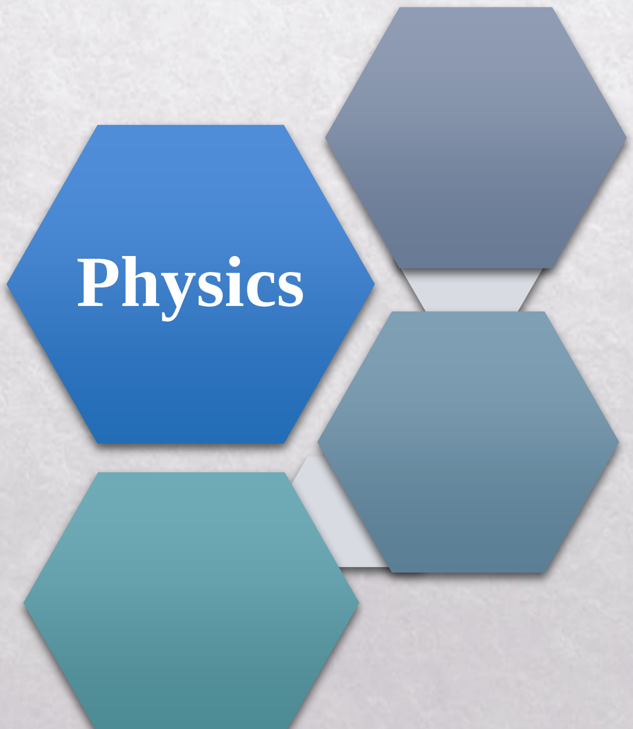
THERMODYNAMICS



Presented By
Md. Maruf Chand

Outline

- Thermodynamics
- Basic terms of thermodynamics
  - System
  - Surroundings
- Laws of thermodynamics
- Different thermodynamical changes in thermal system
  - Isothermal change
  - Adiabatic change
  - Isochronic change
  - Isobaric change
- Application areas of thermodynamics

Thermodynamics

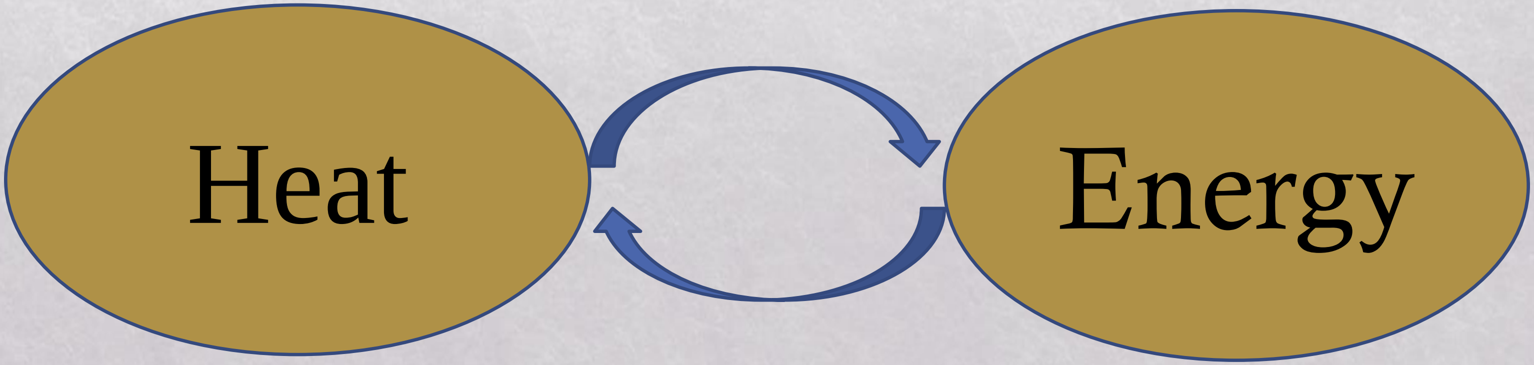
- Branch of science that deals with the quantitative relationship between heat and other forms of energy

- According to Jules Law

$$W \propto H$$

$$W = JH$$

Where, J=mechanical equivalent of heat



Temperature

- Temperature is a measurement of the hotness and coldness of a body.
- Scientifically, we could say that temperature is generally a measure of the kinetic energy of particles in an object, which means particles present in the object are always moving.
- Indicates the direction of flow of heat.

What are the Different Types of Temperature Scales?

- There are three main temperature scales used for thermometers that are Celsius, Kinetic, and Fahrenheit. The two most widely used temperature scales are Fahrenheit and Celsius.

- **1. Kelvins**
  - 0°K is the lowest temperature possible.
  - Particles have no kinetic energy.
  - It is used by scientists.
- **2. Celcius**
  - The absolute zero temperature is -273°.
  - It is used in most other countries.
  - It is expressed by the symbols °C.

What are the Different Types of Temperature Scales?

- **3. Fahrenheit**
  - The absolute zero temperature is -459°F.
  - It is used by the United States.
  - °F is expressed by the symbol °F.

Some Basic Terms of Thermodynamics

- **System:**

  Specified part of the universe that is under observation (mechanical device, biological organism, specified quantity of material etc.)

- **Surroundings:**

  Everything around the system is called surroundings

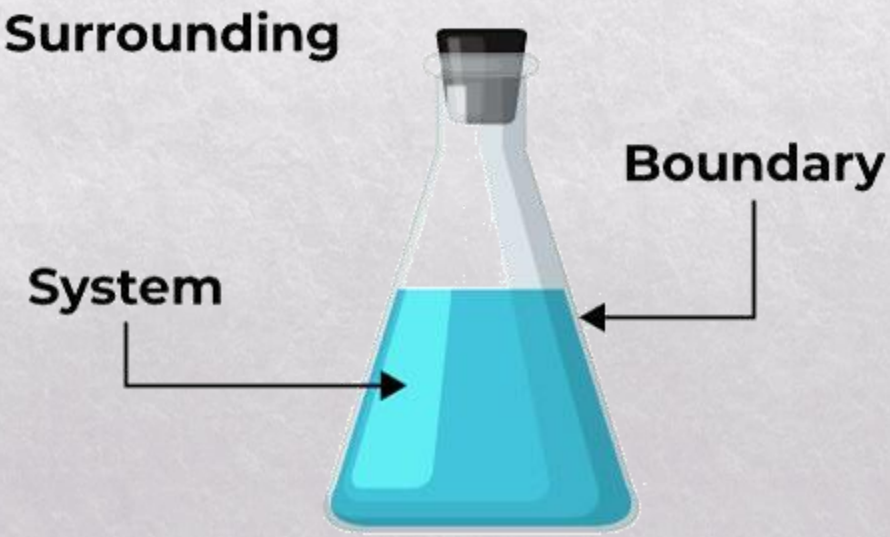


Figure 1: System and surrounding [1]

Types of Thermodynamic System

- **Open system**

  Both mass and energy is being exchanged with the surroundings

- **Closed system**

  Only energy is being exchanged with the surroundings

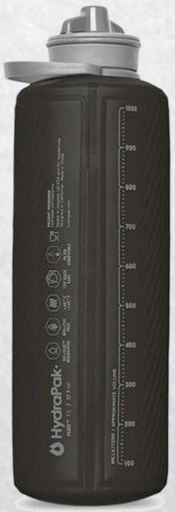
- **Isolated system**

  no mass or energy is being exchanged with the surroundings

Examples of Thermodynamic System

Open system
Heat transfer
Mass transfer

Closed system
Heat transfer
No mass transfer



Isolated system
No heat transfer
No mass transfer

Figure 2: Types of system

Laws of Thermodynamics

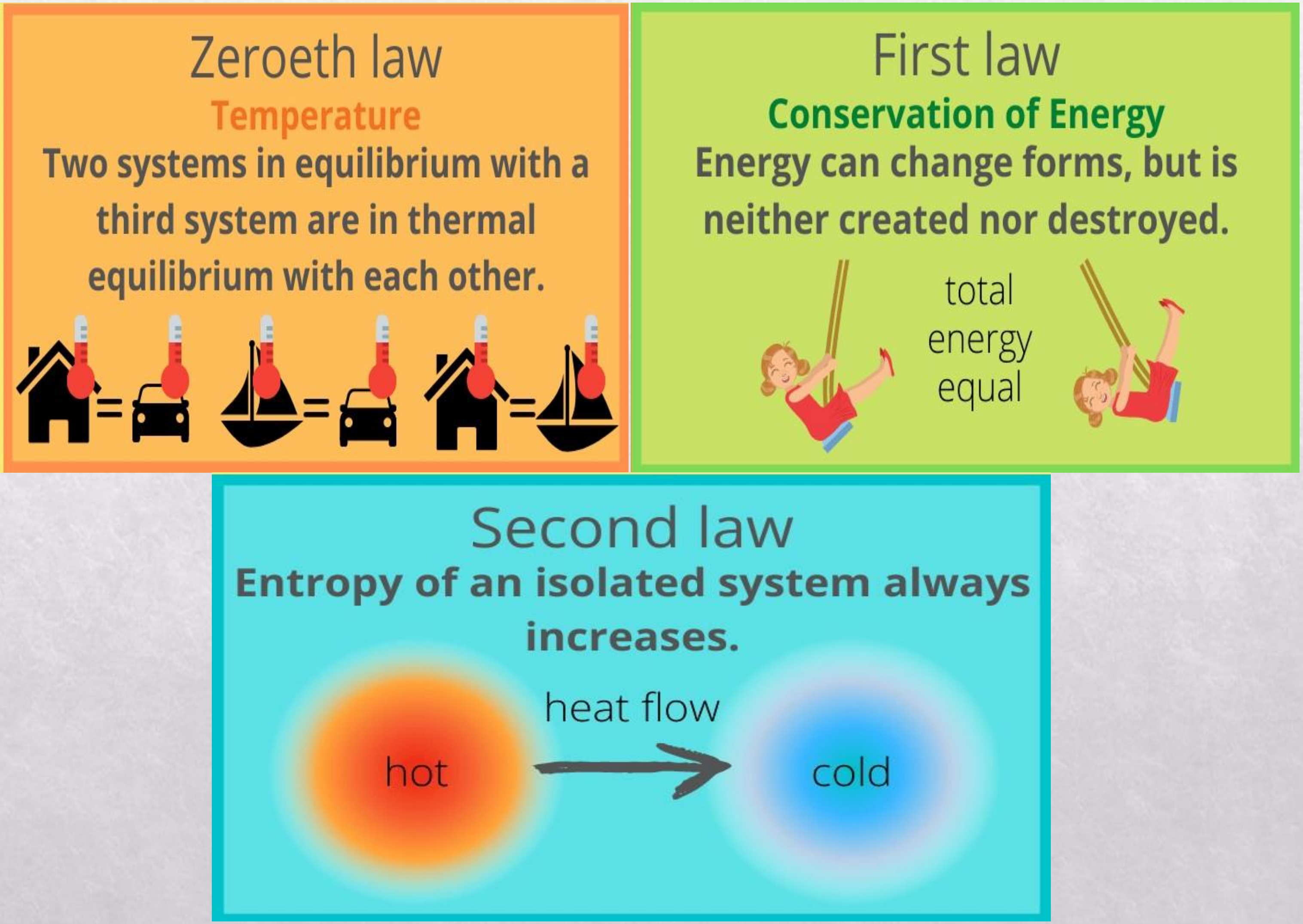


Figure 3: Laws of thermodynamics [3]

First law of thermodynamics

- According to first law of thermodynamics

$$dQ = dU + dW$$

Or, $dQ = dU + PdV$

Where,

$dQ =$ change of heat (absorbed/rediated)

$dU =$ change in internal energy (positive/negative)

$dW =$ workdone (positive/negative)

Different Thermodynamical Changes

Thermodynamic Process

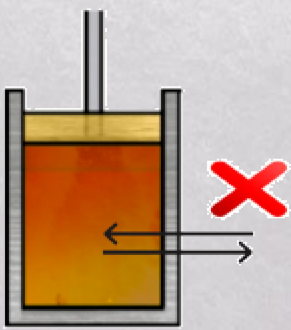
Isobaric process

Thermodynamic process in which the pressure remains constant is known as *isobaric process*.

Isochoric process

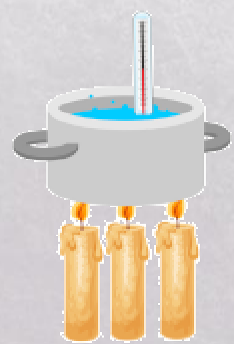
Thermodynamic process in which the volume remains constant is called *isochoric process*.

Adiabatic process



Thermodynamic process in which there is no heat transfer involved is called *adiabatic process*.

Isothermal process



The process in which the temperature remains constant is known as *Isothermal process.*

Isobaric Process

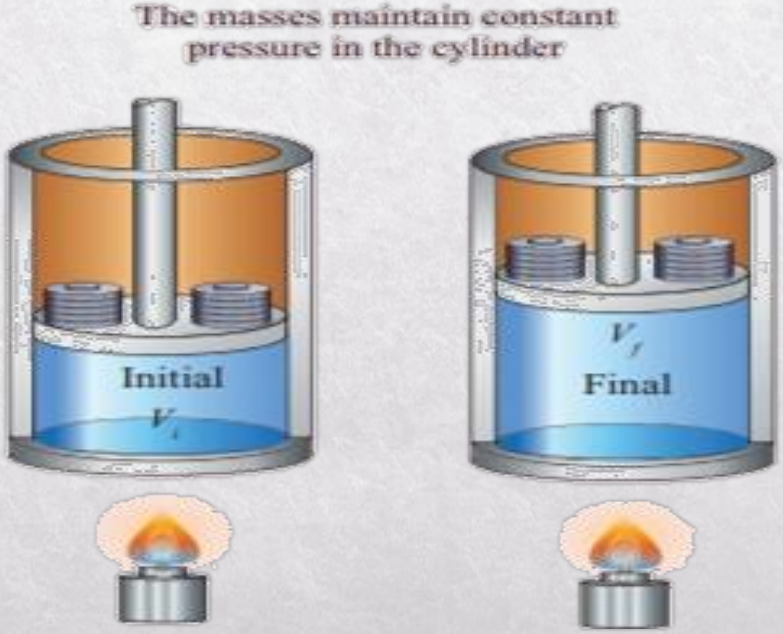


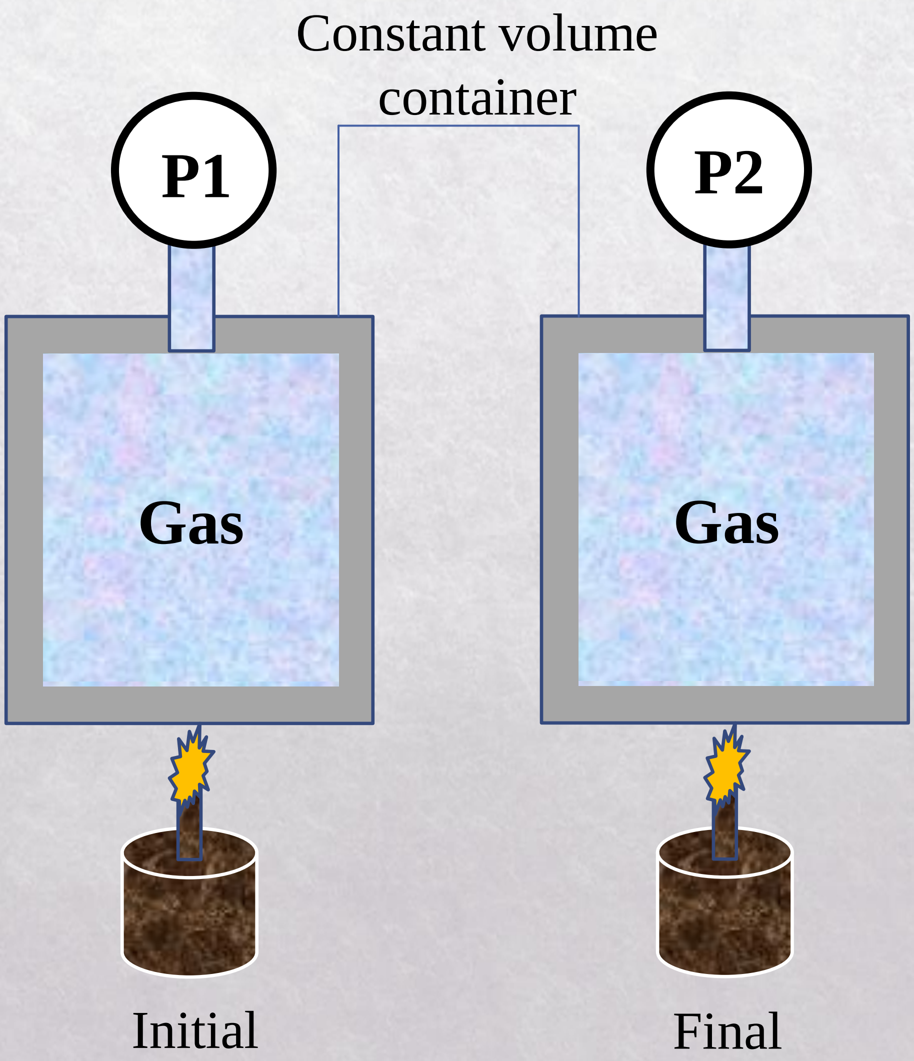
Figure 4: Isobaric process

- In isobaric process

  p=constant

  So, ***dW=PdV***

Isochoric Process



- 1'st law of thermodynamics
  $dQ=dU+dW$

Or, $dQ=dU+PdV$

- In this process
  $dV=0$

So, $dQ=dU$

Adiabatic process

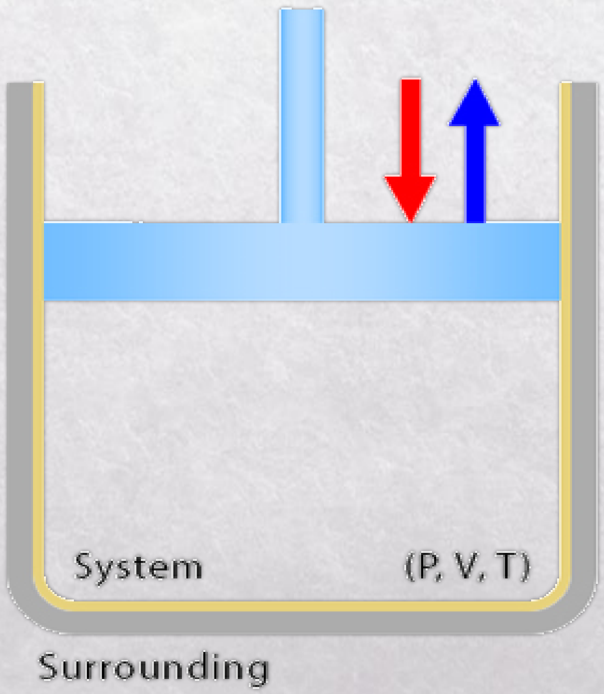


Figure 6: Adiabatic process

- 1’st law of thermodynamics

$$dQ=dU+dW$$

Or, $dQ=dU+PdV$

- In this process

$$dQ=0$$

So, $dU= -dW$

Adiabatic process

◈ Conditions for adiabatic process:

- Gas is to be kept in bad-conducting container
- Thermal capacity of the surrounding should be low
- Change of pressure of the gas must be made very rapidly

◈ Characteristics

- Temperature changes
- Very fast process
- Adiabatic curve is steeper than isothermal curve
- PV^{γ} = constant

Isothermal Process

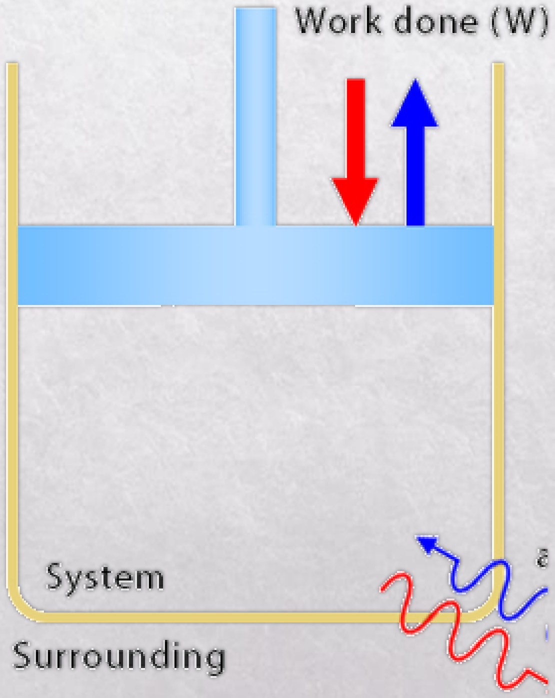


Figure 7: Isothermal process

- 1'st law of thermodynamics

$$dQ=dU+dW$$

Or, $dQ=dU+PdV$

- In this process

$$dU=0$$

So, $dQ= dW$ (for expansion)

$dQ= -dW$ (for compression)

Isothermal Process

⟐Conditions for isothermal process:

- Gas should be kept in good conducting container
- Heat capacity of the surrounding should be very high
- Change of pressure must be made very slowly

⟐Characteristics:

- Very slow process
- Isothermal curve is less steep
- Obeys Boyle's law **PV**=constant

Graphical Representation

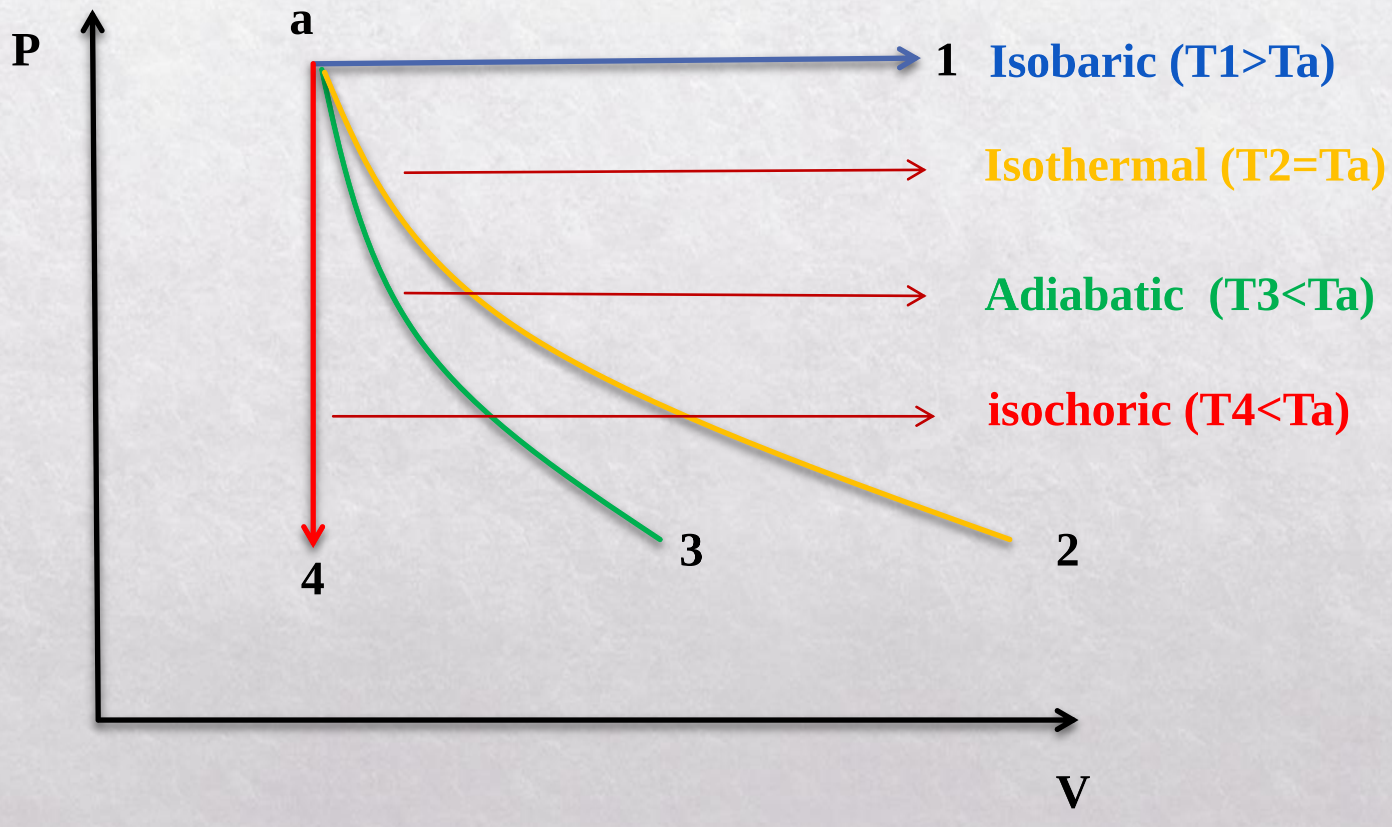
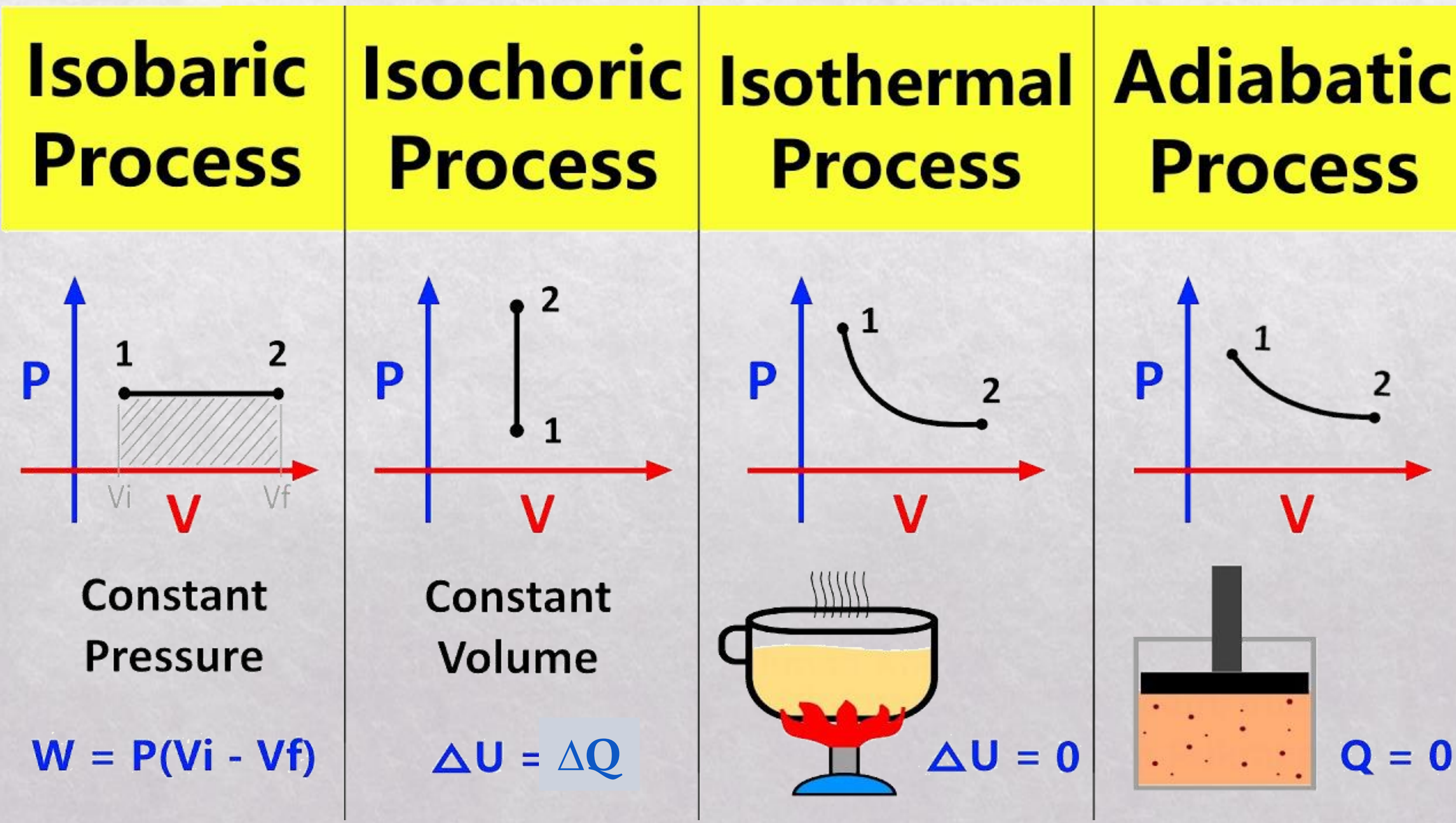


Figure 8: Graphical representation of thermodynamic process

Summary

$$dQ = dU + dW$$

$$dQ = dU + PdV$$

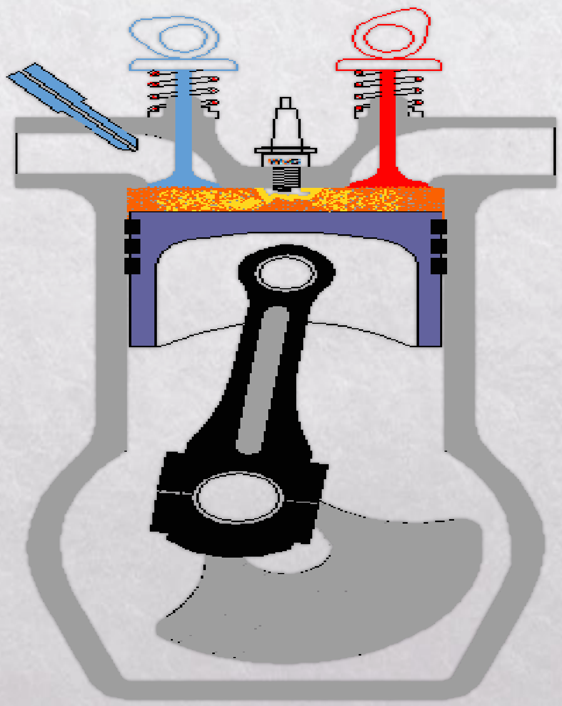


Application Areas of Thermodynamics

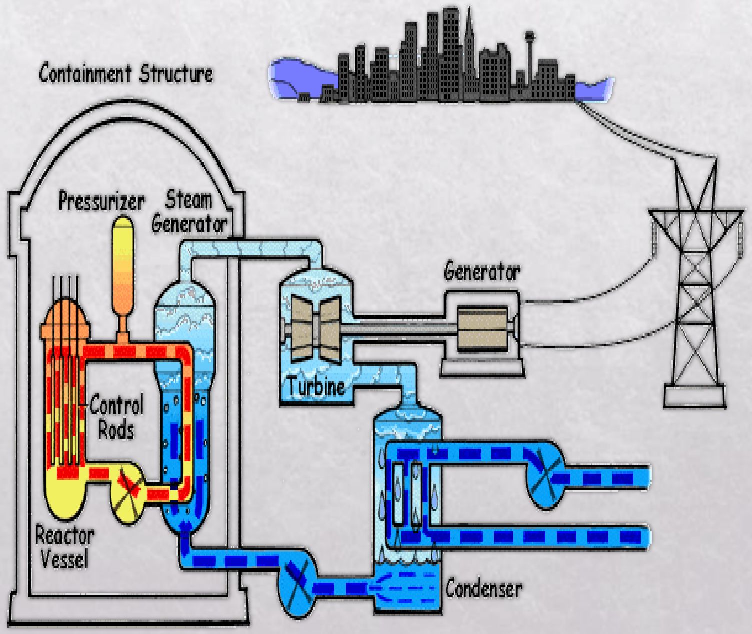
- Automobiles
- Thermal power plants
- Refrigerator and AC
- Water heater
- Aircrafts (Air vehicles)
- Medical science

Application Areas of Thermodynamics

Automobiles

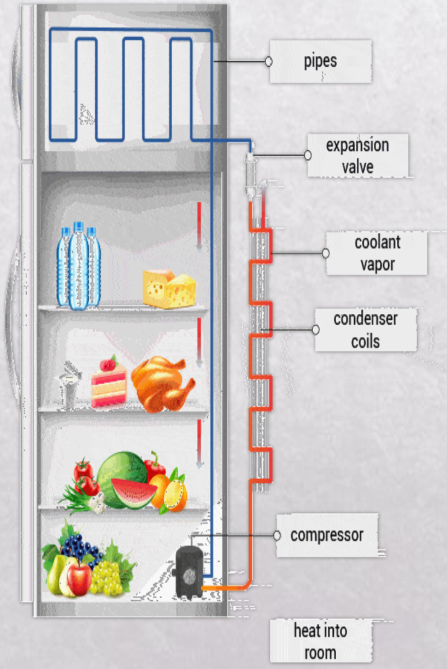


Thermal power plant

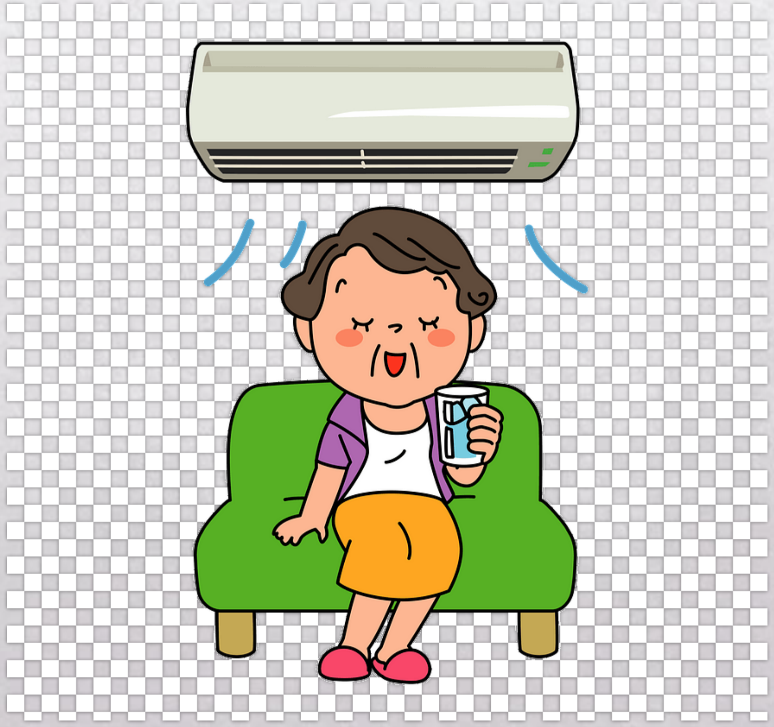


Application Areas of Thermodynamics

Refrigerator

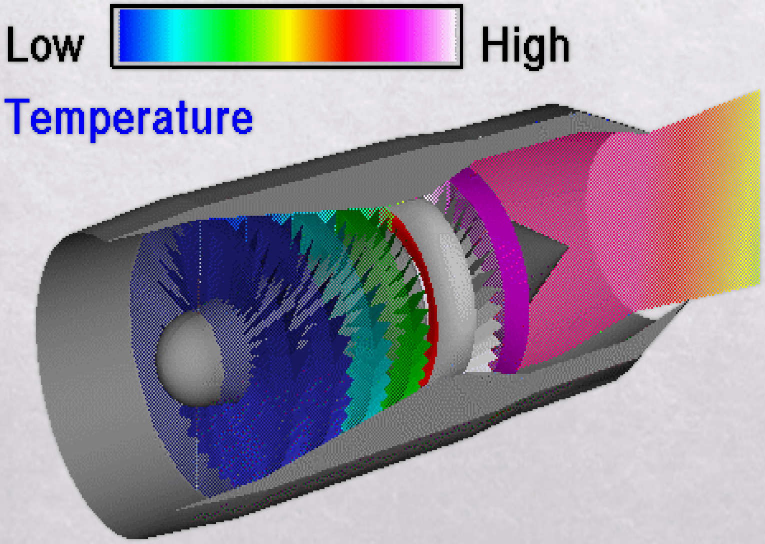


AC

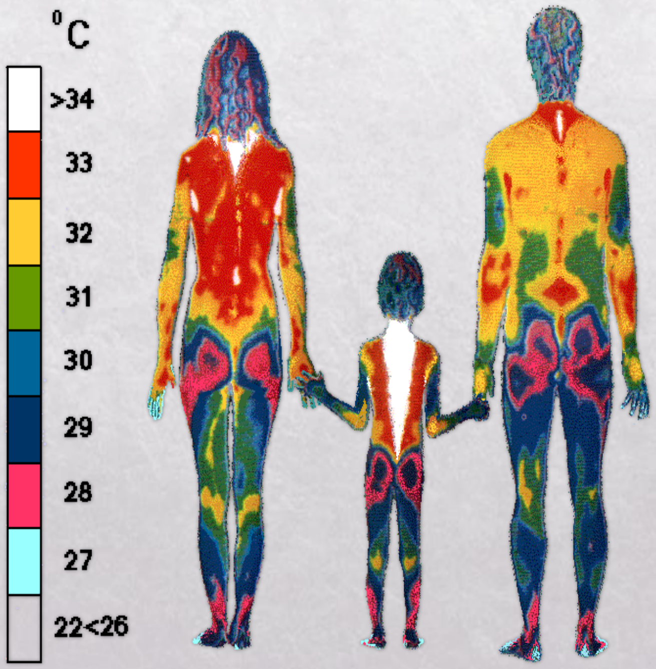


Application Areas of Thermodynamics

Aircraft



Medical science



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Thank you