

AP Biology - Chapter 8 Metabolism Worksheet

Gibb's free energy explanation

What it is: The system's energy that is available to do work. "Free Energy" or "Available Energy"

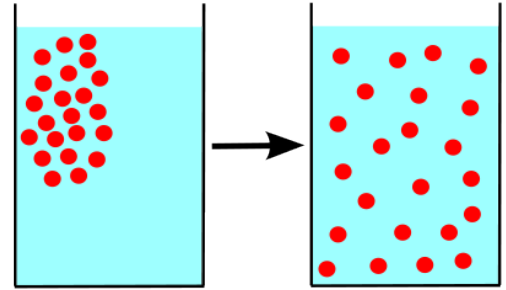
The change in Free Energy during a chemical reaction depends on couple things

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

Where ΔH is enthalpy, total energy of the system, T is temperature in Kelvin, and ΔS is the change in entropy

In the scenario such as diffusion, the particles naturally will go towards the right diagram because it needs to "spread out" or create more disorder (entropy).

So if we look at the total energy ΔH , H_2 will have less potential energy (because it has diffused out) than H_1 . In other words, the energy of the system has gone from high to low (decreased). So ΔH would be negative, making ΔG negative. In biology, the potential energy is stored in the bonds of the molecules (glucose).



If we look at the ΔS , the S_2 is higher than S_1 because it became more disordered. So it would make ΔG more negative, or spontaneous. That is the reason why diffusion is a spontaneous reaction. According to the second law of thermodynamics, reactions favor towards entropy!

To summarize,

$-\Delta G =$ spontaneous

$\Delta G =$ not spontaneous

Since $\Delta G = G_2 - G_1$

In order for ΔG to be spontaneous ($-\Delta G$), G_1 must be greater than G_2 , meaning that G_1 must be more stable than G_2 because it has to go towards disorder (instability). In other words, G_2 must be more disordered than G_1 so that the reaction will occur spontaneously.

G_1 (ordered)	\rightarrow	G_2 (disordered)
Stable		Unstable
More free energy to do work		Less free energy to do work

$\Delta G < 0 =$ Exergonic = spontaneous (energy given off)

$\Delta G > 0 =$ Endergonic = spontaneous in reverse (requires energy)

$\Delta G = 0$ Equilibrium

1. Complete the following table to indicate how free energy of a system relates to the system's stability, tendency for spontaneous change, equilibrium and capacity to do work.

	System with High Free Energy	System with Low free energy
Stability	Low	
Spontaneous		
Is it at Equilibrium or moving towards?		
Work Capacity		

2. Reduced organic compounds tend to contain stored energy in C-H bonds. As a general rule, the greater the number of C-H bonds, the greater the amount of potential energy stored in the molecule. Answer and explain your reasoning behind your answers.

	Reaction 1: $\text{CH}_4 + 2\text{O}_2 \rightarrow \text{H}_2\text{O} + \text{CO}_2$	Reaction 2: $6\text{CO}_2 + 6\text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$
Is the reaction exergonic or endergonic?		
Is it spontaneous?		
Is the reaction anabolic or catabolic?		
Is ΔG positive or negative?		