Kinetic Theory

Thermodynamics

Thermodynamics.

Heat Exchange :

The process of tranfer of internal energy from one body to another caused by a difference of temperature without doing work is called heat exchange

Thermal Equilibrium :-

A state will be reached when thre is no net transfer of internal energy from one body to another. At this stage. the two bodies will be at the same temp. and they will be said to be in thermal equilibrium with each other.

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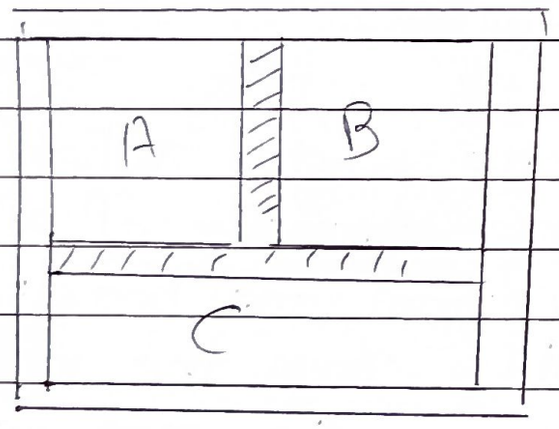
Zeroth law of thermodynamics.

If two system (a) and (b) are separately in thermal equilibrium with a third system C, then the system (a) and (b) are in thermal equilibrium with each other



$T_A = T_B$, $T_B = T_C$

$T_A = T_B = T_C$

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Thermodynamic Process

Thermodynamic process is said to take place if some change occur in the state of a thermodynamic system that is the thermodynamic variable of the system change with time

Isothermal process:

It is that thermodynamic process in which pressure, volume and temp. of the system change but there is no exchange of heat beth the system and the surrounding

A process has to be sudden and quick to be adiabatic.

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Isobaric Process :-

Isobaric process is a thermo. ~~pressu~~ process that take place at constant pressure.

Isochoric Process :-

Isochoric process is a thermo. process ~~th~~ take place at constant volume of the system.

Cyclic Process

It is that thermodynamic process in which the system return to its initial stage after ~~understan~~ going a series of change

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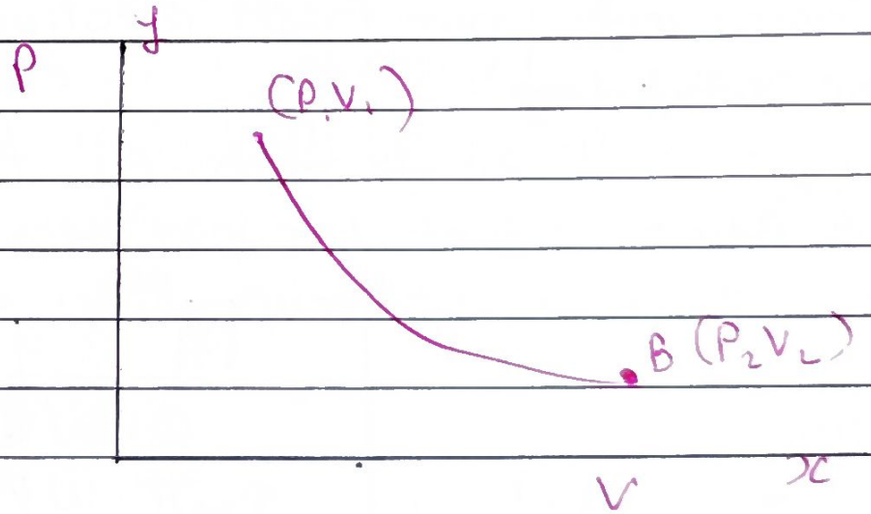
Quasi-static process

It is a thermo-process which proceeds extremely slowly.

Indicator diagram :-

The indicator diagram helps us to calculate the amount of workdone



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Work done in Non-Cyclic process

$P = \frac{f}{A}$ $\quad \therefore \quad f = PA$

$dw = fdx$

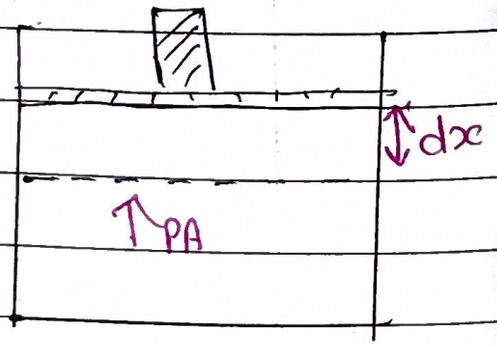
$dw = p(A.dx)$

$[dw = Pdv]$

dv = change in volume

Now the work done

$$w = \int_{V_1}^{V_2} Pdv$$



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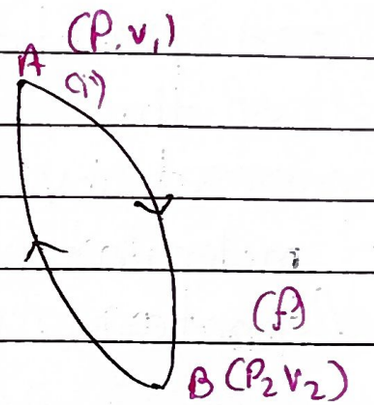
Workdone in a Cyclic Process



W = area of AXBY

Joule's Mechanical Equivalent of heat

It is defined as the amount of work required to be done to produce a unit quantity of heat

$W \propto Q$

$W = JQ$

$J = \frac{W}{Q}$

$J = 4.186 \times 10^7$ erg/calorie

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Internal Energy :

The internal energy of a system is the sum of kinetic energy and potential energy of the molecules of the system. This energy is possesed by a system due to its molecular motion and molecular configuration.

The internal energy is denoted by U

$$[U = E_{K_1} + E_P]$$

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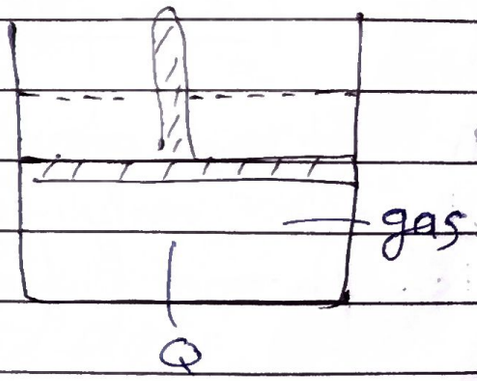
first Law of thermodynamics

If same quantity of heat is supplied to a system capable of doing external work then the quantity of heat is absorbed by the system = to the sum of the increase in the internal energy of the system and the external workdone by the system

$$[\Delta Q = \Delta V + \Delta W]$$

$$[\Delta Q = \Delta U + P\Delta V]$$



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Equation of Iso-thermal process

$[PV = nRT]$

for Isothermal process

$T = Const.$

$PV = Const.$

This is the eqn of state of iso-thermal process According to the 1st Law of thermo.

$$\boxed{\Delta Q = \delta V + P\Delta V}$$

In internal energy of an ideal gas depend only on temp. In an iso-thermal temp. remain constant

So, $\Delta V = 0$

$\Delta Q = P\Delta V$

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Workdone in Isothermal

$$W_{iso} = \int_{V_1}^{V_2} P\,dv \qquad W_{iso} = RT \int_{V_1}^{V_2} dv/v$$

$PV = RT (n = 1)$

$P = \frac{RT}{V}$

$$W_{iso} = RT \int_{V_1}^{V_2} [\log e^V]$$

$$W_{iso} = RT [\log e V_2 - \log e V_1]$$

$$\left[W_{iso} = 2.303\, RT \log 10 \left(\frac{V_2}{V_1}\right)\right]$$

$$\left[W_{iso} = RT \log e \left(\frac{V_2}{V_1}\right)\right]$$

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Eqn of Adiabatic Process

1) Adiabatic relation betn P & V for ideal gas.

$$PV^{\gamma} = K$$

$$P_1V_1^{\gamma} = P_2V_2^{\gamma}$$

$$\gamma = \frac{C_p}{C_v} = \text{Specific ratio}$$

2) Adiabatic relation betn volume & Temp.

$$TV^{\gamma-1} = \text{constant}$$

$$T_1V_1^{\gamma-1} = T_2V_2^{\gamma-1}$$

3) Adiabatic relation betn temp & pressure

$$T^{\gamma}p^{1-\gamma} = \text{constant}$$

$$T_1^{\gamma}p^{1-\gamma} = T_2^{\gamma}p_2^{1-\gamma}$$

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Workdone in Adiabatic Process

$$W_{adia} = C_v(T_1 - T_2)$$

$$W_{adia} = \frac{R}{\gamma - 1}(T_1 - T_2)$$

Limitation of first law of thermodynamics

→ It doesn't indicate the direction in which the change can proceed

→ The 1st law of Thermo gives no idea about the extend to which the change take place.

"These limitation led to be the formation of another law called 2nd law of thermo

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Reversible Process :-

It is that process which can be retrace in opposite direction so that the system and the surrounding pass through exactly the same stage and it stage as inthe direct process

Irreversible Process :-

It is the process which is not exactly reverse that is the system does not passed through the same intermediate state as in the direction process, every process in nature is an ~~irr~~ irreversible process

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2nd law of Thermodynamics

This law specifies the condition for the conversion of heat into work There are two famous statemer ragarding 2nd law of thermodynami

1) Kelvin Plank Statement

It is impossible to construct an engine operating in a cycle which will produced no effect other than extracting heat from a reservoir and perform in a equivalent amount of work

2) Classius statement :

It is impossible to make heat flow from a body at a lowe temp. to a body at higher temp. without doing external work on the working substance

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Heat can't by itself flow a body at a lower temp. to body at higher temp.

Heat Engine :-

Heat engine is a device use to convert heat energy into mechanical energy.

A heat engine consist of the following parts -

i) Source - It is the supplier of heat energy

ii) Sink or cold reservoir - That heat which has not been converted into work is rejected to the sink

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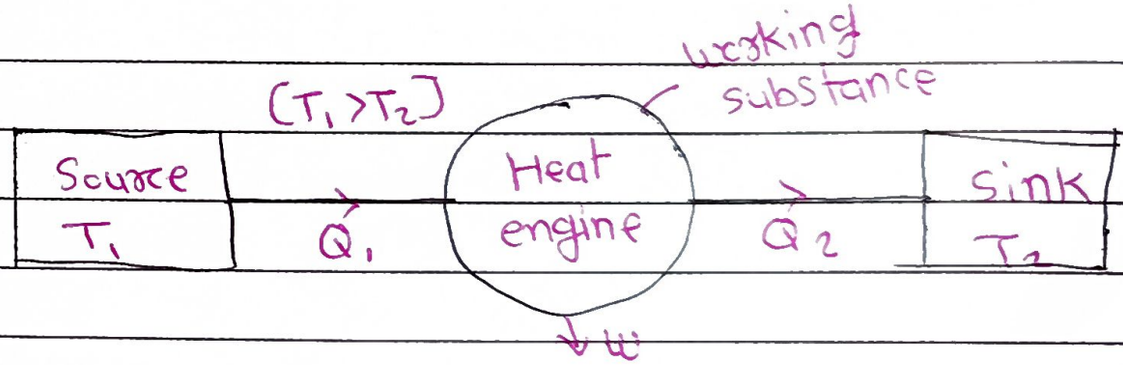
3) Working Substance

It absorb's a certain quantity of heat from the source

The block diagram of heat engine is shown in the following figure :-



Efficiency :

$$\left[\eta = \frac{W}{Q_1} = \frac{Q_1 - Q_2}{Q} = \frac{1 - Q_2}{Q} = 1 - \frac{T_2}{T_1} \right]$$