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Rxn ①

$$\begin{aligned}\Delta H &= -35.0 \text{ kJ/mol} \\ \Delta S &= 101 \text{ J/mol}\cdot\text{K} \\ T &= 21.0 \text{ }^\circ\text{C}\end{aligned}$$

$$\begin{aligned}\Delta G &= \Delta H - T\Delta S \\ &= -35.0 \text{ kJ/mol} - (294 \text{ K})(0.101 \text{ kJ/mol}\cdot\text{K})\end{aligned}$$

$$\Delta G = -64.7 \text{ kJ/mol}$$

Rxn ②

$$\begin{aligned}\Delta H &= 30.0 \text{ kJ/mol} \\ \Delta S &= 18.0 \text{ J/mol}\cdot\text{K} \\ T &= 201 \text{ K}\end{aligned}$$

$$\begin{aligned}\Delta G &= \Delta H - T\Delta S \\ &= (30.0 \text{ kJ/mol}) - (201 \text{ K})(0.018 \text{ kJ/mol}\cdot\text{K})\end{aligned}$$

$$\Delta G = +16.4 \text{ kJ/mol}$$

$$\begin{aligned}T &> 1670 \text{ K} \\ \Delta G &\Rightarrow (-)\end{aligned}$$

$$T = \frac{\Delta H}{\Delta S} = \frac{30.0 \text{ kJ/mol}}{0.0180 \text{ kJ/mol}\cdot\text{K}} = 1670 \text{ K}$$

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$$\Delta G^\circ = \sum \Delta G_f^\circ \text{ products} - \sum \Delta G_f^\circ \text{ reactants}$$

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

The sign on  $\Delta G^\circ$  DOES NOT predict spontaneity

$\Delta G = \Delta G^\circ$  When all reactants and products are at standard conditions

$$[ ] = 1 \text{ M}, P = 1 \text{ atm}$$

As soon as a reaction starts,  $\Delta P$ ,  $\Delta S$ , etc..

Sign on  $\Delta G^\circ \Rightarrow$  EQUILIBRIUM POSITION

Rxn ①

$$\Delta H = -35.0 \text{ kJ/mol}$$

$$\Delta S = 101 \text{ J/mol} \cdot \text{K}$$

$$T = 21.0 \text{ }^\circ\text{C}$$

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

$$= -35.0 \text{ kJ/mol} - (294 \text{ K})(0.101 \text{ kJ/mol} \cdot \text{K})$$

$$\Delta G = -64.7 \text{ kJ/mol}$$

Rxn ②

$$\Delta H = 30.0 \text{ kJ/mol}$$

$$\Delta S = 1810 \text{ J/mol} \cdot \text{K}$$

$$T = 201 \text{ K}$$

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

$$= (30.0 \text{ kJ/mol}) - (201 \text{ K})(0.0181 \text{ kJ/mol} \cdot \text{K})$$

$$\Delta G = (+) 26.4 \text{ kJ/mol}$$

$$T > 1670 \text{ K}$$

$$\Delta G \Rightarrow (<)$$

$$T = \frac{\Delta H}{\Delta S} = \frac{30.0 \text{ kJ/mol}}{0.0181 \text{ kJ/mol} \cdot \text{K}} = 1670 \text{ K}$$

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$$\Delta G^\circ = \sum \Delta G_f^\circ \text{ products} - \sum \Delta G_f^\circ \text{ reactants}$$

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

The sign of  $\Delta G^\circ$  DOES NOT predict spontaneity

$\Delta G = \Delta G^\circ$  when all reactants and products are at standard conditions

$$[ ] = 1 \text{ M}, P = 1 \text{ atm}$$

AS SOON AS A REACTION STARTS,  $\Delta P$ ,  $\Delta [ ]$ , etc..

Sign of  $\Delta G^\circ \Rightarrow$  EQUILIBRIUM POSITION

$-\Delta G^\circ \Rightarrow [P] > [R] @ EQ$   
 $+\Delta G^\circ \Rightarrow [R] > [P] @ EQ$

$\Delta G$  is variable ...  $\Delta G^\circ$  is a constant...

$$\Delta G = \Delta G^\circ + RT \ln(Q) \Rightarrow \text{reaction quotient } \frac{[P]}{[R]}$$

$8.314 \text{ J/mol}\cdot\text{K}$

at EQ

$$Q = K$$

$$\Delta G = 0$$

$$0 = \Delta G^\circ + RT \ln K$$

$$\Delta G^\circ = -RT \ln K$$

standard E term  $\left(\frac{\text{J}}{\text{mol}\cdot\text{K}}\right)(K) = \frac{\text{J}}{\text{mol}}$

$\Delta G$

→ actual, "right now"

→ sign  $\Rightarrow$  spontaneity

Variable

Depends on T, Q,  $\Delta G^\circ$

$\Delta G^\circ$

Standard conditions

→ const @ const T

→ sign  $\Rightarrow$  EQ position

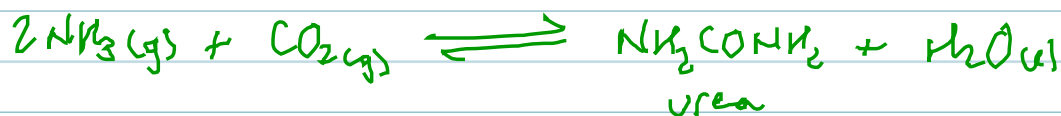
at EQ  $\Rightarrow Q = K, \Delta G = 0 \Rightarrow \Delta G^\circ = -RT \ln K$

<u>K</u>	<u><math>\ln K</math></u>	<u><math>\Delta G^\circ</math></u>	<u>@ EQ</u>
$> 1$	$+$	$-$	$[P] > [R]$
$1$	$0$	$0$	$[P] = [R]$
$< 1$	$-$	$+$	$[R] > [P]$

$$\text{@EQ } \Delta G^\circ = -RT \ln K \quad \left. \begin{array}{l} \text{gases} \Rightarrow K_p \\ \text{soln't} \Rightarrow K_c \end{array} \right\} K_p = K_c (RT)^{\Delta n}$$

$\uparrow$   
0.0821  $\frac{\text{atm} \cdot \text{L}}{\text{mol} \cdot \text{K}}$

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$$\Delta S^\circ = -356 \text{ J/mol} \cdot \text{K}$$

$$\Delta H^\circ = -119.7 \text{ kJ/mol}$$

$$T = 298 \text{ K}$$

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

$$\Delta G^\circ = -13.16 \text{ kJ/mol}$$

$$\Delta G^\circ = -RT \ln K$$

$$\ln K = \frac{\Delta G^\circ}{-RT} = \frac{-13.16 \times 10^3 \text{ J/mol}}{-8.314 \text{ J/mol} \cdot \text{K} (298 \text{ K})}$$

$$\ln K =$$

$$\ln K = 5.49$$

$$K = e^{5.49} = 242$$


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$$K_{sp} \text{ BaSO}_4 = 1.1 \times 10^{-10} \text{ @ } 298 \text{ K}$$

$$\Delta G^\circ = ? \quad \Delta G^\circ = -(8.314 \text{ J/mol} \cdot \text{K})(298 \text{ K}) \ln(1.1 \times 10^{-10})$$

$$\Delta G^\circ = \oplus 57 \text{ kJ/mol}$$

$$\Delta G^\circ \gg 0 \Rightarrow [R] \gg [P]$$