Reversible and irreversible processes

Processes that create new entropy are irreversible.

If they could run backwards they would *decrease* the entropy and that would be against the second law.

Conversely,

Processes that leave the entropy unchanged are reversible.

In practice no macroscopic process is altogether reversible, but some are close.

Reversible work?

A slow adiabatic compression is reversible since it does not by itself increase the entropy. To see this: $\gamma - 1 = 2/f$ in $TV^{\gamma-1} = \text{const}$ gives

$$VT^{f/2} = \text{const.}$$

Together with $U \propto T$ and $f = 3$ for the monatomic case:

$$VU^{3/2} = \text{const.}$$

From the Sackeur-Tetrode equation (below) it then follows that the entropy doesn't change in an adiabatic process.

$$S = Nk_B \left[\ln \left(\frac{V}{N} \left(\frac{4\pi mU}{3Nh^2} \right)^{3/2} \right) + \frac{5}{2} \right].$$

Reversible heat flow?

- Flow of heat occurs precisely because the total multiplicity then increases and therefore the total entropy will increase too.
- For very small temperature difference the entropy increase would be negligible and one could then consider the heat flow to be essentially reversible.

Maxwell's demon

Is it really generally true that all processes lead to the increase of entropy?

Maxwell suggested that a "very observant and neat-fingered being" could deflect faster particles in one direction and slower particles in the other.

However,

- devices for doing this have been found to be ineffective since each such a device has to process the information needed to sort the molecules and this creates entropy.
- The entropy will thus increase and the second law is not violated.