Thermodynamics

↳ study of heat flow.

Heat: is another form of energy.
- J, erg, cal, Kwh
- eV, BTU

Temperature: Measureness of Hottness and coldness.
- Average K.E of particles.
- Units:

SI	Non SI	
Kelvin	Celcius	Farenheite
K	C°	F°
F.P: 273K	0C°	32F
B.P: 373K	100C°	212F

Conversion Shortcut:

Temp Name − F.P

B.P − F.P

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C° & K:

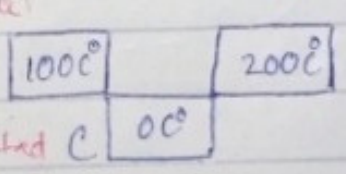
$$\frac{C-0}{100-0} = \frac{K-273}{373-273} \Rightarrow \frac{C}{\cancel{100}} = \frac{K-273}{\cancel{100}}$$

$$\boxed{C = K-273} \text{ or } \boxed{K = C+273}$$

Zeroth Law Of Thermodynamics

Before when bodies were separate:

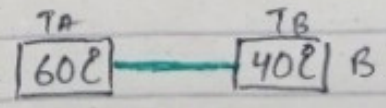
A = 100°C, B = 200°C, C = 0°C



When bodies are thermally in contact

A = B = C = 100°C $T_A = T_B = T_C$

MCQ:



a: $T_A = 60$, $T_B = 40$

(b) $T_A = 44$, $T_B = 44$

c: $T_A = 40$, $T_B = 60$

d: none

Wood and steel ~~at~~ will have same temp. say 50°C, it is experimentally proved. But steel feels hot b/c heat transfer is quick and greater

Types Of System:

i: Open System:

↳ Heat + matter both are transferable (tea)

ii: Close System:

↳ only heat transfer
↳ not matter (Pressure cooker)

iii: Isolated System:

↳ No heat
↳ No matter tranfer (Thermos)

First Law Of Thermodynamics:

↳ It is law of conservation of energy.
↳ E = conserve

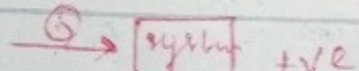
$\Delta Q = \Delta U + \Delta W$

Heat — Change in internal energy — ↳ Work done.

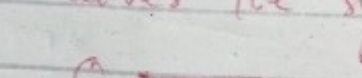
Sign of Convection:

1: Heat:

- Heat is given to system taken as positive



- Heat leaves the system taken as negative.



2: Change in internal energy:

$U \propto T$

$\Delta U \propto T$.

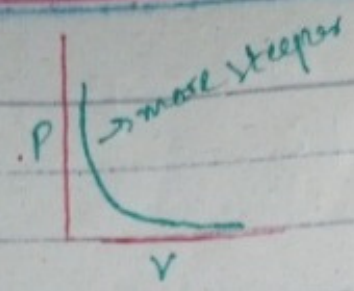
→ $\Delta T = 0$, $\Delta U = 0$

→ $\Delta U = 0$ for cyclic process.

→ ΔU is independant of path

↳ Initial or final state
↳ volume & Temperature } only depends on

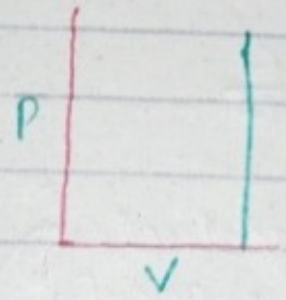
$\uparrow T$, $+U\uparrow$
$\downarrow T$, $-U\downarrow$



→ sudden process
→ Fast process
→ Blastic type
→ Formation of cloud.
→ cold air

iii: Isocohric Process:

- → V = constant
- → $\Delta V = 0$
- → $\Delta W = P\Delta V$
- → $\Delta W = 0$



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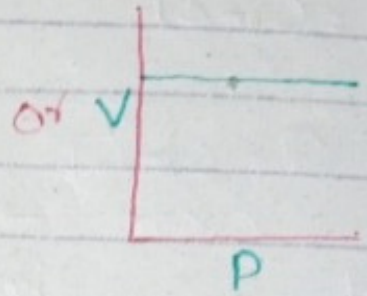


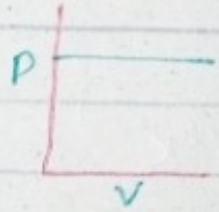
$\Delta Q = \Delta U + \Delta W$

$\Delta Q = \Delta U + \cancel{P\Delta V}^{0}$

$\Delta Q = \Delta U$ ⟶ All heat is used to raise the internal energy.

iv: Isobaric Process:

- → P = constant
- → $\Delta P = 0$
- → $\Delta Q = \Delta U + \Delta W$



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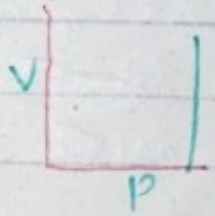
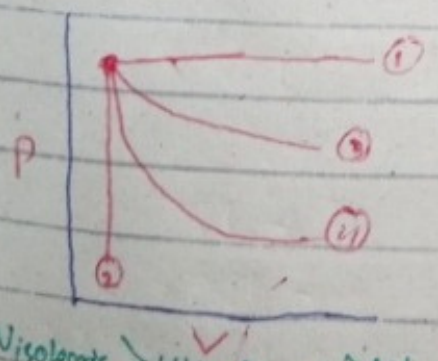


$\Delta Q = \Delta U + P\Delta V$ → It will not zero as pressure remains constant in 1st law.

Maximum Work:

i: For Expansion:

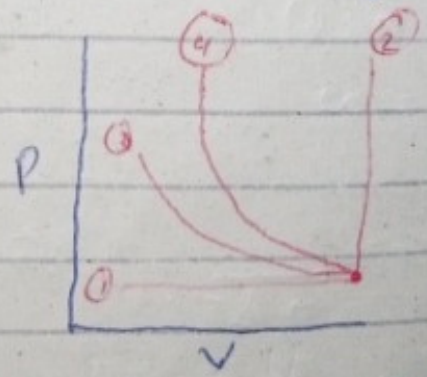


$W_{isobaric} > W_{isothermal} > W_{adiabatic}$

1. Isobaric
2. Isochoric
3. Isothermal
4. Adiabatic

$\frac{W_{isothermal}}{W_{adiabatic}} > 1$

For Compression:



$W_{adiabatic} > W_{isothermal} > W_{isobaric}$

3: Work done:

$W = PV$

$J = pa\,m^3$

$\Delta W = P\Delta V$

$\Delta W = P(V_f - V_i)$

$V_f > V_i$ — $W = +ve$ — Expansion

$V_f < V_i$ — $W = -ve$ — Compress

Workdone

on the sys — $W = -ve$

by the system — $W = +ve$

If 100j heat is given to a system. And system perform work. $\Delta U = ?$

$Q = +100J$

$W = +50j$ ∴ Work done system

$\Delta Q = \Delta U + \Delta W$

$\Delta U = \Delta Q - \Delta W$

$\Delta U = 100 - 50$

$\Delta U = 50J$ ↑

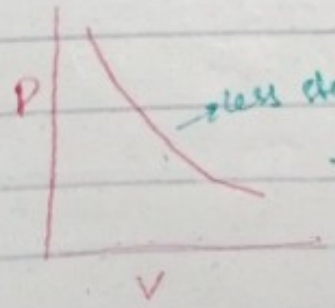
Applications Of 1st law:

i: Isothermal:

- T = constant
- $\Delta T = 0$
- $\Delta U = 0$

$\Delta Q = \Delta U + \Delta W$

$\Delta Q = \Delta W$ → The whole heat is used to do a work. → complete heat in complete work.



→ less steeper

→ slow process

ii: Adiabatic:

- Q = constant
- $\Delta Q = 0$

$\Delta Q = \Delta U + \Delta W$

$0 = \Delta U + \Delta W$

$+\Delta W = -\Delta U$ → Adiabatic Expansion

$+\Delta U = -\Delta W$ → Adiabatic compression

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Molar Specific Heat:

Specific Heat: The amount of heat requir to raise temp of 1kg substance by 1K.

$Q \propto m$

$Q \propto \Delta T$

$Q \propto m\Delta T$

$Q = Cm\Delta T$

Heat Capacity: $\frac{Q}{\Delta T}$

$Q = Cm\Delta T$

$\frac{Q}{\Delta T} = C \times m$ → product of C and m is called heat capacity $\left(\frac{Q}{\Delta T}\right)$

→ $\frac{Q}{\Delta T}$ (JK^{-1})

Molar Specific Heat:

$Q = Cmn\Delta T$

$Cm = \frac{Q}{n\Delta T}$ $\left(\frac{J}{mol^{-1}K^{-1}}\right)$

$R = 8.314\ J\,mol^{-1}K^{-1}$

$Cm = R = J\,mol^{-1}K^{-1}$

→ Molar specific heat for isothermal.

$\Delta T = 0$

$Cm = \frac{Q}{n(0)}$

$Cm = \infty$

→ Molar specific heat for adiabatic:

$Cm = \frac{0}{n\Delta T}$ $\Delta Q = 0$

$Cm = 0$

→ Molar specific heat at constant Volume:

$Q_v = C_v n\Delta T$

at Constant Pressure:

$Q_p = C_p n \Delta T$

$\therefore \Delta U_p = \Delta U_v$

$Q_p = Q_v + W$

$\boxed{Q_p > Q_v}$

$$C_p = C_v + R$$

$C_p - C_v = R$

→ 1 mole of gas.

• For n mole:

$C_p - C_v = nR$

2021: for 3 moles of $C_p - C_v$?

$C_p - C_v = nR$

$C_p - C_v = 3R$

$\frac{C_p}{C_v} = \gamma$
- → mono = 1.6
- → dia = 1.4
- → Poly = 1.29

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Shortcut:

$\gamma = 1 + \frac{2}{f}$

f = degree of freedom
- → 3 for mono
- → 5 for dia
- → 7 for poly

$\gamma_m = 1 + \frac{2}{3} = \frac{5}{3} = 1.6$

$\gamma_d = 1 + \frac{2}{5} = \frac{7}{5} = 1.4$

$\gamma_p = 1 + \frac{2}{7} = \frac{9}{7} = 1.29$

MCQ: $C_v = \frac{3}{2} R$ (f)

a: Which gas is? (mono)

Shortcut: $\boxed{C_v = \frac{f}{2} R}$ → degree of freedom

b: $C_p = ?$ $C_p = C_v + R \Rightarrow C_p = \frac{3}{2}R + R \Rightarrow \frac{5R}{2}$

c: $\gamma = ?$ 1.6 (for mono)

d $\frac{R}{C_v} = ?$ $C_p - C_v = R \Rightarrow \frac{C_p - C_v}{C_v} = \frac{R}{C_v} \Rightarrow \frac{C_p}{C_v} - \frac{C_v}{C_v} = \frac{R}{C_v} \Rightarrow \boxed{\gamma - 1 = \frac{R}{C_v}}$ (→ γ)

$1.6 - 1 = \frac{R}{C_v}$

e: $\frac{R}{C_p} = ?$ $C_p - C_v = R \Rightarrow \frac{C_p - C_v}{C_p} = \frac{R}{C_p} \Rightarrow 1 - \frac{C_v}{C_p} = R \Rightarrow \boxed{1 - \frac{1}{\gamma} = \frac{R}{C_p}}$ (→ 1/γ)