# Hessov zakon

Germain Henri Hess

Entalpije neke reakcije r jednaka je zbroju entalpija reakcija na koje reakciju r možemo rastaviti

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- Stvaranje $\Delta_r H = \sum_i \nu_i \Delta_f H_i$
- Sagorijevanje $\Delta_r H = -\sum_i \nu_i \Delta_c H_i$
- Atomizacija $\Delta_r H = -\sum_i \nu_i \Delta_{at} H_i$

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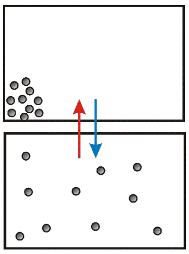
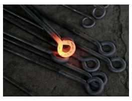
## Spontani procesi





$H_2(g) + O_2(g) \rightarrow H_2O(l)$

$AgNO_3(aq) + KCl(aq) \rightarrow AgCl(s) + KNO_3(aq)$

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**DRUGI ZAKON TERMODINAMIKE**

spontanost neke fizikalne ili kemijske promjene

**ENTROPIJA**

**Entropija svemira raste.**

postoji neprekinuta, jednoznačna jedinstvena ekstenzivna funkcija stanja koja se naziva entropija i to takva da vrijedi:

$$\mathrm{d}S = \frac{\mathrm{d}q_{rev}}{T} \qquad \mathrm{d}S \geq \frac{\mathrm{d}q}{T}$$

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Spontani procesi $\Delta S > 0$

Primjeri:

- Promjena entropije s promjenom volumena
- Promjena entropije s promjenom temperature
- Promjena entropije prilikom fazne transformacije

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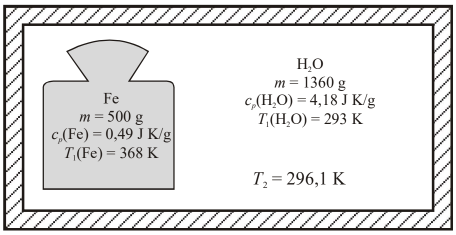
Spontani procesi u izoliranom sustavu popraćeni su povećanjem ukupne entropije.

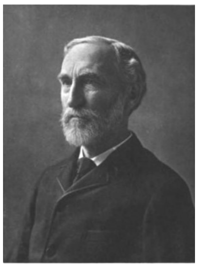


TREĆI ZAKON TERMODINAMIKE

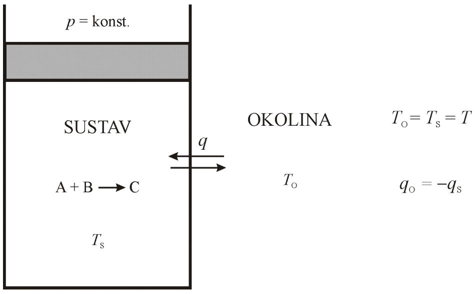
Entropija elemenata i savršenih kristala je nula pri apsolutnoj nuli.

$$S_m(T = 0\ \mathrm{K}) = 0$$

Josiah Willard Gibbs



Gibbsova energija, $G$




$$G = H - TS$$

Spontani proces: $\Delta S_{uk} > 0 \quad \Rightarrow \quad \Delta G < 0$

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

$\Delta_r G > 0$ Povratna reakcija

$\Delta_r G = 0$ Ravnoteža

$\Delta_r G < 0$ Spontana, napredna reakcija

$$G = H - TS \qquad p = konst. \quad T = konst.$$

$$dG = d(H - TS) = dH - d(TS) = dH - TdS - SdT$$

$$H = U + pV$$

$$dH = dU + d(pV) = dU + pdV + Vdp$$

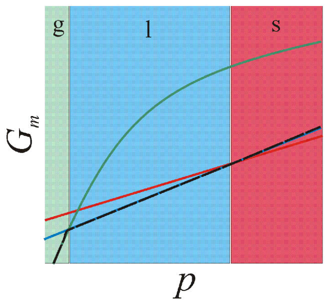
$$dG = dU + pdV + Vdp - TdS - SdT$$

$$dG = dq - pdV + pdV + Vdp - dq - SdT$$

$$dG = Vdp - SdT$$

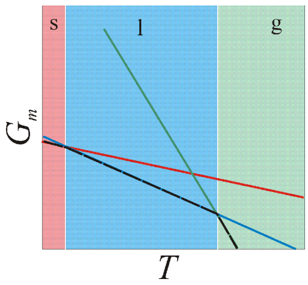
$$dG = Vdp - SdT$$

$$\left(\frac{\partial G}{\partial p}\right)_T = V$$



$$\mathrm{d}G = V\mathrm{d}p - S\mathrm{d}T$$

$$\left(\frac{\partial G}{\partial T}\right)_p = -S$$




Gibbs-Helmholtzova jednadžba

$$\left(\frac{\partial G}{\partial T}\right)_p = -S$$

$$\left(\frac{\partial (G/T)}{\partial T}\right)_p = -\frac{H}{T^2}$$

$$\left(\frac{\partial (G/T)}{\partial (1/T)}\right)_p = H$$