

### Gibbs Free Energy (G):

Also called free energy

Energy from a rxn that is available to do work

$\Delta G^0$  is the change in free energy that will occur if the reactants in their standard states are converted to the products in their standard states

$\Delta G^0$  cannot be measured directly

$\Delta G^0$  – the more negative the value the farther to the right the rxn will proceed in order to reach equilibrium

equilibrium is the lowest possible free energy position for the rxn

Calculating free energy change (constant temp and pressure)

3 methods:

- x 1.  $\Delta G = \Delta H - T\Delta S$   
H = enthalpy  
T = Kelvin temperature

$\Delta S$  convert  $\frac{kJ}{K \cdot mol}$

$\Delta H$  convert  $\frac{J}{mol}$

2. Use Hess's Law: given  $\Delta G^0$  values instead of  $\Delta H$

3. use standard free energy of formation ( $\Delta G_f^0$ )  
Find values on thermo table

$$\Delta G^0 = \sum G_{\text{prod}} - G_{\text{react}}$$

<b>Value of <math>\Delta H</math></b>	<b>Value of <math>T\Delta S</math></b>	<b>Value of <math>\Delta G</math></b>	<b>Spontaneity</b>
Negative	Positive	Negative	Spontaneous
Positive	Negative	Positive	Nonspontaneous
Negative	Negative	???	Spontaneous if the absolute value of $\Delta H$ is greater than the absolute value of $T\Delta S$ (low temperature)
Positive	Positive	???	Spontaneous if the absolute value of $T\Delta S$ is greater than the absolute value of $\Delta H$ (high temperature)

$\Delta G$  is negative, forward rxn is spontaneous

$\Delta G = 0$  rxn at equilibrium

$\Delta G$  is positive, forward rxn is nonspontaneous; work (energy) must be supplied from the surroundings to make it occur

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