

ME 209

Basic Thermodynamics (Lecture-3)

Kannan Iyer
Kiyer@me.iitb.ac.in



Department of Mechanical Engineering
Indian Institute of Technology, Bombay

Review of Lecture 2

- Introduced the property, pressure. Understood the principle of manometers, distinguished between gauge and absolute pressure.
- Introduced the concept of temperature and its measurement. Two point scale and one point Kelvin scale were introduced. Errors on temperature due to non-linear behaviour of thermometers was understood
- Elementary concepts on conversion was discussed
- Today we shall discuss **Work** interaction and **Heat** interaction and introduce **First Law of thermodynamics**.

Work - I

Work in Mechanics

- In mechanics, we have defined work as:

Work = Force x Displacement

$$W = \int \vec{F} \cdot d\vec{S}$$

- By virtue of the above definition, work is a scalar and is positive, if displacement is in the direction of the force.
- The rate of work done is called power

$$\text{Power} = P = \frac{\vec{F} \cdot d\vec{S}}{dt} = \vec{F} \cdot \vec{V}$$

Work - II

Work in Thermodynamics

- In thermodynamics, its definition is a bit complicated and winded
- Positive work is done by a system during a process, when the **Sole** effect **External to the System** can be reduced to a rise of weight
- Why do we need such a winded definition?

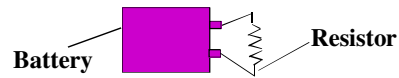
Sole eliminates heat interaction

External eliminates internal conversion

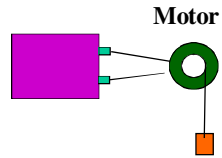
Note that weight need not be actually lifted

Work - III

- Let us look at some examples

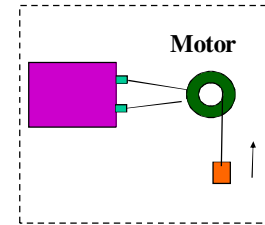


- The above figure shows discharging of a battery through a resistor. If battery is the system, is the process work?
- The answer is yes, as you can replace the resistor by a motor which would raise weight. Hence positive work is done.



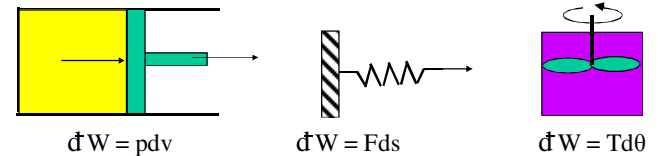
Work - IV

- For the system shown, is there work done in the process?
- No, because it is internal conversion



Types of work

Displacement Work



Work - V

- Electrical work

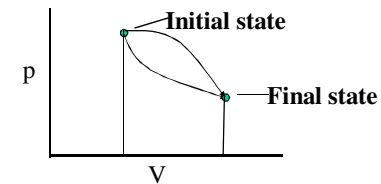
$$dW = Edq = Eidt$$

Sign Convention

- As work is done during system-surroundings interaction, it has opposite signs for system and surroundings
- Work is positive for the system, if it does work on the surroundings and it is negative for the system, if the surroundings do work on the system

Work - VI

- Work is not a property as it depends on the path



- As work done is area under the p-V curve, it depends on the path

Note that work is a commodity in transit and cannot be possessed