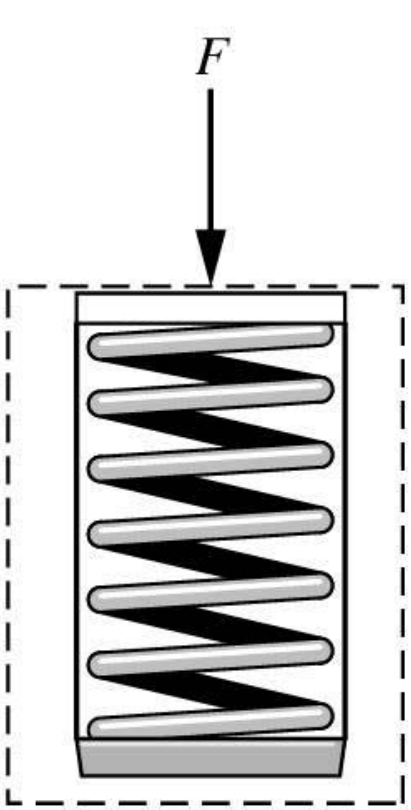
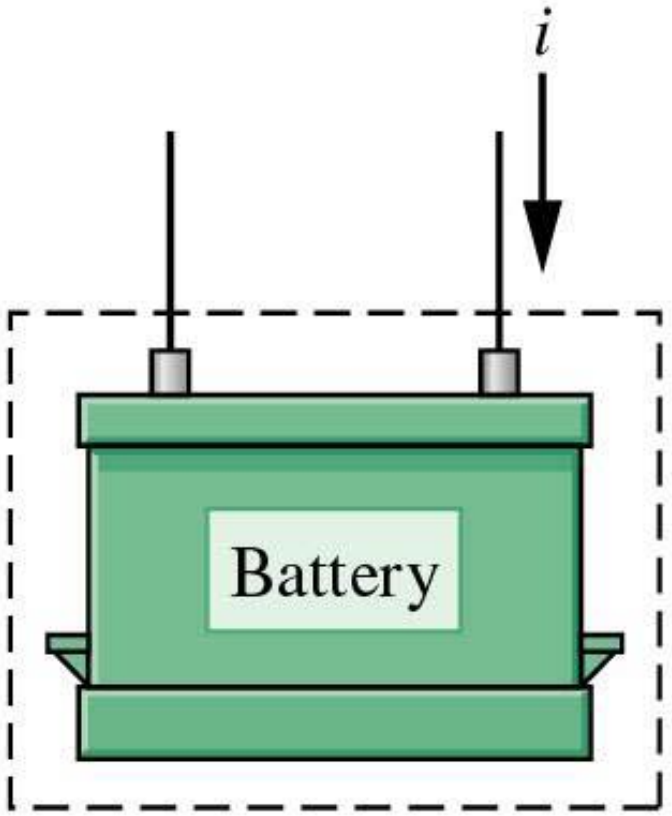
We will cover the following concepts,

- ***Internal Energy***
- ***Energy Transfer by Heat***
- ***Heat Transfer Modes***
- ***First Law of Thermodynamics for a Closed System***

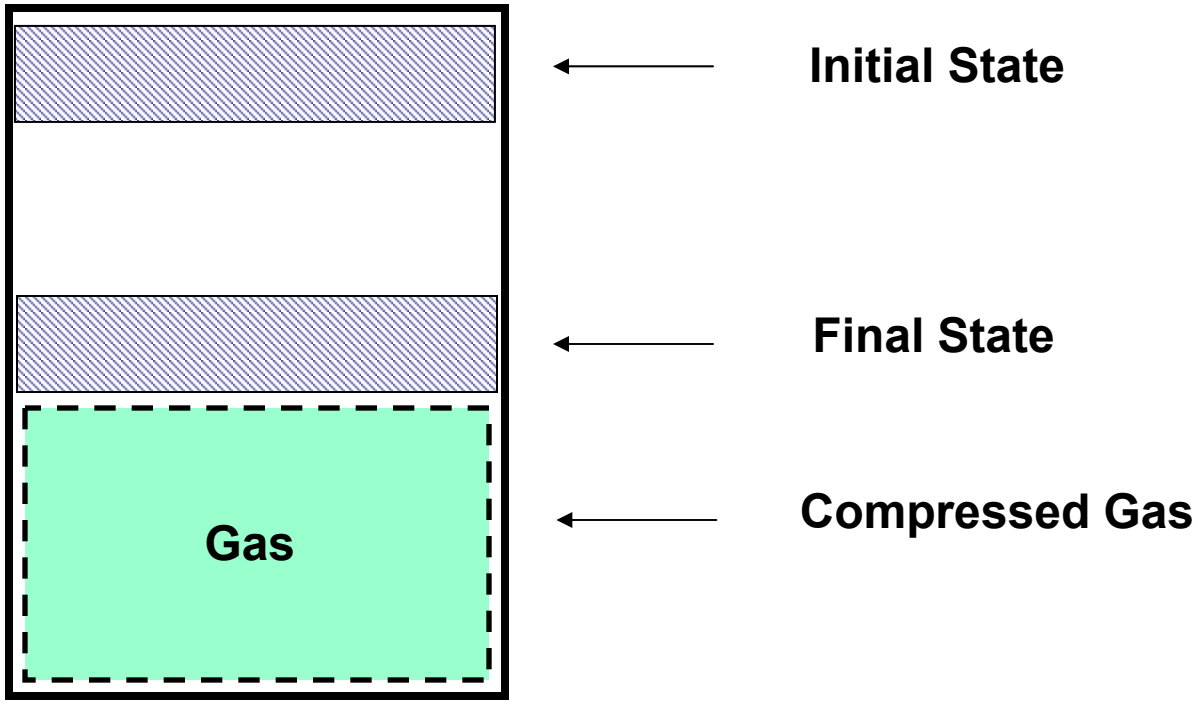
Internal Energy: Summation of any other forms of energy stored in a system is called Internal Energy

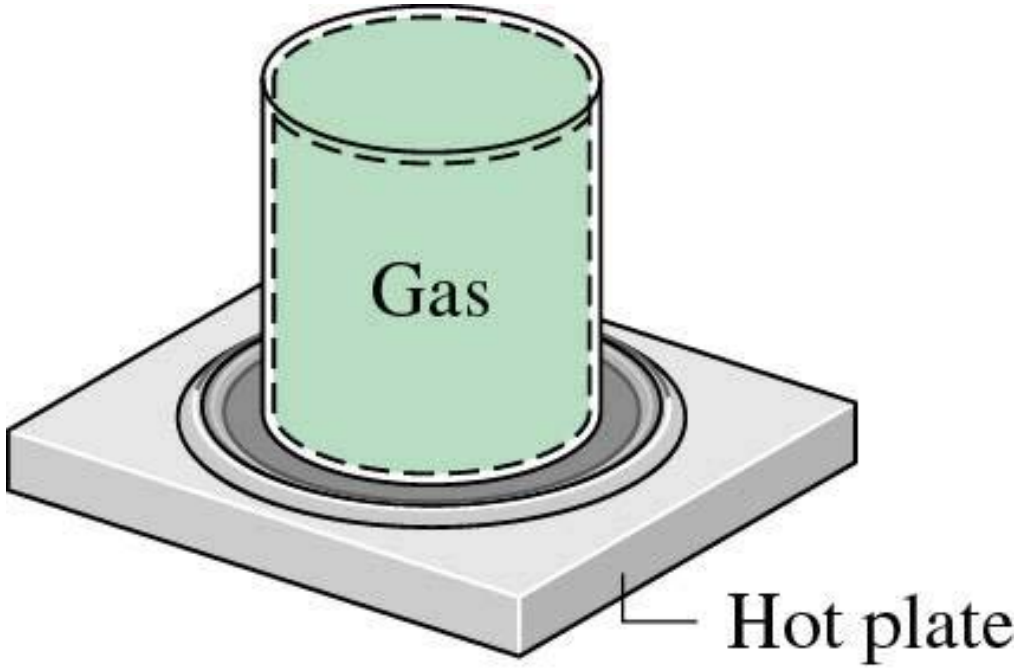




$$\Delta E = \Delta KE + \Delta PE + \Delta U$$

$$= (KE_2 - KE_1) + (PE_2 - PE_1) + (U_2 - U_1)$$





$Q > 0$: heat transfer *to* the system

$Q < 0$: heat tranfer *from* the system

Rate Of Energy Transfer By Heat

$$\dot{Q} = \frac{Heat}{Time} = \frac{dQ}{dt}$$

$$Q = \int_{t_1}^{t_2} \dot{Q} dt$$

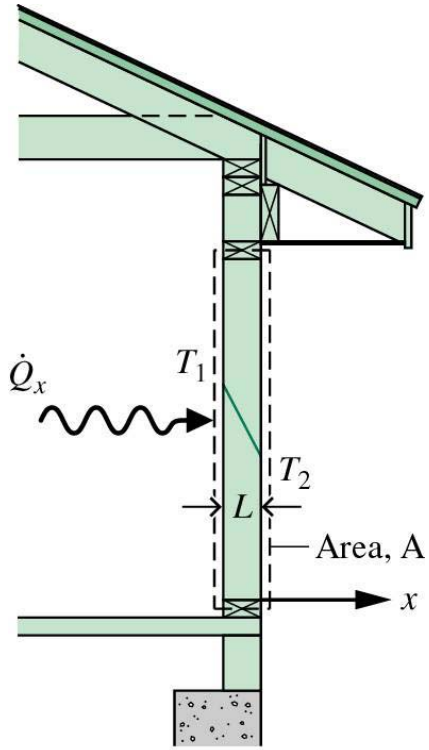
Heat Transfer Modes:

- Conduction: Energy Transfer between the Particles of a Substance
- Radiation: Change in Electronic Configuration of the Molecules
- Convection: Energy Transfer when Contacting Solid-Fluid or Fluid-Fluid

Fourier's Law:

$$\dot{Q}_x = -kA\frac{dT}{dx}$$

***k* is called conductivity.**
A is surface area.



- Linear Variation

$$\dot{Q}_x = -kA\frac{T_2 - T_1}{L}$$

Boltzmann's Law:

$$\dot{Q}_e = \varepsilon \sigma A T_b^4$$

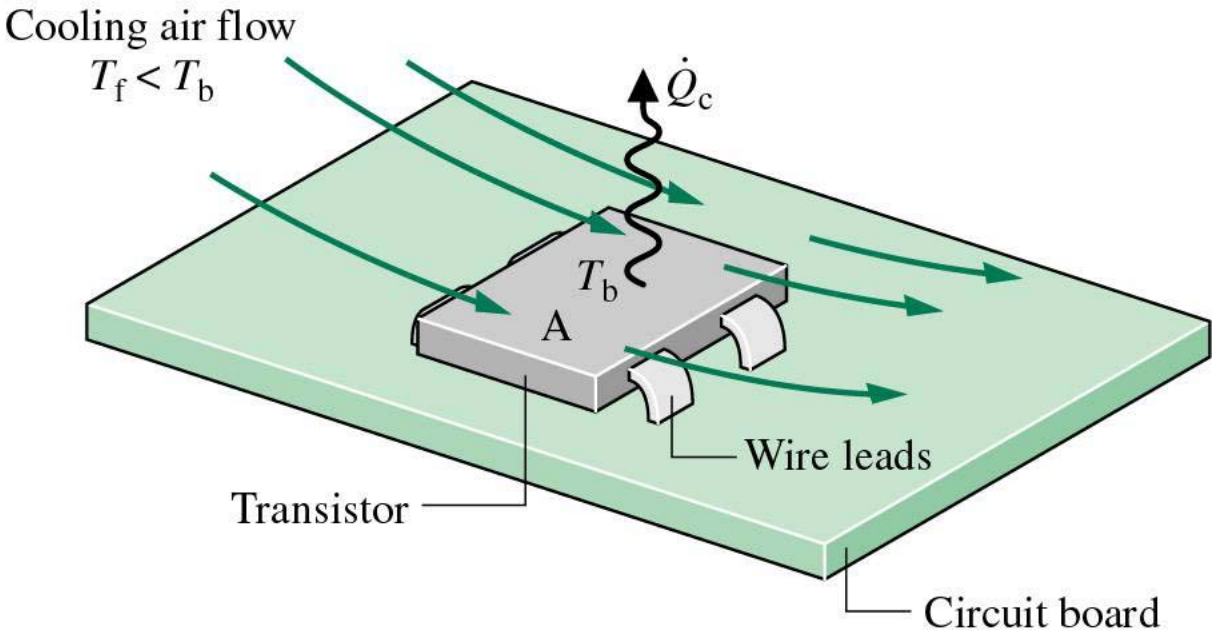
ε emissivity is a property of the surface that shows how effectively the surface radiates.

σ is called Boltzmann's constant.

Newton's Law of Cooling

$$\dot{Q}_c = hA(T_b - T_f)$$

T_b is the solid surface temperature
T_f is the moving fluid temperature
***h* is the heat transfer coefficient**
***A* is the surface area**



Change in Total Energy = Net Heat Transfer In – Net Work Out

$$E_2 - E_1 = \Delta KE + \Delta PE + \Delta U = Q - W$$

Or

$$dE = \delta Q - \delta W$$

$W > 0$: work done *by* the system

$W < 0$: work done *on* the system

$Q > 0$: heat transfer *to* the system

$Q < 0$: heat tranfer *from* the system

Time Rate of Change of Total Energy =
Net Rate of Heat Transfer *In* – Net Rate of Work *Out*

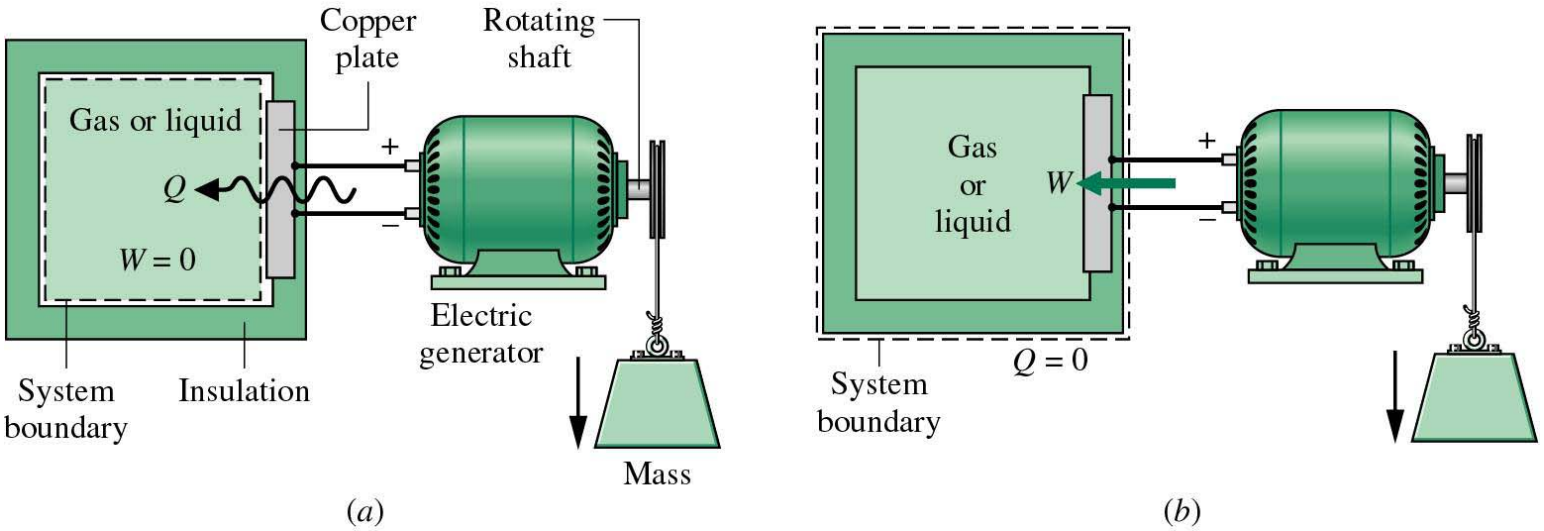
$$E_2 - E_1 = \Delta KE + \Delta PE + \Delta U = Q - W$$

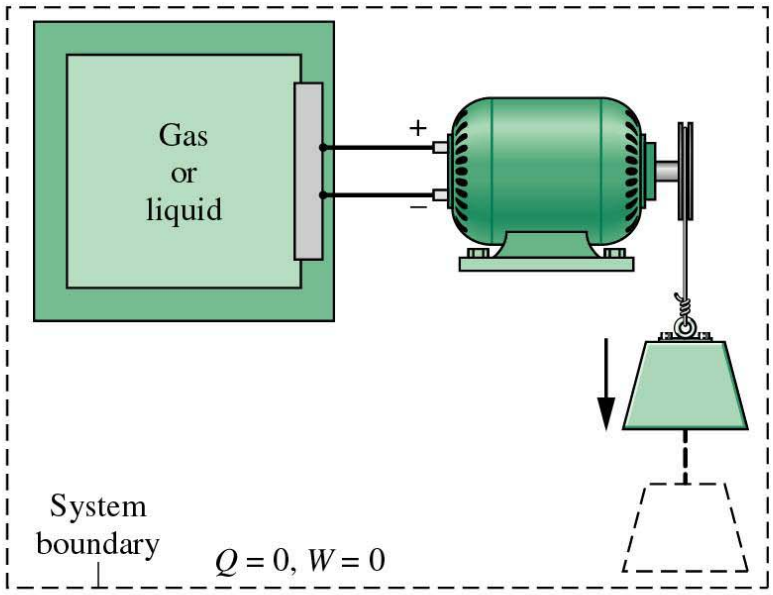
Or

$$\frac{dE}{dt} = \frac{dKE}{dt} + \frac{dPE}{dt} + \frac{dU}{dt} = \dot{Q} - \dot{W}$$

Specific Properties

$$e = \frac{E}{m}, u = \frac{U}{m}$$


Copper plate
Rotating shaft
Gas or liquid
Q
W = 0
+
–
Electric generator
System boundary
Insulation
Mass
(a)
Gas or liquid
W
+
–
Q = 0
System boundary
(b)


Gas or liquid
+
–
System boundary
Q = 0, W = 0
(c)