PHYSICAL CHEMISTRY

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Chemical
Thermodynamics

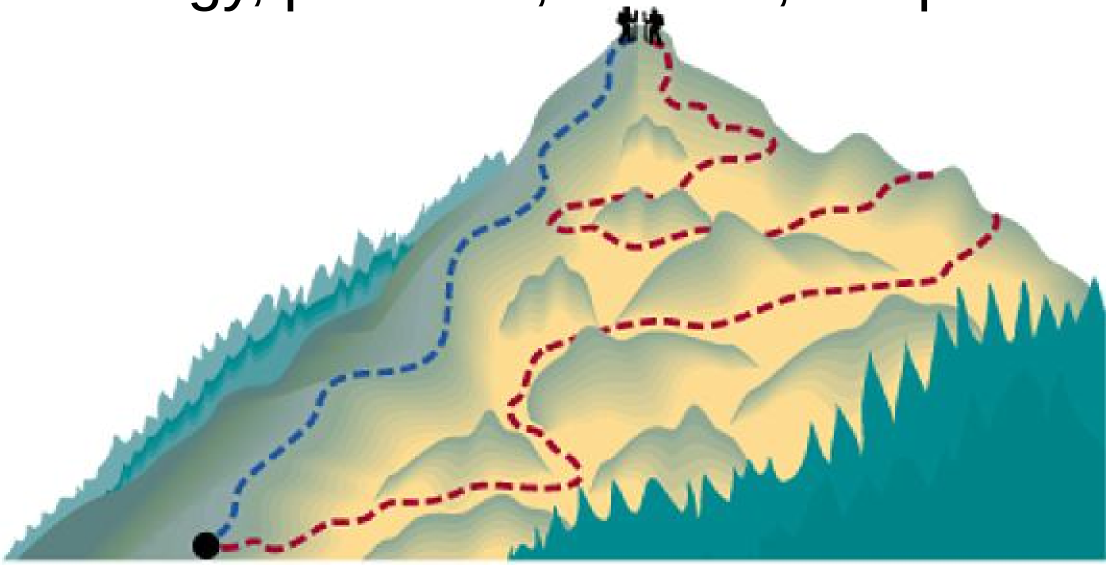
Law of Thermodynamics

1. The Zero Law of Thermodynamics
2. The First Law of Thermodynamics
3. The Second Law of Thermodynamics
4. The Third Law of Thermodynamics

Thermodynamics

State functions are properties that are determined by the state of the system, regardless of how that condition was achieved.

energy, pressure, volume, temperature



- Potential energy of hiker 1 and hiker 2 is the same even though they took different paths.
- Like total energy, *E*, and enthalpy, *H*, entropy is a state function. Therefore, $\Delta S = S_{\text{final}} - S_{\text{initial}}$

The Second Law of Thermodynamics

The entropy of the universe does not change for reversible processes and increases for spontaneous processes.

$$\Delta S_{univ} = \Delta S_{system} + \Delta S_{surroundings} = 0$$

Reversible (ideal):

$$\Delta S_{univ} = \Delta S_{system} + \Delta S_{surroundings} > 0$$

Irreversible (real, spontaneous):

The entropy of the universe increases (real,spontaneous processes).

But, entropy can decrease for individual systems.

Entropy Changes in Surroundings

- Heat that flows into or out of the system also changes the entropy of the surroundings.
- For an isothermal process:

$$\Delta S_{surr} = \frac{-q_{sys}}{T}$$

  - At constant pressure, q_{sys} is simply $\Delta H°$ for the system.

$$\Delta S_{surr} = \frac{-q_{sys}}{T} = \frac{-\Delta H°}{T}$$

ENTROPY CHANGES SYSTEMS

1. **Reversibly Processes**

$T_{sys} = T_{surr}$

P, V dan T-nya.

$$S = q / T \qquad dS = dq/T$$

$$q = q_{rev} \qquad dq = dq_{rev}$$

$$dS = dq_{rev}/T$$

$$\Delta S = q_{rev} / T$$

Determaint Entropy Changes Reversibly Processes

1. Adiabatik Process, dq = 0

$dq_{rev} = 0$, and $dS = 0$ ➔ S

so➔ $dq_{rev} = 0$ and $dS = 0$

2. Isotermal Process ,

$PV = nRT$ and $dq = Cv.dT$

so

$$S_2 - S_1 = \int_1^2 \frac{d'Q_r}{T} = \frac{1}{T}\int_1^2 d'Q_r = \frac{Q_r}{T}$$

$$(s_2 - s_1)_v = \int_{T_1}^{T_2} c_v \frac{dT}{T}$$

$$(s_2 - s_1)_v = c_v \ln \frac{T_2}{T_1}$$

3. Isotermal in the ideal Gas

$\Delta S = q_{rev} = nRT \ln V_2 / V_1$

Calculate entropy exchange surroundings when 1 mol H_2O (l) at 25^0 C!

$H_2 (g) + ½ O_2 (g) \text{--->} H_2O (liq)$

$\Delta H = -285{,}8$ KJ mol-1

$\Delta S = -\Delta H/T = -(-286 \times 1000J) / 298\ K$

$= 959\ Jk^{-1}$ → Eksoterm S

Law 1 & 2 THERMODyNAMIKA

$$du = dq + dw$$

$$dw = -p\,dV$$

$$dq = T\,ds$$

Sehingga

$$du = T\,ds - p\,dV$$

→ ***Fundamental Equality***.

THANK YOU

Chemical Thermodynamics