1. From each pair, which has more entropy?

a. $H_2O(\ell)$ vs. $H_2O(g)$

b. $H_2O(\ell)$ at 80°C vs. $H_2O(\ell)$ at 20°C

c. $Ca_3(PO_4)_2(s)$ vs. $FeO(s)$

d. $CaBr_2(s)$ vs. $CaBr_2(aq)$

e. $C_3H_8O(\ell)$ vs. $C_3H_6(\ell) + H_2O(\ell)$

2. Will ΔS be Positive or Negative?

a. $2Mg(s) + O_2(g) \longrightarrow 2MgO(s)$ $\quad \underline{\Delta S}$

b. $NaNO_3(s) \xrightarrow{water} NaNO_3(aq)$

c. $2C_2H_6(\ell) + 7O_2(g) \longrightarrow 4CO_2(g) + 6H_2O(g)$

d. $C_4H_8Br_2(\ell) \longrightarrow C_4H_8(\ell) + Br_2(\ell)$

e. $AgNO_3(aq) + NaCl(aq) \longrightarrow AgCl(s) + NaNO_3(aq)$

f. $C_7H_{14}(s) \longrightarrow C_7H_{14}(\ell)$

g. $CO_2(g) \longrightarrow CO_2(s)$

h. $CaCO_3(s) \longrightarrow CaO(s) + CO_2(g)$

① Find ΔS° for $C_2H_6(\ell) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(\ell)$

$S^\circ =$ 161 205 214 70

② $CaCO_3(s) \longrightarrow CaO(s) + CO_2(g)$

$S^\circ =$ 92.9 38.1 213.7

Calculate overall ΔS when 2.3 moles of $CaCO_3$ decomposes.

Classify as Product-Favored or Reactant-Favored

1. $A \rightarrow B$ $\Delta S^\circ = +52$ J/K $\Delta H^\circ = -32$ kJ/mol

2. $A \rightarrow B$ $\Delta S^\circ = -116$ J/K $\Delta H^\circ = +12$ kJ/mol

3. $A \rightarrow B$ $\Delta S^\circ = +76$ J/K $\Delta H^\circ = +4$ kJ/mol

The following Reactions are Product-Favored. Which are enthalpy favored, entropy favored, or both?

4. $C \rightarrow D$ $\Delta S^\circ = -28$ J/K $\Delta H^\circ = -112$ kJ/mol

5. $E \rightarrow F$ $\Delta S^\circ = +563$ J/K $\Delta H^\circ = +7.3$ kJ/mol

6. $G \rightarrow H$ $\Delta S^\circ = +89$ J/K $\Delta H^\circ = -42$ kJ/mol

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

Derivation from

$$\Delta S_{universe} = \Delta S_{surroundings} + \Delta S_{system}$$

Recall: $\Delta S_{surroundings} = -\frac{\Delta H_{system}}{T}$

So $\Delta S_{universe} = -\frac{\Delta H}{T} + \Delta S$

Multiply by $-T$

So $-T\Delta S_{universe} = \Delta H - T\Delta S$

By definition, $-T\Delta S_{universe} = \Delta G$

So $\boxed{\Delta G = \Delta H - T\Delta S}$

Note: ΔG reflects $\Delta S_{universe}$, but ΔH, ΔS are both for system only. Easy to measure

Note: ΔG and $\Delta S_{universe}$ have opposite sign

18-13

1. $C(s) + O_2(g) \longrightarrow CO_2(g)$ $\quad \Delta H^\circ = -394$ kJ/mol
$\Delta S^\circ = 42.9$ J/mol·K

a. What is ΔG° at 25°C?

b. What is ΔG when 0.32 mol of C reacts?

2. $C + 2H_2 \longrightarrow CH_4$ $\quad \Delta G^\circ = -50.8 \frac{kJ}{mol}$ $\quad \Delta H^\circ = -74.5 \frac{kJ}{mol}$

what is ΔS° (by definition, at 25°C)

3. $CH_4(g) + 2O_2(g) \longrightarrow CO_2(g) + 2H_2O(l)$
$\Delta G_f^\circ = -51$ $\quad -394$ $\quad -237$

Find ΔG°

Positive or Negative? ΔG ΔS ΔH

ΔH dominates over $-T\Delta S$

Provide Sense of ΔG, ΔH, ΔS (Given Reaction Knowledge)

	ΔG	ΔH	ΔS

① $H_2O(\ell) \longrightarrow H_2O(g)$ at 50°C

② " " at 200°C

③ $C_6H_{12}(\ell) + 9O_2(g) \longrightarrow 6CO_2(g) + 6H_2O(\ell)$

④ $A(s) \longrightarrow A(\ell)$ $\Delta H^\circ = +132$ kJ/mol

$\Delta S^\circ = +34.3$ J/mol·K

What is the melting temp for A?

At what temp limits is process product favored?

⑤ When will the following be Product-Favored?

a. ΔH neg ΔS neg

b. ΔH neg ΔS pos

c. ΔH pos ΔS neg

d. ΔH pos ΔS pos.

⑥ $A \longrightarrow B$ $\Delta H = -14.9$ kJ/mol $\Delta S = -48$ J/mol·K

At what temp limits is process product-favored?