

Thermodynamics:

Physics that deals with the mechanical action or relations between **heat** and **work**

Example Heat to work

Heat q from flame provides energy to do work w

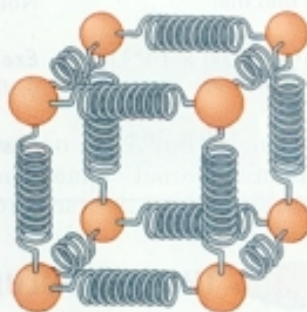


Internal Energy (ΔE)

(measured in joules)

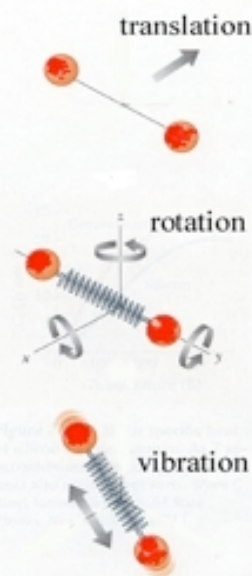
Sum of random **translational**, **rotational**, and **vibrational** kinetic energies

Thermal Energy:
same as internal energy



Vibrational kinetic energy in solids

The hotter the object, the larger the vibrational kinetic energy



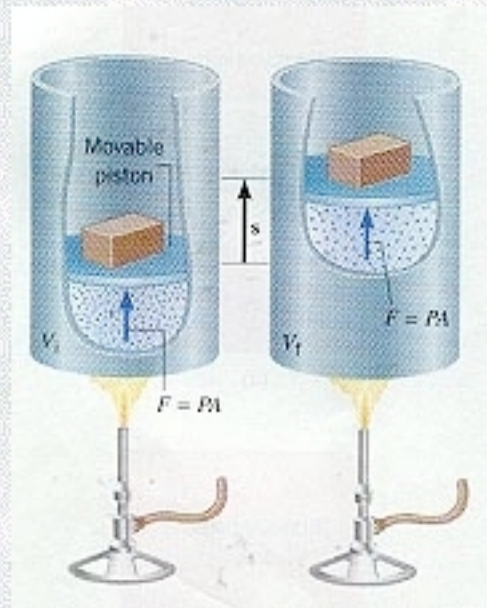
Motions of a diatomic molecule in a fluid

Heat (q)

- ... is the amount of internal energy entering or leaving a system
- ... occurs by conduction, convection, or radiation.
- ... causes a substance's temperature to change
- ... is not the same as the internal energy of a substance
- ... is **positive** if thermal energy flows *into* the substance
- ... is **negative** if thermal energy flows *out of* the substance
- ... is measured in joules



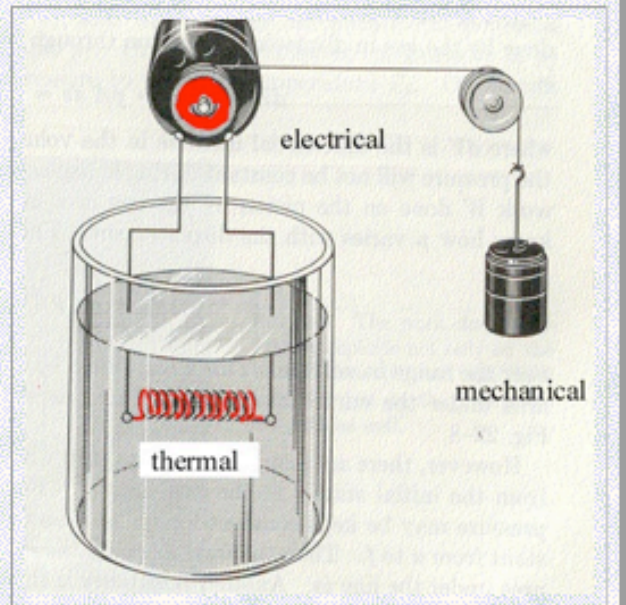
w is **negative** if work is done *by* system.



The First Law of Thermodynamics (Conservation of Energy)

"Energy can neither be created nor destroyed, but only transferred from one system to another and transformed from one form to another."

$$\Delta E = q + w$$



Types of Thermodynamic Processes

Isothermal: Same temperature

Isobaric: Same pressure

Isochoric: Same volume

Adiabatic: Zero heat $q = 0$