Introduction to thermodynamics

Thermodynamics

Rub your hand for 10 seconds

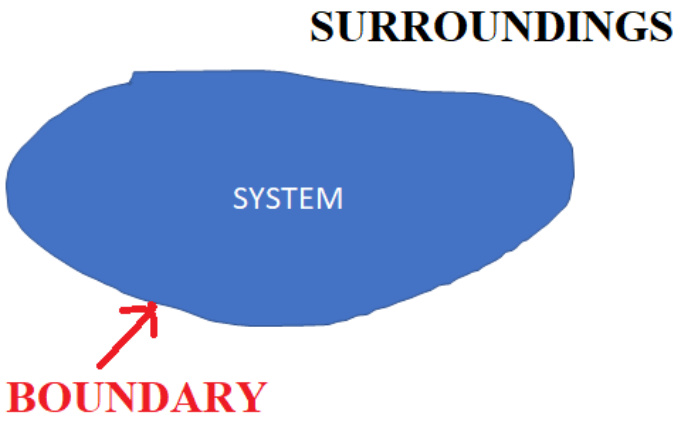
Are your hands warm?

Thermal Energy

Thermodynamics

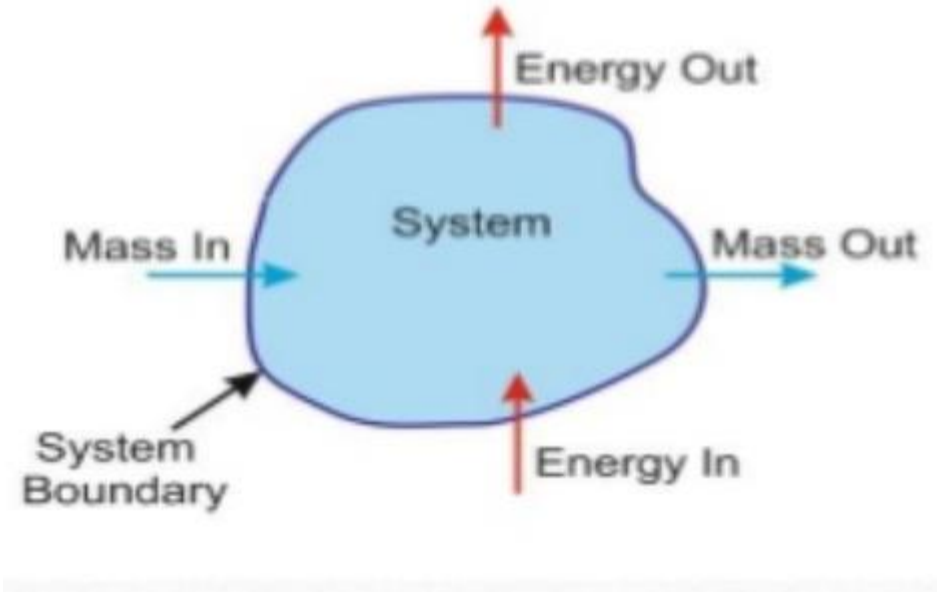
- Branch of science, which deals with conversion of heat energy into other forms of energies and describes these conversions quantitatively.

- Study of the effects of work, heat flow and energy on a system



Thermodynamic systems

- The word ‘system’ is very commonly used in thermodynamics; let us know what it is. Certain quantity of matter or space which is under thermodynamic study is called as system.



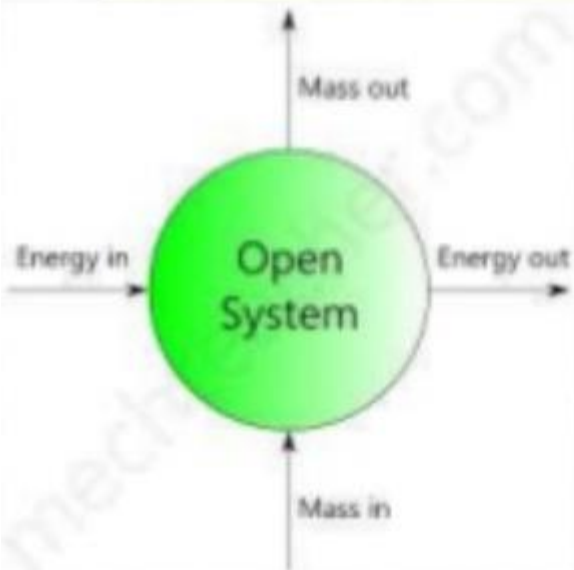
System

- May be defined as the part of universe selected for thermodynamic consideration i.e. to study the effect of temperature, pressure etc.
- It may also be defined as specified part of universe in which energy changes are taking place

Surrounding

- The remaining portion of universe excluding the system is called surrounding
- Universe = System + Surrounding
- The System and surrounding can be separated by boundary

TYPES OF SYSTEMS



Thermodynamic Variables

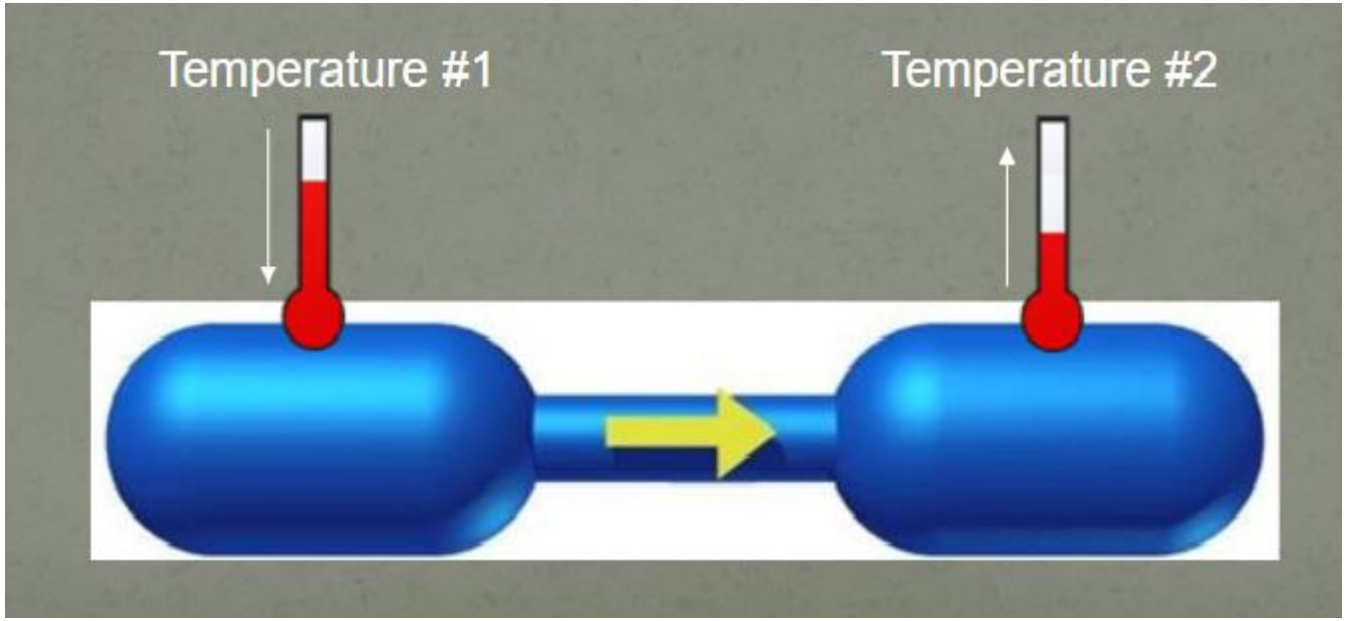
Intensive Variables

- They do not depend on the size of the system or quantity of matter present in it.
- They are dependent on the nature of substance present in it.
- Example: pressure, temperature, density, surface tension

Extensive Variables

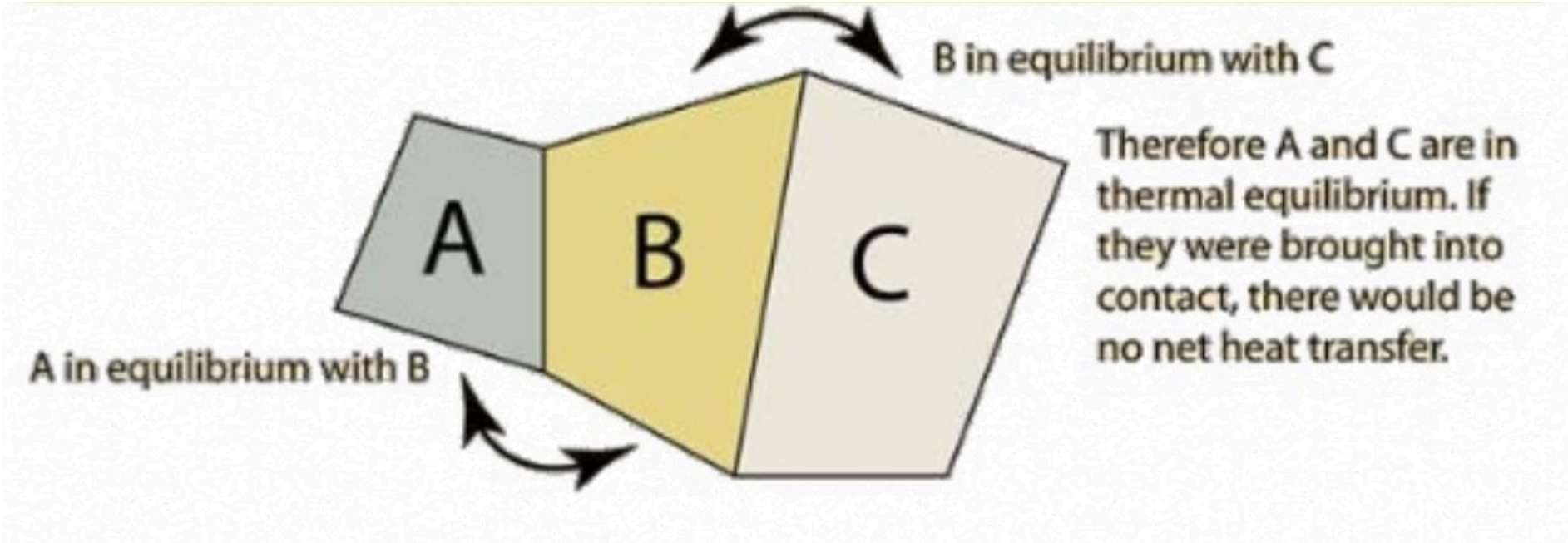
- Depend on the quantity of matter present in the system
- Example: volume, energy, heat capacity, entropy

Thermal Equilibrium



Zeroth Law of Thermodynamics

- If two systems are separately in thermal equilibrium with a third system, they will also be in thermal equilibrium with one another.



Thermodynamic Equilibrium

- A system is said to be in a thermodynamic equilibrium when it is in thermal, mechanical and chemical equilibrium

✓ Thermal Equilibrium

✓ Mechanical Equilibrium

✓ Chemical Equilibrium

Quasi-static Process

It is a process which takes place so slowly that the system always remains in equilibrium with itself

Internal Energy

- *Internal Energy*, U, is the energy associated with the microscopic components of the system
  - Includes kinetic and potential energy associated with the random translational, rotational and vibrational motion of the atoms or molecules
  - Also includes any potential energy bonding the particles together

The Internal energy of a system can be changed (1) by heating the system, or (2) by doing work on it, or (3) by adding or taking away matter

State function

- It is defined as the property whose value *depends only upon the state of the system and is independent of the path by which state has been reached*
- For example: a person standing on the roof of the building has a fixed value of potential energy and the potential of person does not depend whether he has reached there by stairs or lift. Ex. *Potential energy, pressure, volume, temperature, internal energy etc*.

Heat

- Energy transferred from one object to another due to their temperature difference

Work

- Work is the transfer of mechanical energy to or from a system

First Law of Thermodynamics

- The First Law of Thermodynamics tells us that the internal energy of a system can be increased by
  - Adding energy to the system
  - Doing work on the system
- There are many processes through which these could be accomplished
  - As long as energy is conserved

First law of thermodynamics cont.

- It states that the amount of heat given to a system is equal to the sum of the increase in the internal energy of the system and the external work done.

$$\delta Q = \delta U + \delta W$$

Thank you