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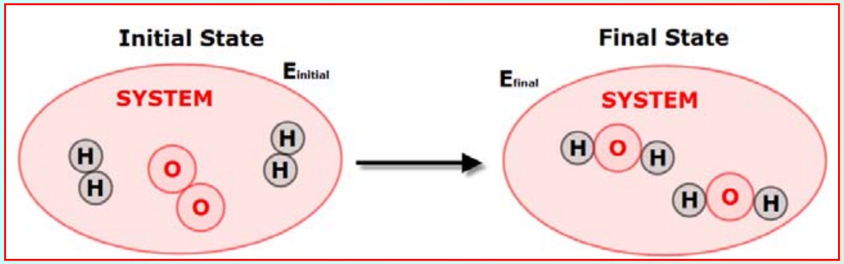
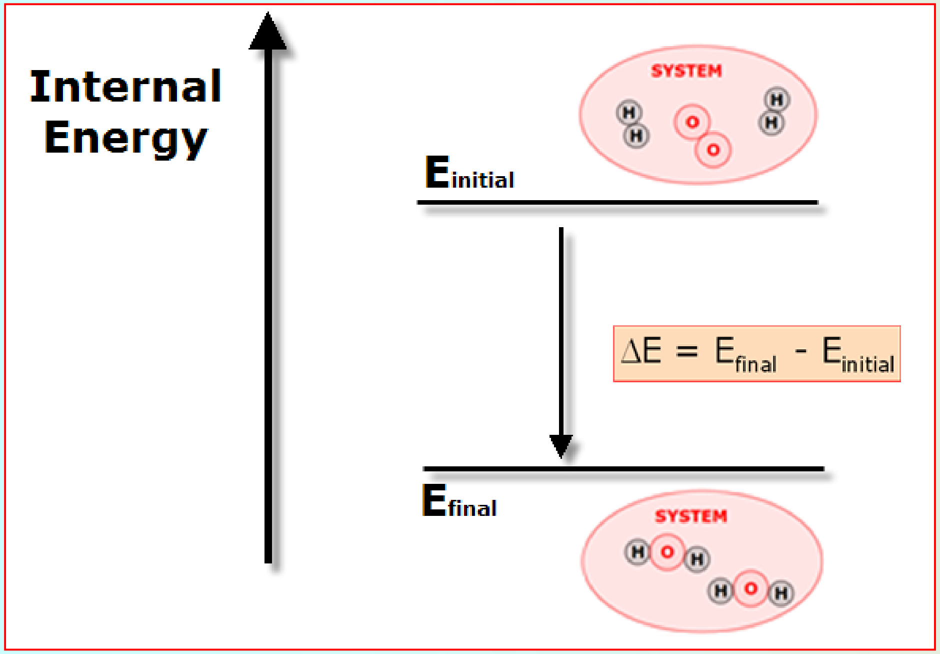
First Law of Thermodynamics





Internal Energy

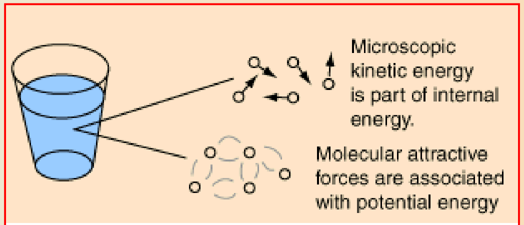
The internal energy of a system is the sum of all the kinetic and potential energies of all the components of the system.

In our example, the internal energy includes the motions and interactions of all the particles (nuclei and electrons) of the O_2 and H_2 molecules.

We represent the internal energy with the symbol **E**.

When the system undergoes a change, if the initial internal energy is called $\mathbf{E_{initial}}$ and the final internal energy $\mathbf{E_{final}}$, the change in internal energy (**ΔE**) is:

$$\Delta E = E_{final} - E_{initial}$$



http://hyperphysics.phy-astr.gsu.edu/hbase/thermo/imgheat/inteng1.gif

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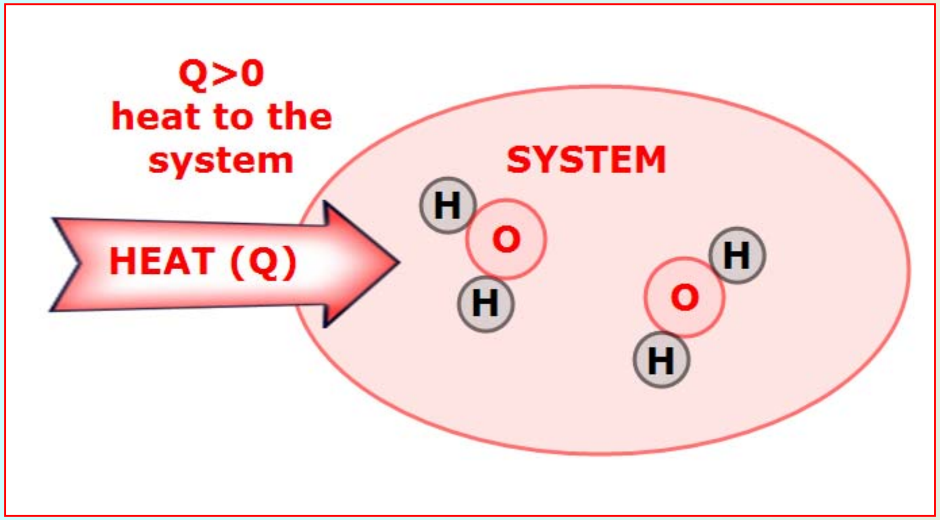

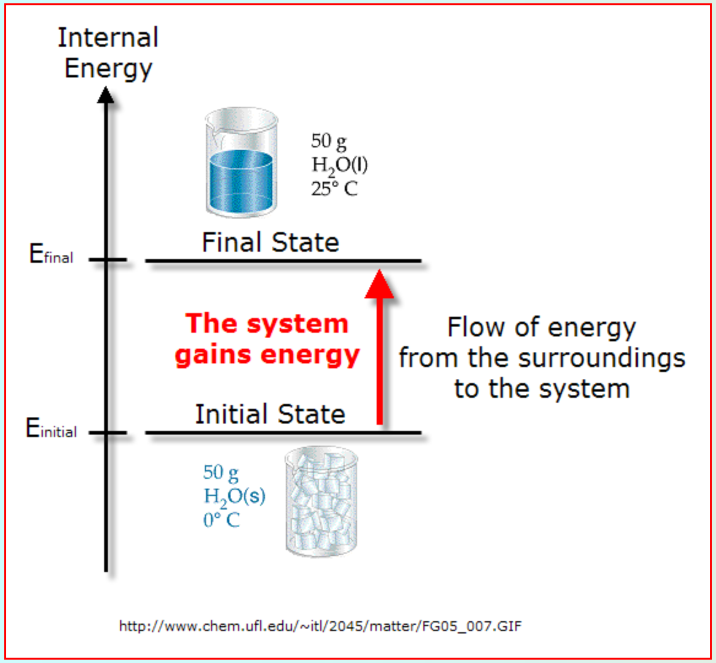

Transferring Energy: Work and Heat

When energy is transferred between the system and the surroundings, it appears as **work** and/or as **heat**.

Heat

Energy in the form of heat is transferred between a system and its surroundings as a result of a difference in their temperatures.

In this example, the system gains energy from the surroundings, because ice is heated until it becomes water at 25 ºC.

Therefore:

$$\Delta E = E_{final} - E_{initial} = Q > 0$$

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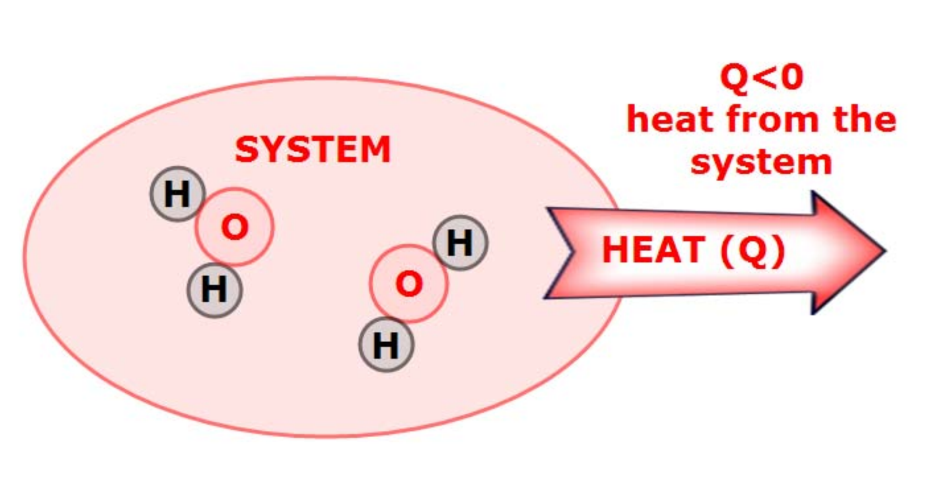


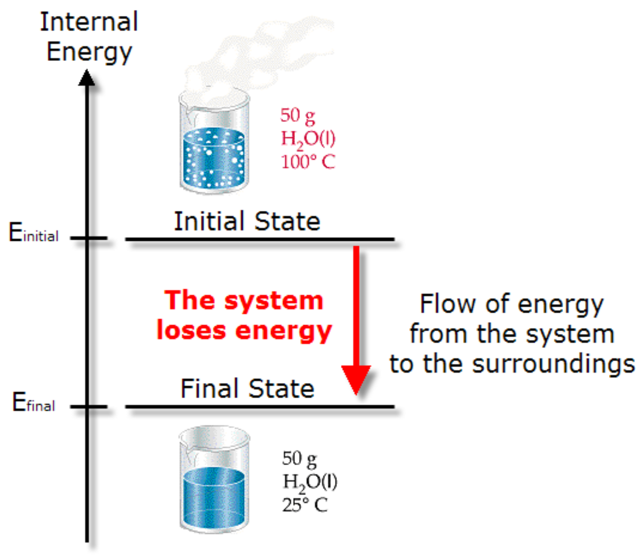
Transferring Energy: Work and Heat

Heat

In this example, the system transfers (loses) energy to the surroundings, because water is cooled.

Therefore:

$$\Delta E = E_{final} - E_{initial} < 0$$



http://www.chem.ufl.edu/~itl/2045/matter/FG05_007.GIF

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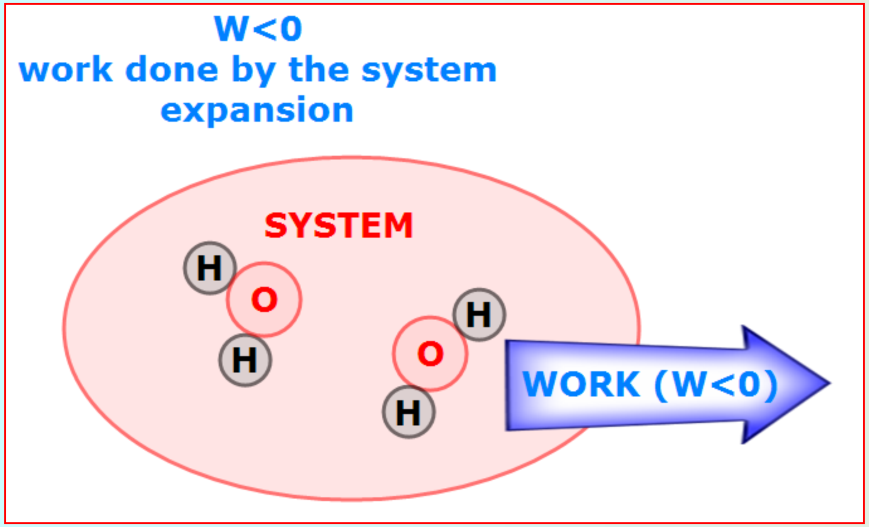
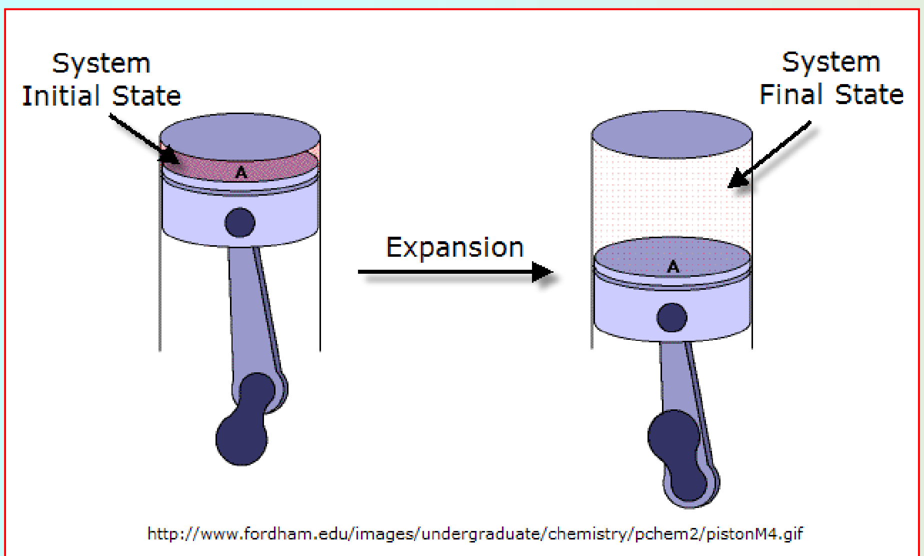


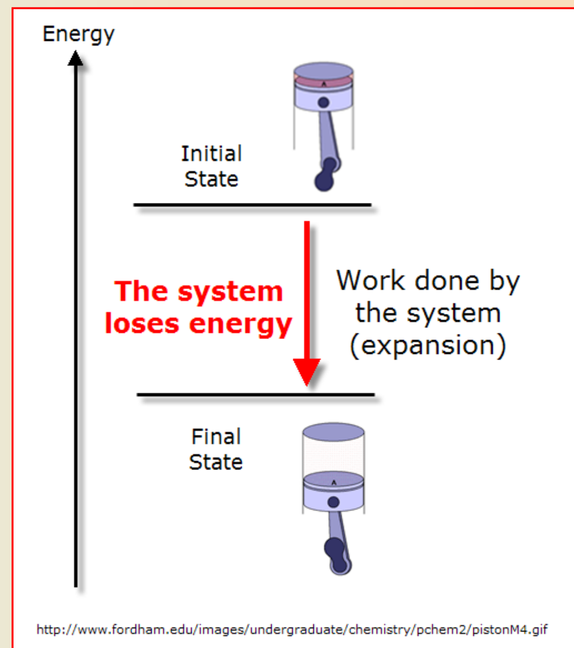
Transferring Energy: Work and Heat

Work

In this example, some of the internal energy of the gas inside the cylinder is used to do work on the surroundings (expansion)

$$\Delta E = E_{final} - E_{initial} < 0$$





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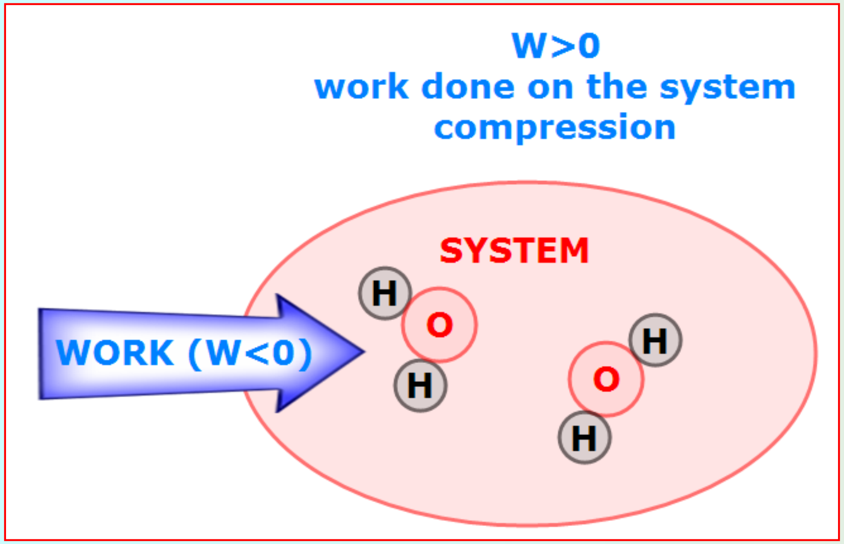
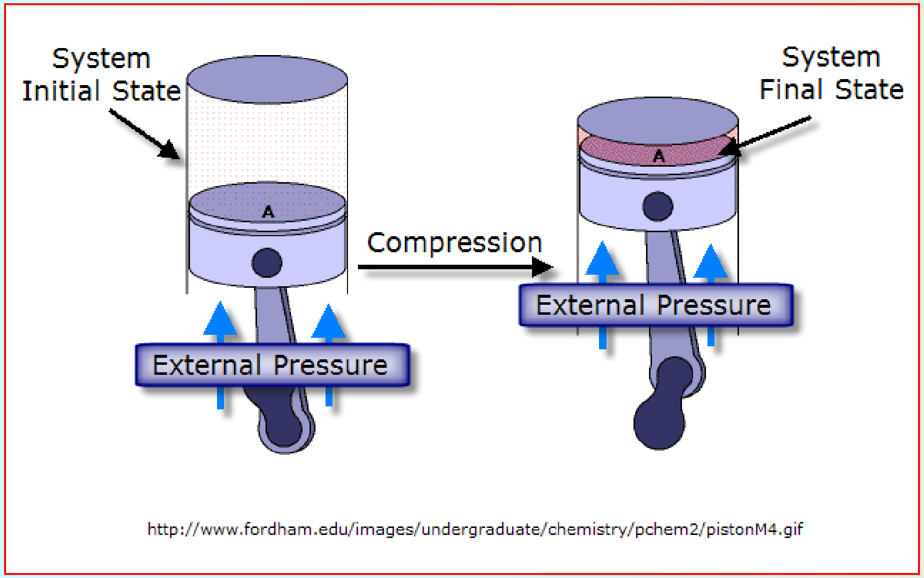


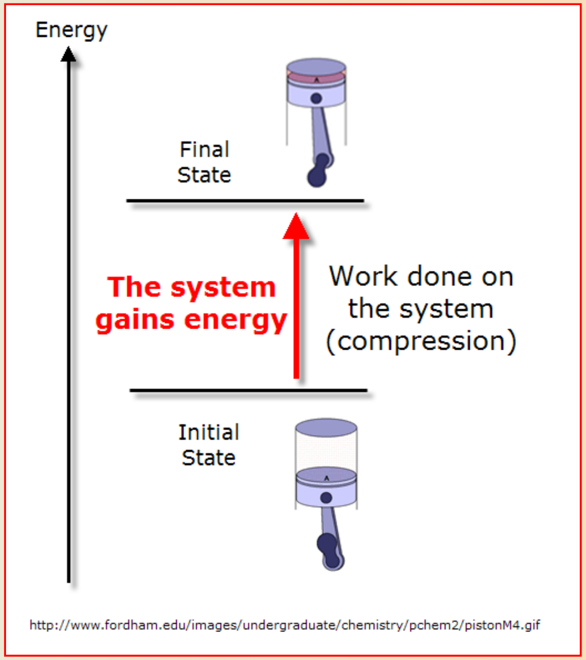
Transferring Energy: Work and Heat

Work

In this example, some the work is done on the system by the surroundings: the external pressure is exerted on the piston and the system is compressed.

$$\Delta E = E_{final} - E_{initial} > 0$$





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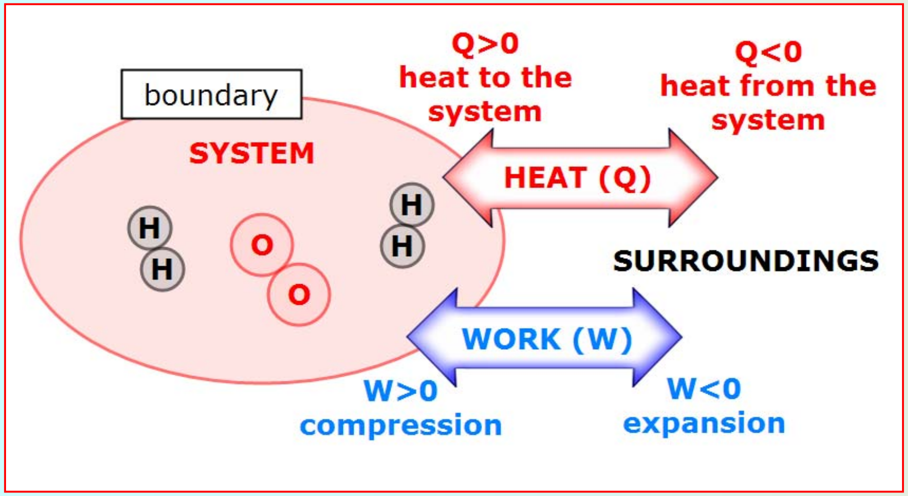

The First Law of Thermodynamics

The first law of thermodynamics relates the change in internal energy (ΔE) to the transfer of heat and work between the system and surroundings.

$$\Delta E = E_{final} - E_{initial} = Q + W$$

It means that the heat added to the system and the work done on the system increase its internal energy.

Sign Convention for Q (heat)	
$Q > 0$	Heat is transferred from the surroundings to the system
$Q < 0$	Heat is transferred from the system to the surroundings

Sign Convention for W (work)	
$W > 0$	Work is done by the surroundings on the system (compression)
$W < 0$	Work is done by the system on the surroundings (expansion)