

Specific heat capacity of water:

It is found that the specific heat of water varies slightly with temperature.

One calorie: one calorie is defined to be amount of heat required to raise the temperature of 1gm of water from 14.5°C to 15.5°C .

* In S.I. units, the specific heat capacity of water is $4186 \text{ J/kg/K} = 4186 \text{ J/g/K}$.

Relationship between ^{molar} specific heat capacity at const. Volume (c_v) and ^{molar} specific heat capacity at const. Pressure (c_p)

Relationship between c_p & c_v :

From 1st law of thermodynamics: —

$$\Delta Q = \Delta U + P\Delta V \rightarrow \textcircled{1}$$

~~Now, molar heat capacity (c) = $\frac{\Delta Q}{\Delta T}$~~

let us consider for one mole of gas (ie. $n = 1$ mole)

\therefore molar specific heat capacity (c) = $\frac{1}{n} \cdot \frac{\Delta Q}{\Delta T}$

$$\therefore C = \frac{\Delta Q}{\Delta T} \quad (\text{since } n = 1 \text{ mole})$$

Using equation ① \Rightarrow

$$C = \frac{(\Delta U + P\Delta V)}{\Delta T}$$

$$\Rightarrow C = \left(\frac{\Delta U}{\Delta T} + P \frac{\Delta V}{\Delta T} \right) \rightarrow \text{②}$$

If we keep the volume const. then $\Delta V = 0$

$$\therefore C_V = \left(\frac{\Delta U}{\Delta T} + P \cdot 0 \right)_V = \left(\frac{\Delta U}{\Delta T} \right)_V$$

$$\Rightarrow C_V = \left(\frac{\Delta U}{\Delta T} \right) \rightarrow \text{③}$$

The subscript V can be dropped since internal energy (U) depends only on Temp^o (T) not on volume for ideal gas.
If we keep the pressure const then,

$$\therefore C_P = \left(\frac{\Delta U}{\Delta T} + P \cdot \frac{\Delta V}{\Delta T} \right)_P$$

$$\Rightarrow C_P = \left(\frac{\Delta U}{\Delta T} \right)_P + P \cdot \left(\frac{\Delta V}{\Delta T} \right)_P = \left(\frac{\Delta U}{\Delta T} \right)_P + P \left(\frac{\Delta V}{\Delta T} \right)_P \rightarrow \text{④}$$

the subscript P can be dropped since internal energy (U) depends only on Temp^o (T) not on pressure for ideal gas.

$$\therefore \text{④} - \text{③} \Rightarrow C_P - C_V = P \cdot \left(\frac{\Delta V}{\Delta T} \right)_P \rightarrow \text{⑤}$$

For an ideal gas,

$$PV = nRT$$

$$\Rightarrow PV = RT \quad (\because n = 1 \text{ mole})$$

$$\therefore PV = RT \rightarrow (6)$$

For const. pressure,

$$P \Delta V = R \Delta T$$

$$\Rightarrow P \left(\frac{\Delta V}{\Delta T} \right)_P = R \rightarrow (7)$$

using eqn (7) in eqn (5) \Rightarrow

$$\boxed{C_p - C_v = R} \rightarrow (8)$$

Equation of State:

The connection between the state variables is called the equation of state:

$$PV = nRT \rightarrow (1)$$

Question: diff. between reversible & quasi-static process:

Ans:- All reversible processes are quasi-static but all quasi-static processes are not reversible.

The system must need to go back to initial state in a reversible process but the same is not the case for quasi-static process.