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Kinetic energy
- Translational KE
- Rotational KE
- Vibranational KE

Potential Energy
- Electrostatic PE
- Gravitational PE
- Nuclear PE

Note:—

Kinetic energy of a substance or system depends only on temperature

$T = 300K$ — $\Delta KE = 0$

$A + B \rightarrow C + D$

exo
$Q < 0$
$Q = -50kJ$
PE $\downarrow$

endo
$Q > 0$
$Q = 50kJ$
PE $\uparrow$

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Internal Energy

$$\Delta U = \int n C_v \, dT$$

$$\boxed{\Delta U = n C_v \Delta T}$$

for ideal gas not undergoing any chemical & phase change

1st law of T.D

$$\Delta U = q + W$$

$$W = -\int P_{ext} \, dV$$

$$q = n C \, dT$$

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Q. find <u>heat transfer</u> for 1 mol monoatomic ideal gas undergoing a change from (2 lit, 300 K) to (4 lit, 500 K) against a constant external pressure 10 bar.

$R = 8.314$ J/K/mol

$\simeq \frac{25}{3}$ J/K/mol

$R \simeq 2$ cal/mol/K

$$\frac{\cancel{P} V_2}{\cancel{P} V_1} = \frac{\cancel{n} T_2 \cancel{R}}{\cancel{n} T_1 \cancel{R}}$$

$$\frac{P_2}{P_1} = \frac{T_2}{T_1} \times \frac{V_1}{V_2} =$$

$Q = nC_v\Delta T$

$Q = nC_p\Delta T$ ✗

$$\Delta U = nC_v\Delta T$$
$$= 1 \times \frac{3}{2} \times R \times 200$$
$$= \frac{\cancel{3}}{\cancel{2}} \times \frac{25}{\cancel{3}} \times \cancel{200}^{100} = 2500$$

$$W = -P_{ext}(V_2 - V_1)$$
$$= -10 \text{ bar } (4-2) \text{ lit}$$
$$= -2000 \text{ J}$$

from 1st law of T.D

$$Q = \Delta U - W = 2500 + 2000$$
$$= 4500$$

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$\Delta U = nC_v\Delta T$ for ideal gas
undergoing any change except chemical & phase change

$Q = nC_v\Delta T$ for a substance
undergoing a change at const volume
(but change should not be chemical or phase change)

$Q = nC_p\Delta T$ for a substance undergoing a change at const 'p'
( )

$W = -\int P_{ext}\, dV$ is always applicable

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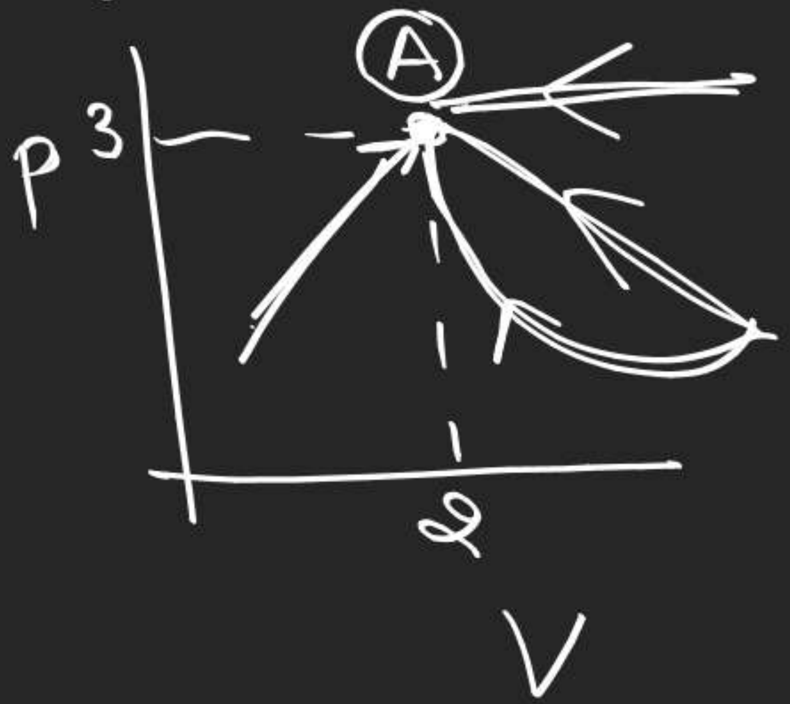
State variable :→ which depends only on present state of system and is independent of process/path used to achive the present state of the system.

or

state function

lattitude and Longitude



P, V, T etc are state variable

'U' is also a state function.

↑ internal Energy.

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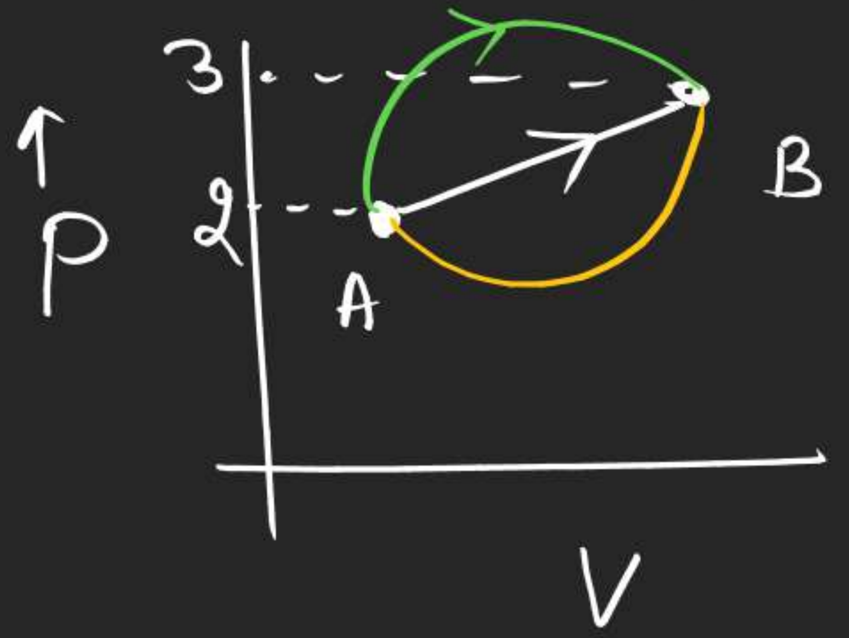
Change in state function

distance travelled ← path dependent

displacement ← path independent

T ← Temperature – state function ⟶ final or present state — path independent

ΔT ← change in temperature ⟶ change in State function ⟶ initial & final — path independent



ΔP
ΔT
ΔV
ΔU
← path independent

heat & work are path dependent

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Enthalpy (H) : →

$$H = U + PV$$

for a change

$$dH = dU + PdV + VdP$$

$$dH = q + w + PdV + VdP$$

at const Pressure

$P_{ext} = P = \text{const}$

$$W = -P_{ext}\, dV$$
$$= -PdV$$

$$dH = q \cancel{-PdV} + \cancel{PdV} + VdP$$

$$\boxed{dH = q_p}$$

$$\Delta H = -50 kJ$$
$$=$$

$$dU = q + w$$

at const 'V' $\quad w = 0$

$$\boxed{dU = q_v}$$

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heat transfer at constant volume $(q_v) = \Delta U$

" " " " pressure $(q_p) = \Delta H$

$\Rightarrow \quad H = U + PV$

$$\int dH = \int dU + \int d(PV)$$

$$\Delta H = \Delta U + \Delta(PV)$$

$$\boxed{\Delta H = \Delta U + (P_2V_2 - P_1V_1)}$$

$\Delta H = \Delta U + \Delta(PV)$

for an ideal gas

$\Delta H = \Delta U + \Delta(nRT)$

$\Rightarrow$ for a substance not undergoing any chemical & phase change

$$\Delta H = \Delta U + nR\Delta T$$
$$= nC_v\Delta T + nR\Delta T$$
$$= n(C_v + R)\Delta T$$

$$\boxed{\Delta H = nC_p\Delta T}$$

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$$\Delta H = \Delta U + \Delta(nRT)$$

for chemical & phase change

$$\boxed{\Delta H = \Delta U + \Delta n_g RT}$$

change in no. of moles of gases

$$H_2O(l) \longrightarrow H_2O(g)$$

$$\Delta n_g = 1$$

$$2NH_3(g) \longrightarrow N_2(g) + 3H_2(g)$$

$$\Delta n_g = 1 + 3 - 2$$
$$= 2$$

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find ΔU for the given Rxn at 300 K

$$H_2O(l) \longrightarrow H_2O(g) \qquad \Delta H = +40\ kJ/mol$$

at 300 K

$\Delta n_g = 1$

$R = \frac{25}{3}\ J/K/mol$

$$\Delta H = \Delta U + (P_2V_2 - P_1V_1)$$

or

$$\Delta H = \Delta U + \Delta n_g RT$$

$$40\ kJ = \Delta U + \frac{1 \times \frac{25}{\cancel{3}} \times \overset{100}{\cancel{300}}}{1000}$$

$$40 = \Delta U + 2.5$$

$$37.5 = \Delta U$$

$\Delta U = 37.5\ kJ$

$= 37500\ J$