

Thermodynamics (ESC-S202)

Lecture- 13 Work and Heat Transfer



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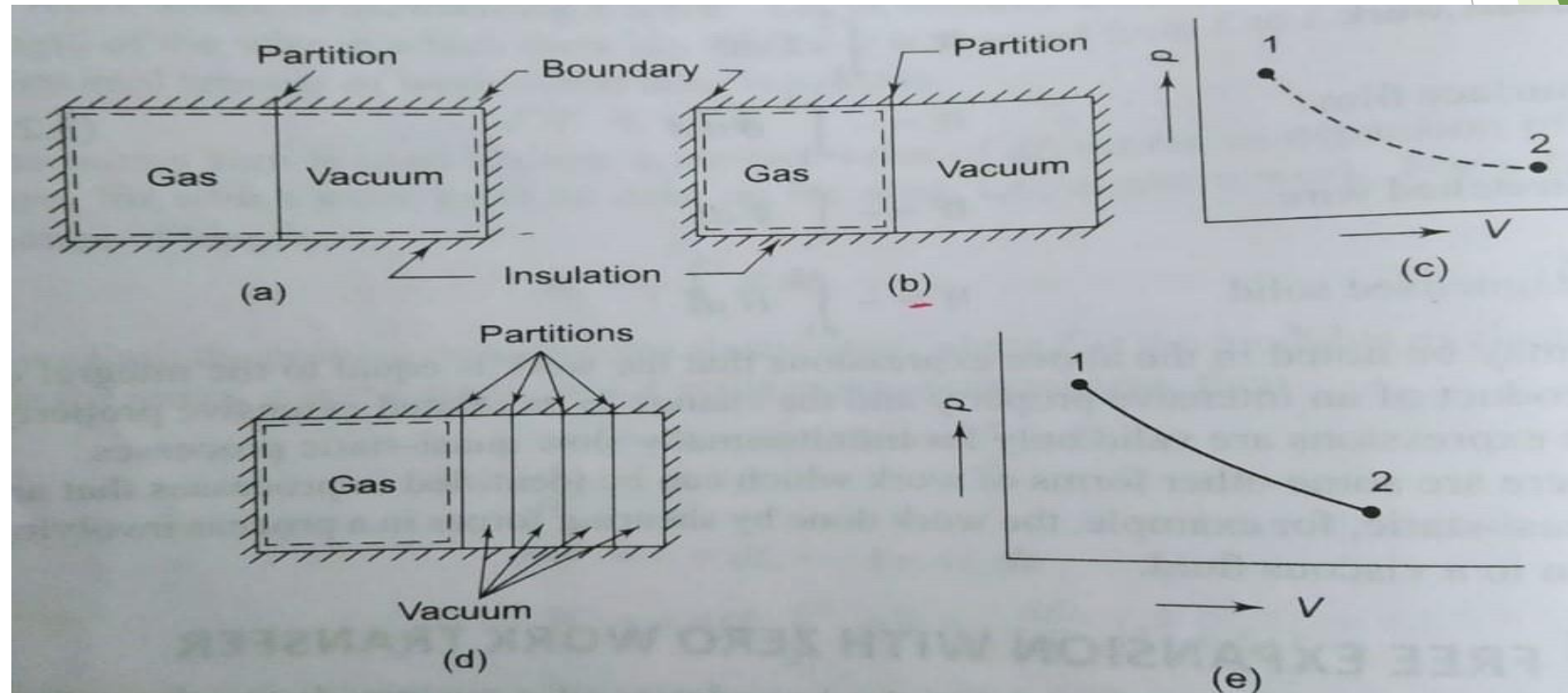
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Free Expansion

- Let us consider a gas separated from the vacuum by a partition. If the partition is removed, the gas rushes to fill the entire volume. The expansion of gas against vacuum is called free expansion.
- There is no work transfer involved here, since no work crosses the system boundary and hence

$$\int_1^2 dW = 0 \text{ although } \int_1^2 p dV \neq 0$$



Free Expansion

- In free expansion of a gas, there is no resistance to the fluid at the system boundary as the volume of the gas increases to fill up the vacuum space.
- **Work is done by a system to overcome some resistance.**
- Since vacuum does not offer any resistance, there is no work transfer involved in free expansion.

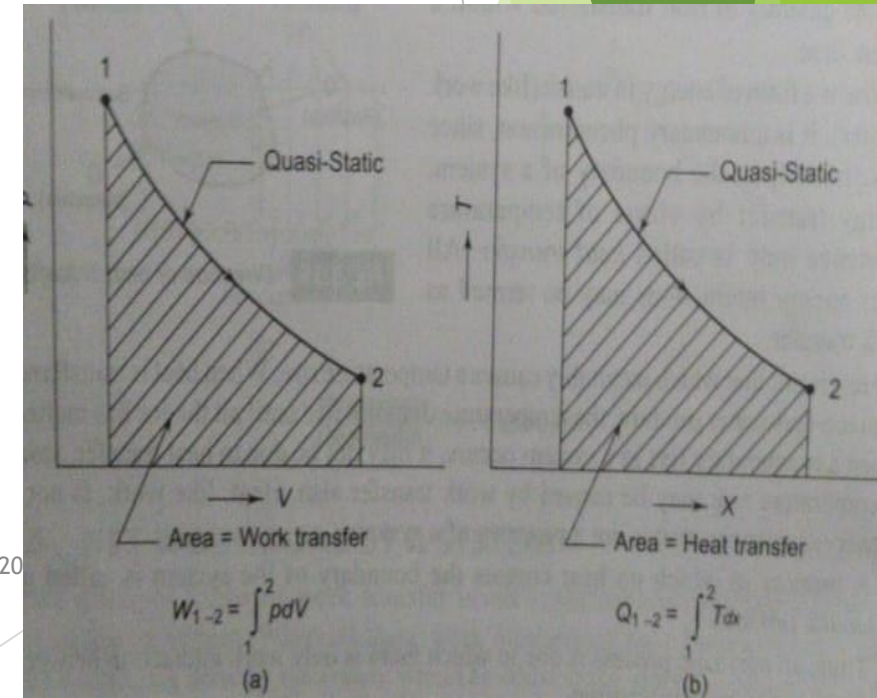
Heat Transfer

- Heat flow into a system is taken to be positive and heat flow out of a system is taken as negative.
- **Energy transfer by virtue of temperature difference only is called heat transfer.**

Heat Transfer- A Path Function

- Heat Transfer is a path function. It depends upon intermediate states through which the system passes.

$$\int_1^2 dQ = Q_{1-2}$$



Q.1 It is required to melt 5 tonnes/h of iron from a charge at 15 C to molten metal at 1650 C. The melting point is 1535 C and the latent heat is 270 kJ/kg. The specific heat in solid state is 0.502 and in liquid state (29.93/atomic wt.)kJ/kgK. If an electric furnace has 70% efficiency, find the KW rating needed. If the density in molten state is 6900 kg/m³ and the bath volume is three times the hourly melting rate, find the dimensions of the cylinder furnace if the length to diameter ratio is 2. The atomic weight of iron is 56.