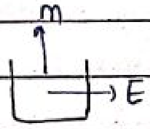
5 fed 2022

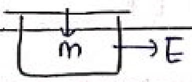
THERMODYNAMICS

Science which deals with study of different forms of energy with quantitative relationship.

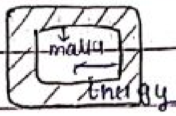
System and Surrounding — universe



Open system



Closed System



Isolated system

State function and path functions —

State function	Path function
- Those properties of system that depends only on initial and final state of system but it does not depend on path ex- enthalpy (H) entropy (S), gibb's free energy (G), Internal energy (U) etc.	- Those properties of system that depend on path ex- work, heat -

Extensive and Intensive property —

M_1	m_2
V_1	V_2
T	T
P	P
d	d

Extensive — Those properties which depend on size of matter present in the system ex – mass, volume, all type of Energy, mole etc.

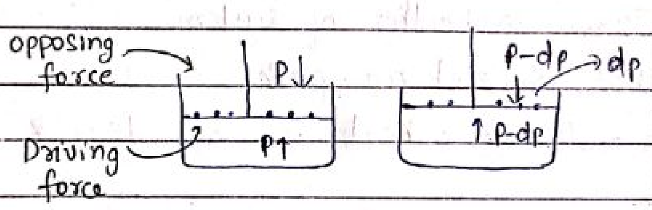
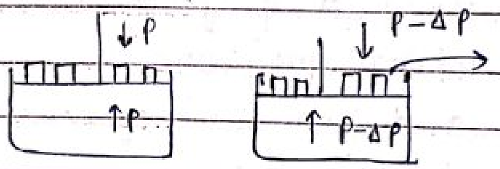
Intensive – does not depend on size of matter
ex – p^H, molarity, Temp., Pressure, density, all type of constants etc.

Note The ratio of 2 extensive properties is equal to intensive property.

$$\frac{\text{mole } [E]}{\text{Volume } [E]} = \text{Molarity } [I]$$

$$\frac{\text{mass } (E)}{\text{Volume } (E)} = \text{density } (I)$$

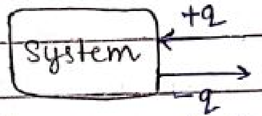
Reversible and Irreversible Thermodynamic Process –

Reversible	Irreversible
	
• It is carried out in multistep	• It is carried out in single step
• It takes infinite time for completion (very slow)	• It is immediately completed (fast process)
• Each step is in equillibrium with previous step.	• Equillibrium exist only with initial and final state not in b/w
• This is ideal process	• This is real process
• Driving force is slightly large than opposing force Driving force > opposing force	• Driving force is very very large than opposing force Driving force >>> opposing force

Heat

- It is denoted by q.
- It is a form of energy which is exchange between system and surrounding due to diff. of temp.

- q is +ve when heat is transfer from surrounding to system while q is -ve, which means heat is transfer from system to surrounding.



unit — J, erg, calorie, atm lit

$$1\,J = 10^7\,erg$$

$$1\,J = \frac{1}{4.182}\,cal.$$

$$1\,cal = 4.182\,J$$

→ Specific Heat Capacity (c) :—

Amount of heat req. to rise the temp. of 1 g of a gas by 1°C or 1K

$$\boxed{c = \frac{q}{m\Delta T} \quad \text{OR} \quad q = c \cdot m\Delta T}$$

for Isothermal process,

$$\Delta T = 0 \quad \text{so} \quad c = \infty$$

for Adiabatic process,

$$q = 0 \quad \text{so} \quad c = 0$$

So, we can say that specific heat capacity value can be from zero to infinite.

Specific heat capacity at constant vol. and constant pressure should be written as – c_v and c_p respectively.

$$\boxed{c_v = \frac{q}{m \cdot \Delta T}}$$ (S.H.C at constant V)

$$\boxed{c_p = \frac{q}{m \cdot \Delta T}}$$ (S.H.C at constant pressure)

Molar specific heat capacity :–

- denoted by (C)

$$C = \frac{q}{n \Delta T}$$

$$\boxed{C_v = \frac{q}{n \Delta T}} \qquad \boxed{C_p = \frac{q}{n \Delta T}}$$

→ Relation between Cv and Cp –

$C_p - C_v = R$ (Nayer eq.) —— (1)

Here R = Universal Gas constant

R = 1.98 Calorie / mole. K or 8.31 Joule / mole K

→ Poison's ratio (Adiabatic Index)

$\frac{C_p}{C_v} = \gamma$ (gamma) —— (ii)

Some different Relation or formulas —

$$C_p = \gamma C_V \quad \text{—— (3)}$$

③ in ①

$$\gamma C_V - C_V = R$$

$$C_V(\gamma - 1) = R$$

$$C_V = \frac{R}{\gamma - 1} \quad \text{—— (4)}$$

Relation between degree of freedom (f) and Molar heat capacity —

Molar heat capacity of diff. gases depends on degree of freedom (DOF) for monoatomic gas the value of DOF is 3, for diatomic gas is 5 and triatomic or polyatomic it should be 6

$$\boxed{C_V = \frac{f}{2} \cdot R} \text{ —— (5)} \quad \boxed{C_P = R\left(1 + \frac{f}{2}\right)} \text{ —— (6)}$$

	C_V $(\frac{f}{2}R)$	C_P $(R(1+\frac{f}{2})$	γ $\frac{C_P}{C_V}$
Mono atomic gas	$\frac{3}{2}R$	$\frac{5}{2}R$	$\frac{5}{3} = 1.66$
Diatomic gas	$\frac{5}{2}R$	$\frac{7}{2}R$	$\frac{7}{5} = 1.4$
Polyatomic gas	$3R$	$4R$	$\frac{4}{3} = 1.33$

Decreasing order of poison ratio for different gases should be

$$\begin{array}{ccccc} \gamma_{Monoatomic} & > & \gamma_{diatomic} & > & \gamma_{polyatomic} \\ 1.66 & & 1.40 & & 1.33 \end{array}$$

Que Calculate the Cv and Cp value in calorie for oxygen gas.

$$Cv = \frac{f}{2} \times R = \frac{5}{2} \times 2 = 5 \text{ calorie}$$

$$Cp = 2\left(1+\frac{5}{2}\right) = \frac{2+5}{2} \times 2 = 7 \text{ calorie}$$

Que calculate the cp value in J for CO_2 gas

$$Cp = R\left(1+\frac{f}{2}\right) = \left(1+\frac{6}{2}\right) \times 8.31$$

$$4 \times 8.31 = 33.24 \text{ J}$$

★ The value γ also calculated by

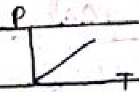
★ $$\boxed{\gamma = 1+\frac{2}{f}}$$

→ Type of Thermodynamic Process —

- Reversible
  - Adiabatic
  - Isothermal
- Irreversible
  - → Isochoric $\Delta V = 0$
  - → Isobaric $\Delta P = 0$
  - → Isothermal $\Delta T = 0$
  - → Adiabatic $\Delta q = 0$
  - → Cyclic

1) Isochoric Process —

- change in volume $\Delta V = 0$
- Pressure and Temperature is variable



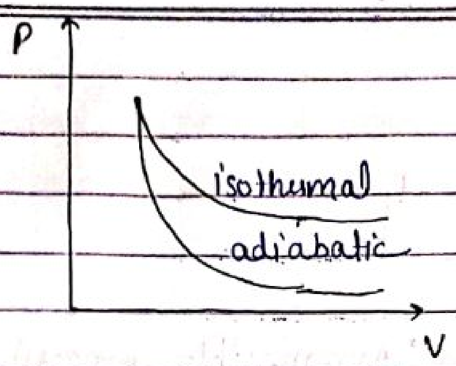
- Workdone is equal to $-P_{ext}\Delta V$. 0
- It is applicable for closed system (Irreversible process)

2) Isobaric Process —

- Pressure is constant
- Carried out in open system
- Volume and temperature are variable.
- Workdone should be equal to $-P_{ext}\Delta x$
- It is always irreversible process.

Isothermal and Adiabatic Process —

$\Delta T = 0$	$\Delta q = 0$
conductive system	Insulated system
very slow process	very fast process
$PV = \text{constant}$	$PV^\gamma = \text{constant}$
$P_1V_1 = \text{constant}$	$P_1V_1^\gamma = \text{const}$.
$P_2V_2 = \text{constant}$	$P_2V_2^\gamma = \text{const}$.
P and V variable	P & V should be variable
follow boyle's law	follow boyle's law but not
property	proper hold
$\Delta V = 0$.	$\Delta S = 0$



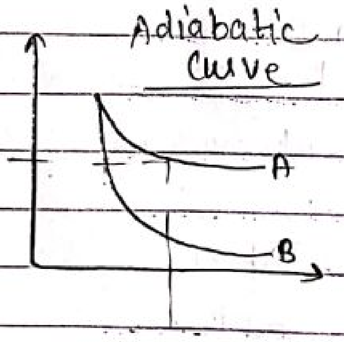
Cyclic Process –

When a system undergoes a no. of diff pathway process and finally returned to its initial state.
It is termed as cyclic process
In cyclic process, all change in state fun. will be zero.

Example of Adiabatic process –

Brusting of tyre and shaking thermos

Que



$PV^{\gamma} = \text{constant}$

B = monoatomic
A = diatomic