Entropy

Entropy concept

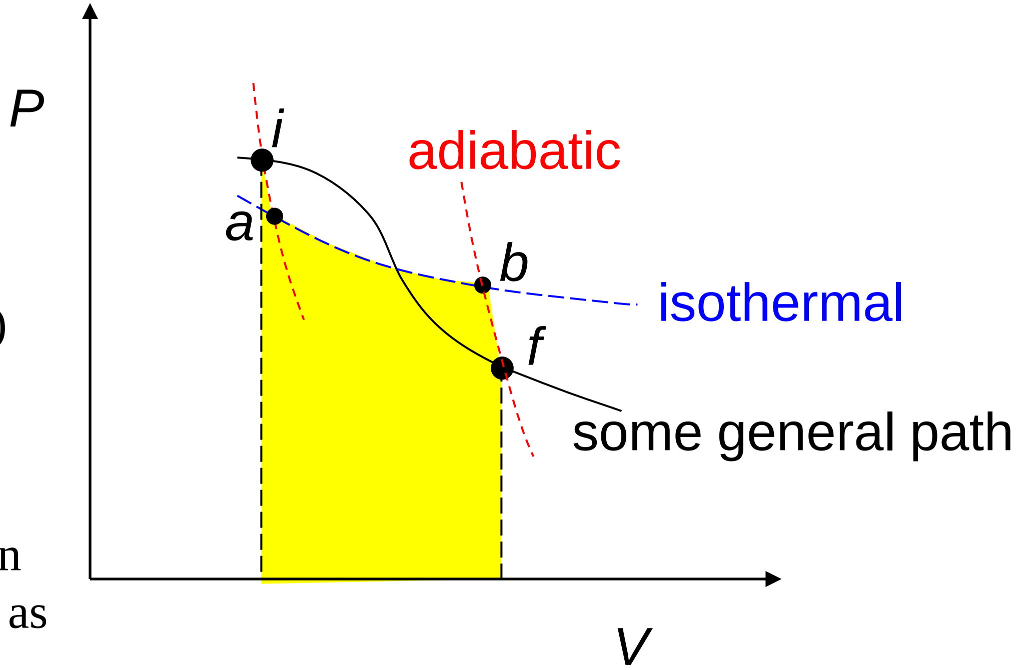
1. Replace the path $i \rightarrow f$ along the general path by $iabf$ such that

$W_{iabf} = W_{if}$ (equal areas)

$\Delta U_{iabf} = \Delta U_{if}$ (U function of state)

$\therefore\ Q_{iabf} = Q_{if}$ (from first law)

We can find a zig-zag path having an isothermal with the same Q transfer as in the actual path element.



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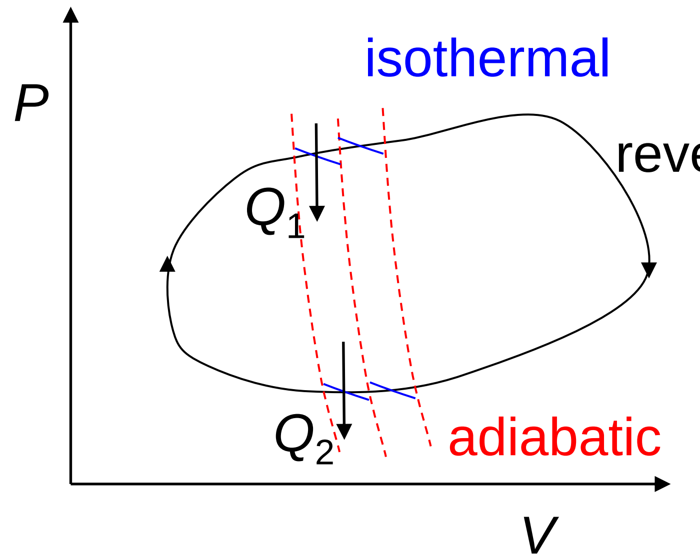
2. Taking account of sign convention for heat transfers

$$\frac{Q_1}{T_1} + \frac{Q_2}{T_2} = 0$$



For slice

$$\frac{Q_1}{T_1} = \frac{Q_2}{T_2}$$

Over all slices $\sum\left[\frac{Q_1}{T_1} + \frac{Q_2}{T_2}\right] = 0$

Round zig-zag loop $\sum\frac{Q_R}{T} = 0$

In limit of thin slices $\boxed{\oint\frac{dQ_R}{T} = 0}$

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3. $$\oint \frac{dQ_R}{T} = \underset{\text{A}}{\int_i^f \frac{dQ_R}{T}} + \underset{\text{B}}{\int_f^i \frac{dQ_R}{T}} = 0$$

$$\therefore \underset{\text{A}}{\int_i^f \frac{dQ_R}{T}} = \underset{\text{B}}{\int_i^f \frac{dQ_R}{T}} = \underset{\text{Any reversible route}}{\int \frac{dQ_R}{T}}$$

Definition: the difference in **entropy *S*** between any states *i* and *f* is

$$S_f - S_i = \int_i^f dS = \int_i^f \frac{dQ_R}{T}$$