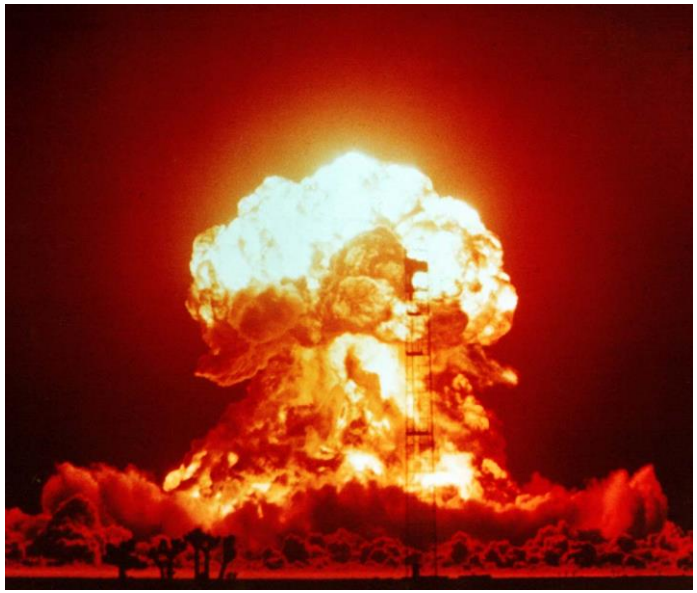
Picture taken from Wikipedia



Spontaneous processes

First law of thermodynamics

Content last lecture

- 0^{th} law of thermodynamic
- Thermal equilibrium
- Temperature
- Reversibility

Picture taken from Wikipedia

Spontaneous processes

System in equilibrium with surroundings will remain unchanged.

If out of equilibrium it will spontaneously drive towards equilibrium

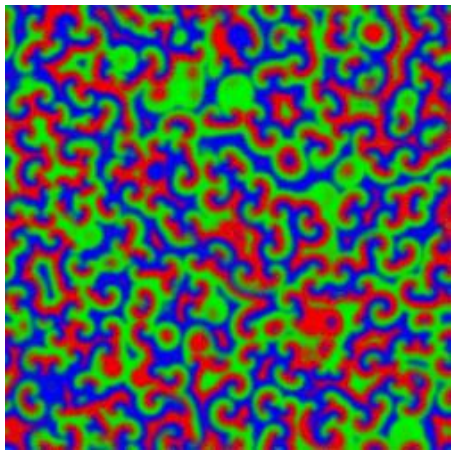
Reverse processes will NEVER occur

Need to apply external "force" to prevent this from happening or to drive system out of equilibrium

not a force per se but can = "push"

Spontaneous = irreversible

So what happens in a Belousov-Zhabotinsky reaction? (see YouTube videos)



Picture taken from Wikipedia

Pitch drop experiment

Spontaneous ≠ Instantaneous

First law of Thermodynamics

The change in internal energy of a system, ΔU, is equal to the work done on the system, ΔW, plus the heat supplied to the system, ΔQ.

$$\Delta U = \Delta W + \Delta Q \quad \text{(for finite processes)}$$

$$\mathrm{d}U = đW + đQ \quad \text{(infinitesimal processes)}$$

This states the conservation of energy.

"Work" for a gas is $(-p\,\mathrm{d}V)$ but what is the general distinction between heat and work?

Example electrical heating:

the work $đW = \mathcal{E}\,\mathrm{d}q$ ($\mathcal{E}$ is electromotive force, q is charge)

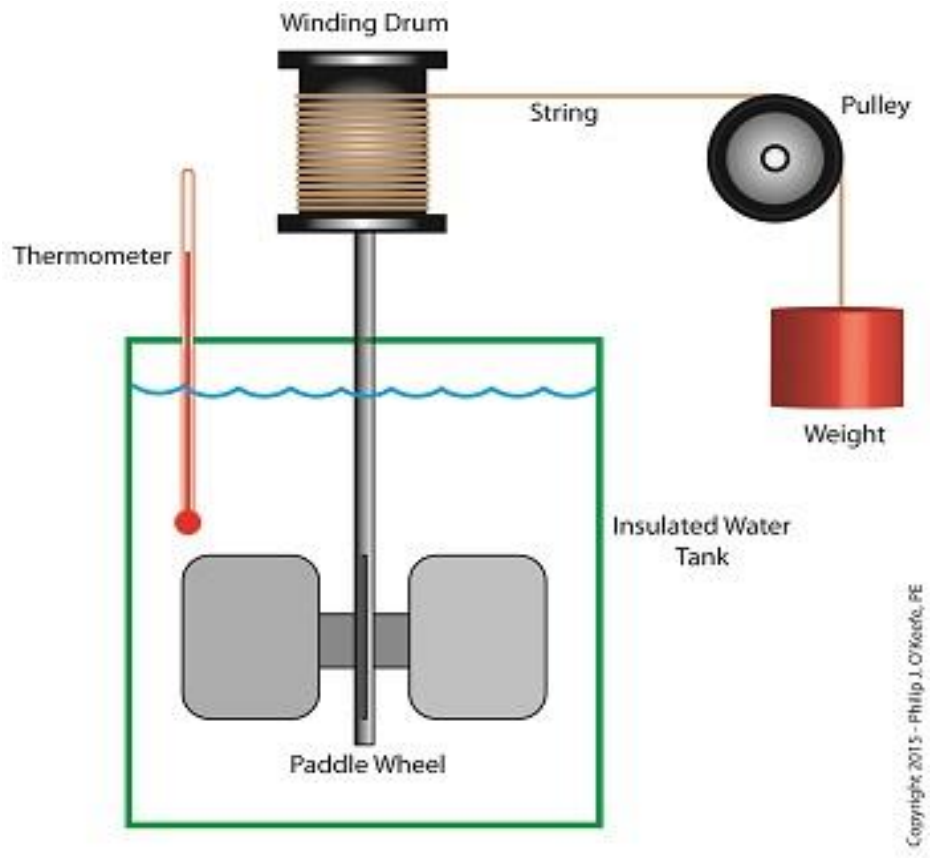
work = energy exchanged by transfer between direct macroscopic observables $(p_1V_1 \rightarrow p_2V_2)$;

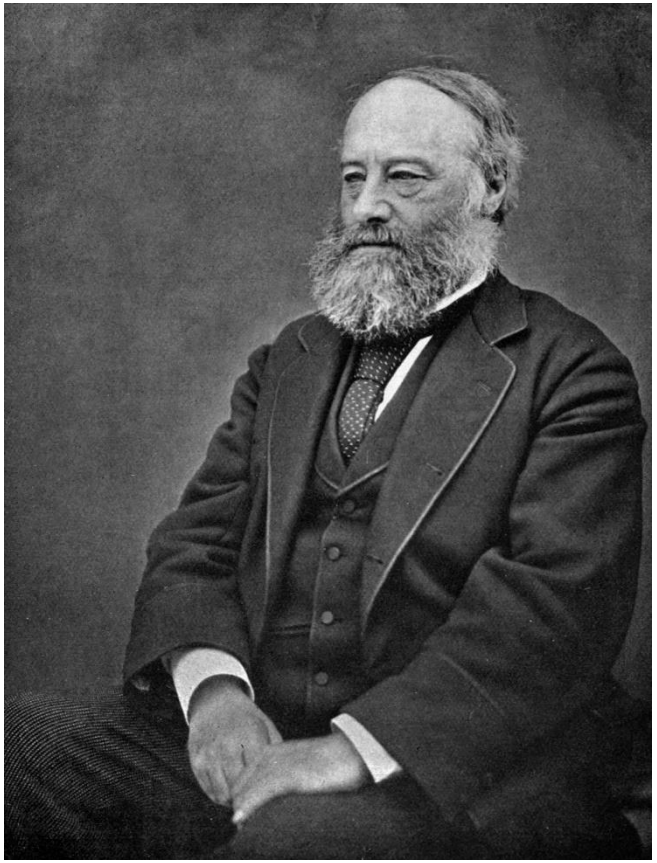
heat = energy exchanged directly between microscopic degrees of freedom of the system (microscopic work).

Pictures taken from Wikipedia

Energy can only be converted from one form into the other. It can never be created or destroyed.

Examples of 1st law in action:





James Prescott Joule

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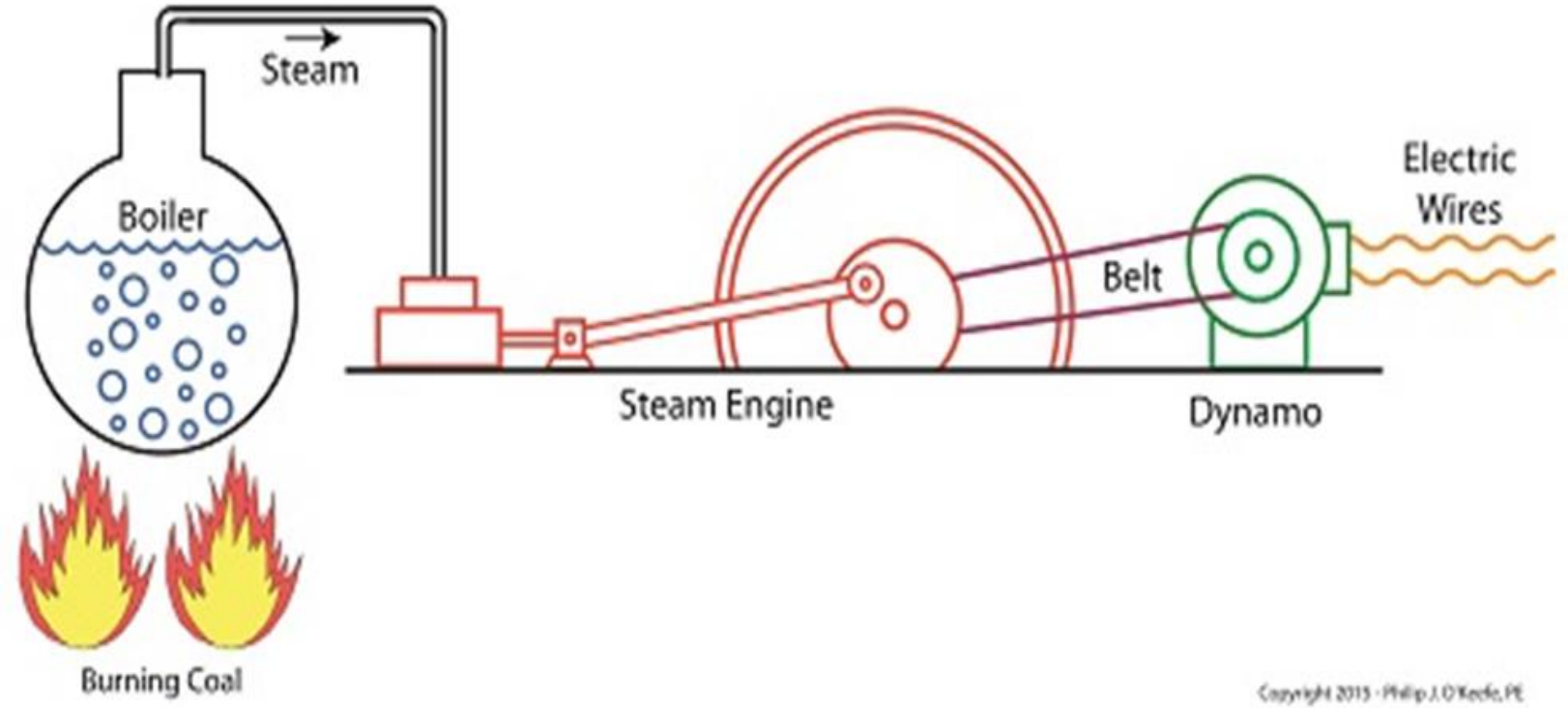
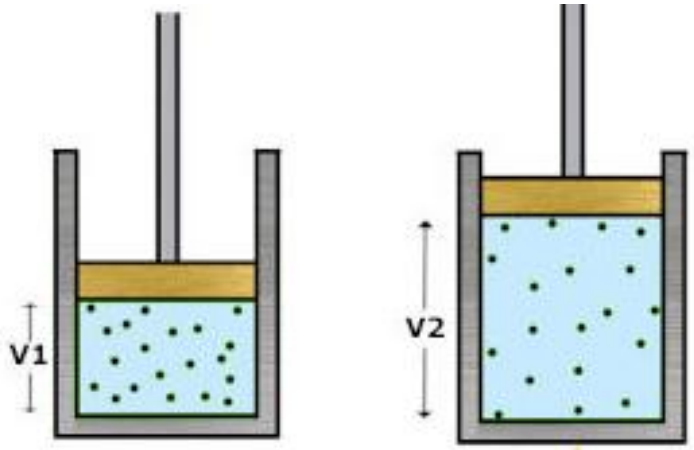
Examples of 1st law in action:



Assume adiabatic work

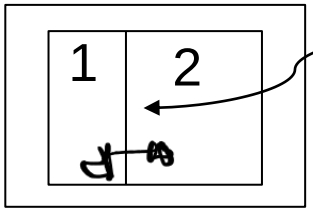


$$\Delta U = \Delta W + \Delta Q$$

$$\Delta U = \Delta W = -\int_{V_1}^{V_2} p dV$$

this is work done by the system

Now assume isolated system



Diathermal, movable wall

$$\Delta U_1 = \Delta W_{2->1} + \Delta Q_{2->1} \qquad \Delta U_2 = \Delta W_{1->2} + \Delta Q_{1->2}$$

In a closed system, energy cannot be lost or gained it can only be converted from one form into another.