.7 \times 10^3)}{-105} = 111.4 = -T$$

111 K max. temp at which reaction is spont.

$$\frac{\Delta G = 0}{T} = \frac{\Delta H}{\Delta S}$$