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 + ΔS
   b) A vapor converts to solid. decreases − ΔS
   c) A liquid boils. increases + ΔS
   d) A solid is dissolved in water. increases + ΔS
   e) Water freezes to form ice. decreases − ΔS
   f) Sugar crystallizes from a supersaturated solution. decreases − ΔS

2) Predict whether the entropy change is positive or negative in the following reactions.
   a) $2KClO_4(s) \longrightarrow 2KClO_3(s) + O_2(g)$ + ΔS
   b) $H_2O(g) \longrightarrow H_2O(l)$ − ΔS
   c) $2Na(s) + 2H_2O(l) \longrightarrow 2NaOH(aq) + H_2(g)$ + ΔS
   d) $PCl_3(l) + Cl_2(g) \longrightarrow PCl_5(s)$ − ΔS
   e) $H_2(g) \longrightarrow 2H(g)$ + ΔS
   f) $U(s) + 3F_2(g) \longrightarrow UF_6(s)$ − ΔS

3) Which of the following has a larger standard entropy.
   a) Li(s) or Li(l)
   b) $C_2H_5OH(l)$ or $CH_3OCH_3(l)$
   c) $O_2(g)$ or $O_3(g)$
   d) $NO_2(g)$ or $N_2O_4(g)$

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

a) $S(rhombic) + O_2(g) \longrightarrow SO_2(g)$ (Ans: 11.6 J/K mol)

31.88 + 205 → 248.5

prod - react = 11.6 J/K mol

b) $MgCO_3(s) \longrightarrow MgO(s) + CO_2(g)$ (Ans: 174.75 J/K mol)

65.69 → 26.78 + 213.6

prod - react = 174.7 J/K mol

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

a) $N_2(g) + O_2(g) \longrightarrow 2NO(g)$ (Ans: 173.4 kJ/mol)

0 + 0 → 2 × 86.7

prod. - read. = 173.4 kJ/mol.

b) $2C_2H_2(g) + 5O_2(g) \longrightarrow 4CO_2(g) + 2H_2O(l)$ (Ans: -2470 kJ/mol)

2 (209.2) + 5(0) → 4(-394.4) + 2(-237.2)

Prod - react = -2470 kJ/mol.

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

a) Reaction A: ΔH = 10.5 KJ/mol; ΔS = 30 J/K. (Ans: 1560 J/ mol, non-spont.)

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

$= 10500 J/mol - (298 \times 30 J/K mol)$.

= 1560 J/mol (NON-SPONT)

b) Reaction B: ΔH = 1.8 KJ/mol; ΔS = -113 J/K. (Ans: 35,470 J/ mol, non-spont.)

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

$= 1800 - (298 \times 113)$

= 35474 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: $\Delta H = -126$ kJ/mol; $\Delta S = 84$ 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: $\Delta H = -11.7$ kJ/mol; $\Delta S = -105$ J/K. (Ans: spont. ~~above~~ 111 K)

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

111k max. temp at which reaction is spont.

$\Delta G = 0$

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