Thermodynamics (ESC-S202)

Lecture- 9
Work and Heat Transfer

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Energy Interactions

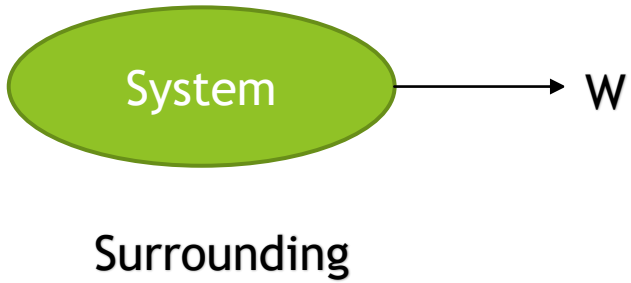
- A closed system and its surroundings can interact in two ways:

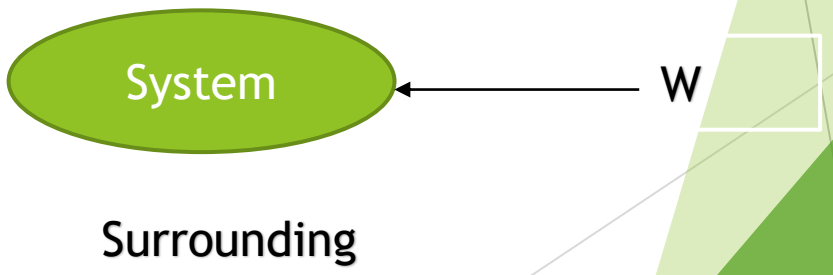
(i) By work transfer

(ii) By heat transfer

Work Transfer

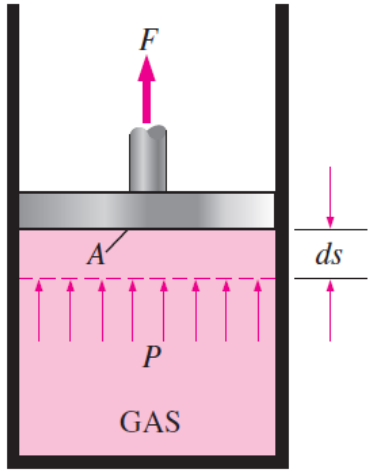
- Work is one of the basic modes of energy transfer.
- In Mechanics, the action of a force on a moving body is identified as work.
- The work is done by a force as its acts upon a body moving in the direction of force.
- In thermodynamics, work transfer is considered as occurring between the system and surroundings.
- When work is done by a system, it arbitrarily taken to be positive.
- When work is done on a system, it is taken to be negative.





Displacement Work

- One form of mechanical work frequently encountered in practice is associated with the expansion or compression of a gas in a piston–cylinder device.
- During this process, part of the boundary (the inner face of the piston) moves back and forth. Therefore, the expansion and compression work is often called **moving boundary work,** or simply **boundary work.**



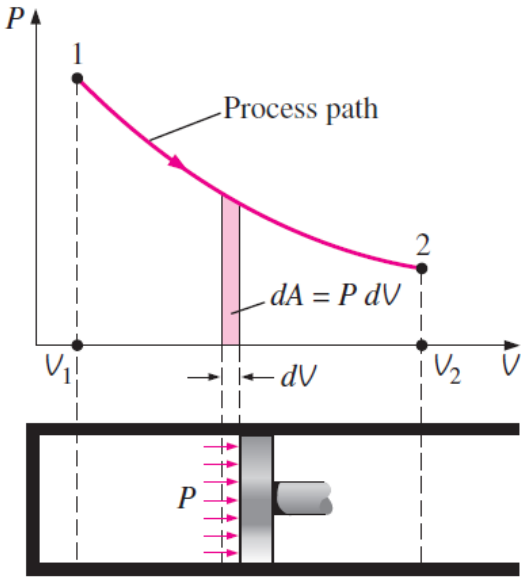
$$\delta W_b = F\,ds = PA\,ds = P\,dV$$

$P\,dV$ → Change in Volume

P ↓ Absolute Pressure

- As an expression for boundary work output, W_b, out. A negative result indicates boundary work input (compression).

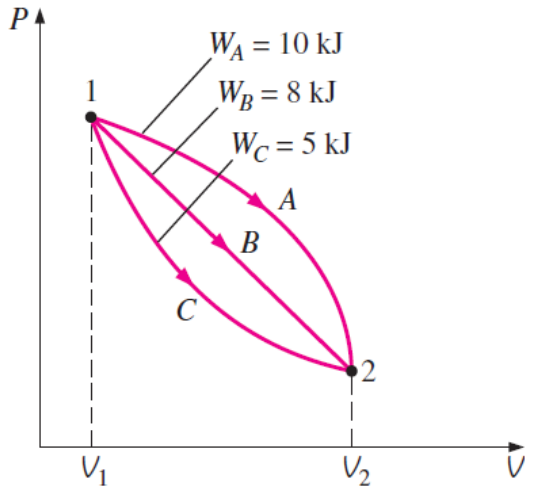
Boundary Work



$$\text{Area} = A = \int_1^2 dA = \int_1^2 P\,dV$$

- A comparison of this equation with Equation reveals that the area under the process curve on a P-V diagram is equal, in magnitude, to the work done during a quasi-equilibrium expansion or compression process of a closed system.

Path Function



- Gas can follow several different paths as it expands from state 1 to state 2.
- In general, each path will have a different area underneath it, and since this area represents the magnitude of the work, the work done will be different for each process .
- This is expected, since work is a path function.
- It is an inexact or imperfect differential.

Q- An electric motor drives a stirrer fitted with a horizontal cylinder. The cylinder of 40 cm diameter contains a fluid restrained by a frictionless piston. During the stirring of fluid for 15 min the piston moves outwards slowly by a distance of 30 cm against the atmospheric pressure of 1 bar. The current supplied to the motor is 0.5 amp. From a 24 V lead acid accumulator. If the conversion efficiency from electrical work to mechanical work output is 90%, estimate the work done on the motor, stirrer and the atmosphere.