Fundamental Concepts and Definitions

THERMODYNAMICS:

- It is the science of the relations between heat, Work and the properties of the systems.
- How to adopt these interactions to our benefit?

Thermodynamics enables us to answer this question.

Analogy

All currencies are not equal

Eg: US$ or A$ or UK£ etc. Have a better purchasing power than Indian Rupee or Thai Baht or Bangladesh Taka similarly,all forms of energy are not the same.

Human civilization has always endeavoured to obtain

- Shaft work
- Electrical energy
- Potential energy to make life easier

Examples

If we like to

- Rise the temperature of water in kettle
- Burn some fuel in the combustion chamber of an aero engine to propel an aircraft.
- Cool our room on a hot humid day.
- Heat up our room on a cold winter night.
- Have our beer cool.

What is the smallest amount of electricity/fuel we can get away with?

Examples (Contd…)

On the other hand we burn,

- Some coal/gas in a power plant to generate electricity.
- Petrol in a car engine.

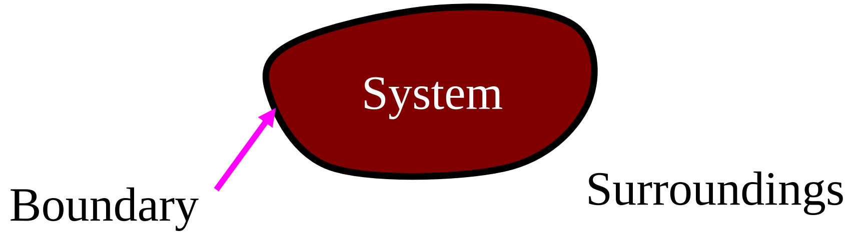
What is the largest energy we can get out of these efforts?

Thermodynamics allows us to answer some of these questions

Definitions

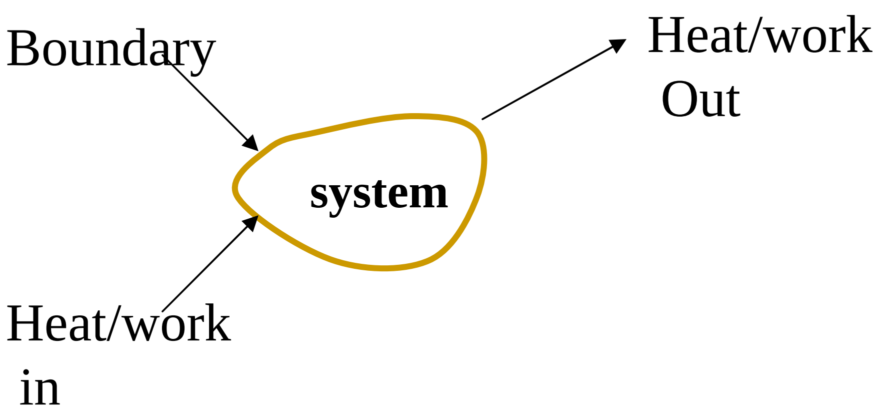
- In our study of thermodynamics, we will choose *a small part of the universe* to which we will apply the laws of thermodynamics. We call this subset a SYSTEM.
- The thermodynamic system is analogous to the free body diagram to which we apply the laws of mechanics, (i.e. Newton's Laws of Motion).
- The system is a macroscopically identifiable collection of matter on which we focus our attention (eg: the water kettle or the aircraft engine).

- The rest of the universe outside the system close enough to the system to have some perceptible effect on the system is called the surroundings.
- The surfaces which separates the system from the surroundings are called the boundaries as shown in fig below_(eg: walls of the kettle, the housing of the engine).



Types of System

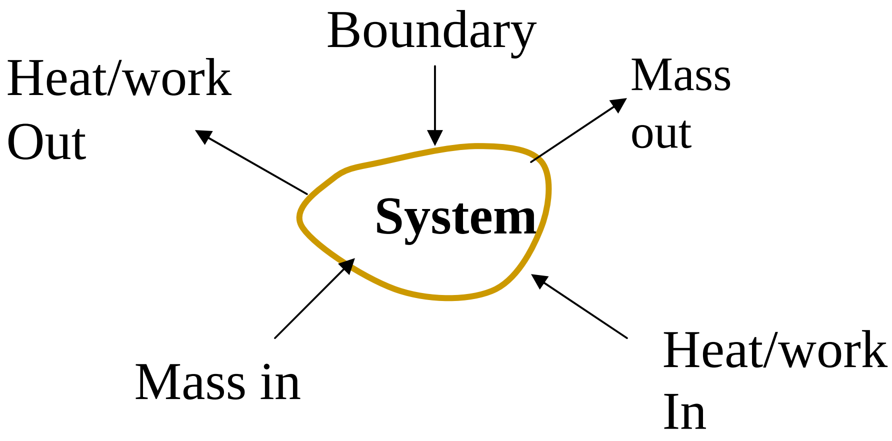
- Closed system - in which no mass is permitted to cross the system boundary i.e. we would always consider a system of constant mass.We do permit heat and work to enter or leave but not mass.



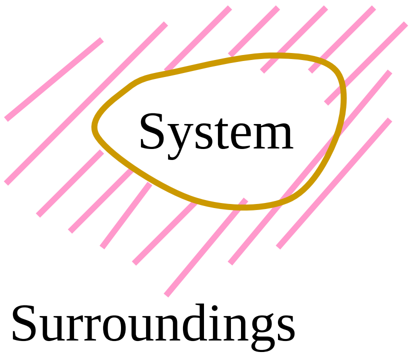
No mass entry or exit

- Open system- in which we permit mass to cross the system boundary in either direction (from the system to surroundings or *vice versa*). In analysing open systems, we typically look at a specified region of space, and observe what happens at the boundaries of that region.

Most of the engineering devices are open system.



- Isolated System - in which there is no interaction between system and the surroundings. It is of fixed mass and energy, and hence there is no mass and energy transfer across the system boundary.



Definition Of Temperature and Zeroth Law Of Thermodynamics

- Temperature is a property of a system which determines the degree of hotness.
- Obviously, it is a relative term.

eg: A hot cup of coffee is at a higher temperature than a block of ice. On the other hand, *ice is hotter than liquid hydrogen.*

Thermodynamic temperature scale is under evolution. What we have now in empirical scale.

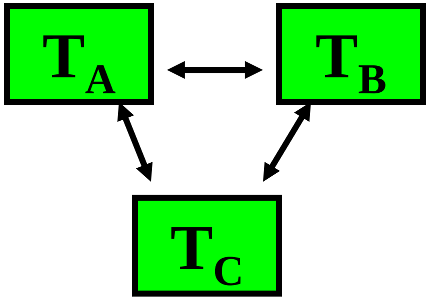
Zeroth Law Of Thermodynamics (Contd…)

- Two systems are said to be equal in temperature, when there is no change in their respective observable properties when they are brought together. In other words, "when two systems are at the same temperature they are in thermal equilibrium" (They will not exchange heat).

Note:They need not be in thermodynamic equilibrium.

Zeroth Law

- If two systems (say A and B) are in thermal equilibrium with a third system (say C) separately (that is A and C are in thermal equilibrium; B and C are in thermal equilibrium) then they are in thermal equilibrium themselves (that is A and B will be in thermal equilibrium



Explanation of Zeroth Law

- Let us say T_A,T_B and T_C are the temperatures of A,B and C respectively.
- A and c are in thermal equilibrium. $T_a = t_c$
- B and C are in thermal equilibrium. $T_b = t_c$

Consequence of of ‘0’th law

- A and B will also be in thermal equilibrium $T_A = T_B$
- Looks very logical
- All temperature measurements are based on this LAW.