Name → Prathmesh. B. Kore
Branch → Mechanical Engg. (Lateral Entry) ①
Sem → 3rd Sem. (2nd year)
Sub. & code → Basic Thermodynamics (18ME33)

Que 1] Explain Thermodynamics definition of Work.

a) Work done according to mechanics
b) Work done according to the thermodynamics

→ In thermodynamics work transfer is considered as occouring between the system and surroundings. Work is said to be done by a system if the sole effect on things external to the system could be reduced to to raising of weight →

It can be explained as fallows →

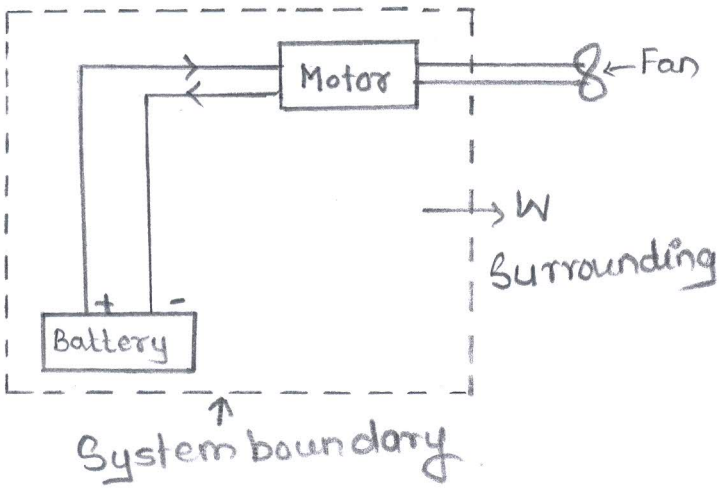


Fig (i) Work done according to Mechanics.

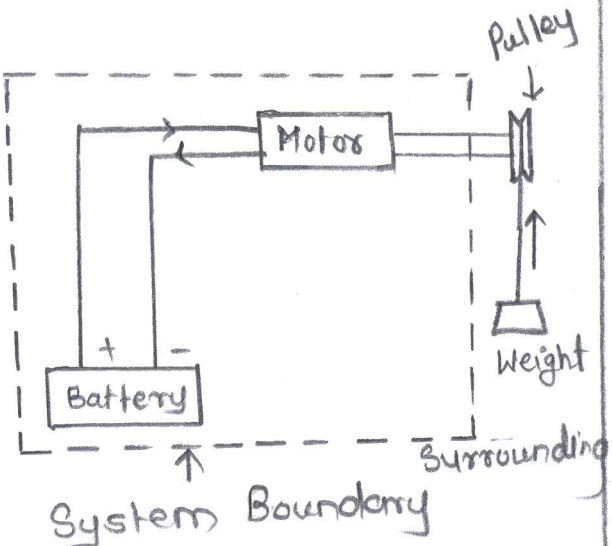


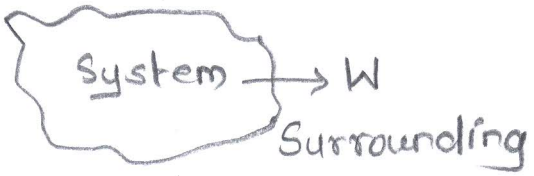
Fig (ii) Work done according to the thermodynamics.

In the Fig (i) the motor drives fan. The system is doing Work upon the surroundings. When the fan is replaced by pulley and weight as in fig (ii) the weight may be raised with the pulley. driven by the motor. The sole effect on thing external to the system is thus raising of a weight.

Work is a transient quantity which only appears at the boundary while change of the state is taking place with system.

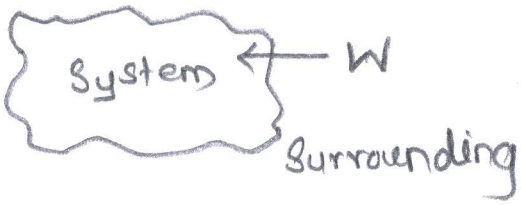
Sign Convention for Work →

a) When work is done by the system on the surroundings for example → Expansion of fluid pushing a piston outward, Work is said to be positive.



W is +ve.

b) If work is done on the system by the surroundings for examples → When force is applied to a piston to compress the Fluid.. the work said to be a Negative.

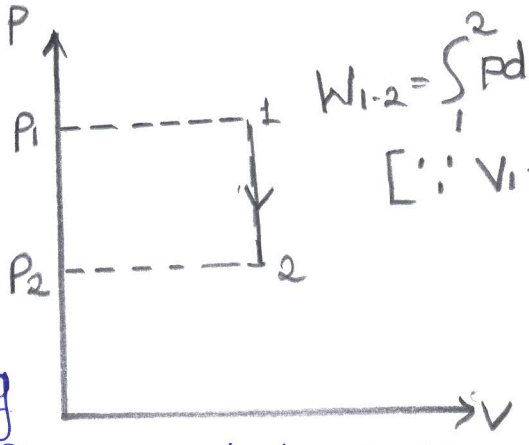


W is -ve

Que 2] Explain Displacement Work pdv work for various Thermodynamics (Quasistatic) Processes.

→ 1) Constant Volume (Isochronic) Process →

Consider a gas undergoes expansion at Constant Volume. Workdone by the gas.



$$W_{1-2} = \int_1^2 pdV = 0$$

$$[\because V_1 = V_2]$$

When a force is applied on a spring the length of the spring changes, If F is the spring force and dx is the differential amount of change in length of spring, then the spring Work,

$$dW_{spring} = F_x \cdot dx$$

But For Springs displacement x is linearly proportional to the force applied.

i.e. $F = kx$

$dW = kx \cdot dx$

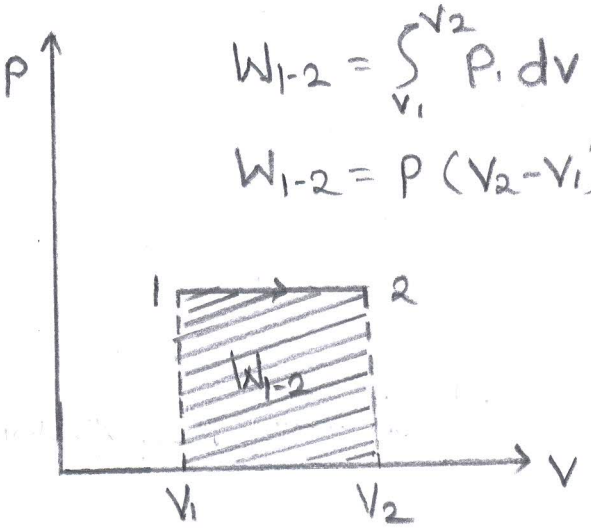
For a finite amount of change in length of the spring.

$$\int_1^2 dW = \int_{x_1}^{x_2} kx \cdot dx$$

$$W_{1-2} = k \frac{(x_2^2 - x_1^2)}{2}$$

2] Constant Pressure (Isobaric) Process →

Consider a gas is expanded at constant pressure from volume V_1 to V_2 work done.



$$W_{1-2} = \int_{V_1}^{V_2} P \cdot dV$$

$$W_{1-2} = P(V_2 - V_1)$$

3] Process in which $pV = C$ (Isothermal Process)

W.K.t

$$W_{1-2} = \int_1^2 P \cdot dV$$

But $PV = C$

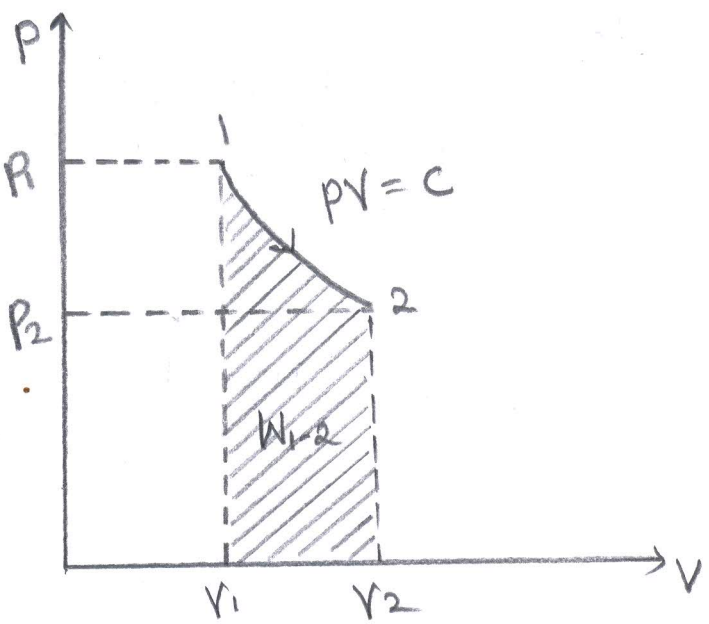
i.e. $pV = P_1V_1 = P_2V_2 = C$

or $P = \frac{P_1V_1}{V}$

$$\therefore W_{1-2} = \int_1^2 \left(\frac{P_1V_1}{V}\right) dV$$

$$= P_1V_1 \times \int_1^2 \frac{dV}{V}$$

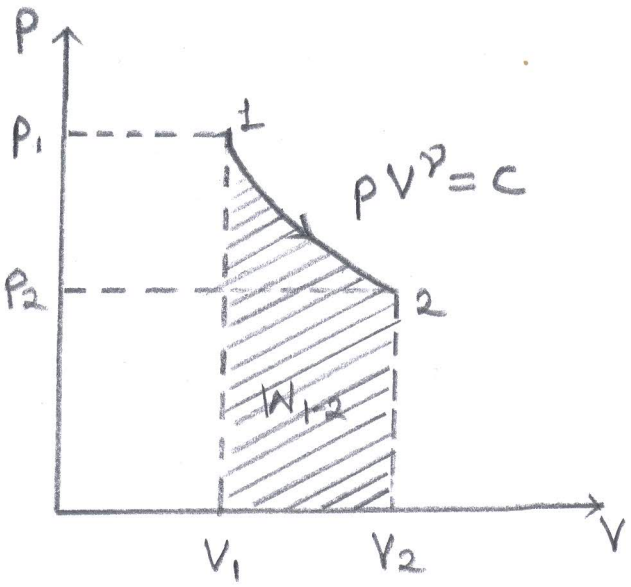
$$= P_1V_1 \log_e \frac{V_2}{V_1}$$



or $W_{1-2} = P_1V_1 \log \frac{P_1}{P_2}$ $\left[P_1V_1 = P_2V_2 \text{ or } \frac{V_2}{V_1} = \frac{P_1}{P_2}\right]$

4] Process in which $PV^\gamma = C$ (Reversible Adiabatic or isentropic process) →

Displacement Work →



$$W_{1-2} = \int_1^2 P \cdot dV$$

But $PV^\gamma = P_1 V_1^\gamma = P_2 V_2^\gamma = C$

or $P = \frac{P_1 V_1^\gamma}{V^\gamma}$

$$\therefore W_{1-2} = \int_1^2 \frac{P_1 V_1^\gamma}{V^\gamma} \cdot dV$$

$$= P_1 V_1^\gamma \int_1^2 \frac{dV}{V^\gamma}$$

$$= P_1 V_1^\gamma \left[\frac{V^{-\gamma+1}}{-\gamma+1}\right]_1^2 = \frac{P_1 V_1^\gamma}{1-\gamma}\left[V_2^{-\gamma+1} - V_1^{-\gamma+1}\right]$$

$$W_{1-2} = \left[\frac{P_1 V_1^\gamma V_2^{-\gamma+1} - P_1^\gamma V_1^{-\gamma+1}}{1-\gamma}\right]$$

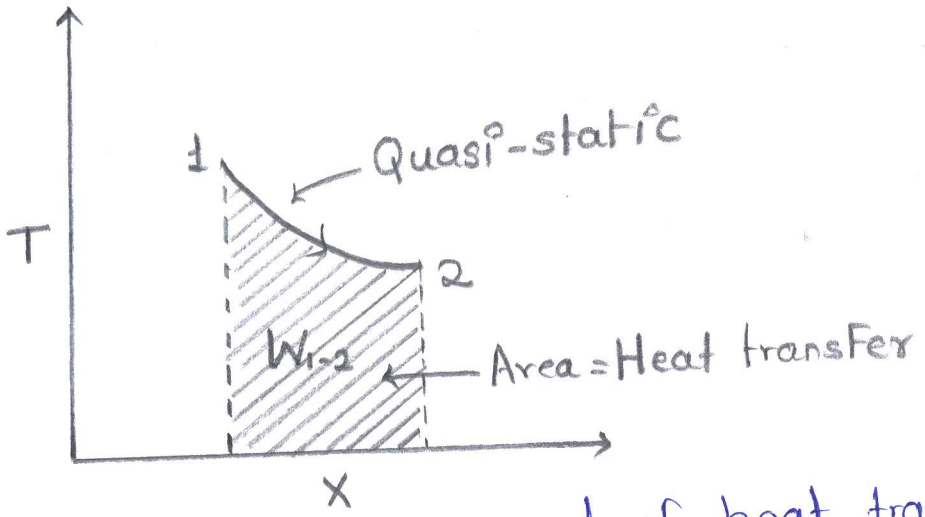
$\therefore$ But $P_1 V_1^\gamma = P_2 V_2^\gamma$

$$\therefore W_{1-2} = \frac{P_2 V_2^\gamma \cdot V_2^{-\gamma+1} - P_1 V_1^\gamma V_1^{-\gamma+1}}{1-\gamma}$$

$$W_{1-2} = \frac{P_2 V_2 - P_1 V_1}{1-\gamma}$$

$$W_{1-2} = \frac{P_1 V_1 - P_2 V_2}{\gamma - 1}$$

Que 3] Explain Heat is a path function? (5)



Heat is path function is the amount of heat transfered When a system changes from state 1 to a state 2 depends on a the intermediate states through which the system passes.

Whenever there is a temperature difference there will be heat Flow. The temperature difference is the cause and heat transfer is the effect. Like displacement work, heat transfer can also be written as the integral of the product of the intensive property T & the differential change of an extensive property ; say φ.

$$Q_{1-2} = \int_1^2 \delta Q = \int_1^2 T \cdot d\varphi.$$

Que-4] Explain Comparison of Heat & Work?

Similarities →

1) Both are path functions and inexact differentials
2) Both are boundary phenomena i.e. both are recognized at the boundaries of the system.
3) Both are associated with a process not a state. Unlike properties, work or heat has no meaning at a state
4) System posses energy but not work or heat.

Dissimilarities →

1) In heat transfer temperature difference is required.

2] In a stable system, there cannot be work transfer, however there is no restriction for the transfer of heat

3] For work, the sole effect external to the system could be reduced to raise of a weight. But in the case of heat transfer other effects are also observed.

4] Heat is a low grade energy where as work is high grade energy.