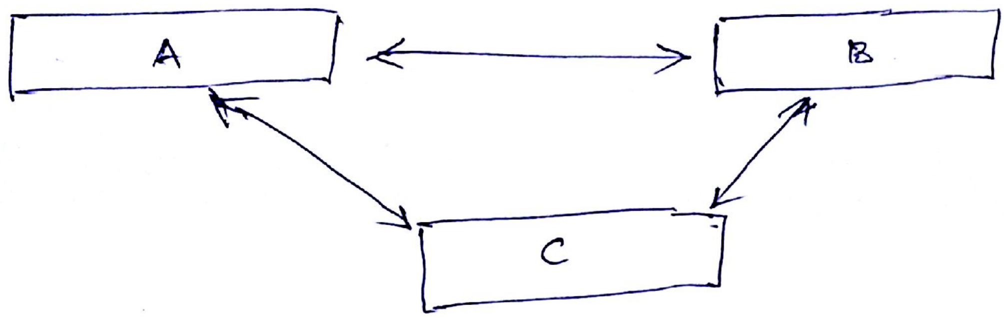
Comparison between Work and Heat.

- Both heat and work are boundary phenomena, i.e) they occurs only at the boundary.
- Both work and heat are path function
- The interaction due to the temperature difference is heat and all other interactions are to be taken as work.

Zeroth Law of Thermodynamics :-

When a body A is in thermal equilibrium with a body B, and also separately with a body C, then B and C will be in thermal equilibrium. This is known as Zeroth law of thermodynamics

It is based on temperature measurement.



First Law of Thermodynamics :-

When a system undergoes cyclic process, then the net heat is equal to the net work transfer.

$$\oint dQ = \oint \delta W.$$

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

Heat transfer = Work + Change in internal Energy.

Law of Conservation of Energy.

Energy can be neither created nor destroyed. It can only be transferred from one form to another form.

First law for a closed system :-

The expressions $(\Sigma W)_{cycle} = (\Sigma Q)_{cycle}$ the applies only to system undergoing cycles and the algebraic summation of all energy transfer across system boundaries is zero.

But if a system undergoes a change of state during which both heat transfer and work transfer are involved, the net energy transfer will be stored within the system.

If Q is the amount of heat transferred to the system during and W is the amount of work transferred from the system during the process, the net energy transfer $(Q-W)$ will be stored in the system. Energy in storage is neither heat nor work, and is given the name internal energy

$$Q - W = \Delta E.$$

$$\boxed{Q = \Delta E + W}$$

Limitations :-

It does not specify the directions of flow of heat or work. (Whether the heat flows from hot body to cold body. (or) from cold body to hot body)

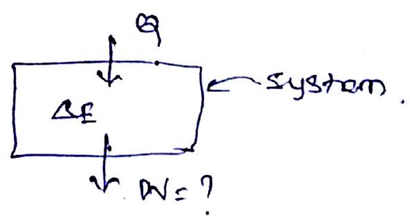
Problem :-

A closed system receives an input heat of 450 KJ and increases the internal energy of the system for 325 KJ. Determine the work done by the system.

Given.

$Q = 450$ KJ.

$\Delta E = 325$ KJ.



Solution

$Q = W + \Delta E.$

$450 = W + 325$

$$\boxed{W = 125 \text{ KJ}}.$$

Result :-

Work done $(W) = 125$ KJ.

2. A piston and cylinder machine contains a fluid system which passes through a complete cycle of four processes. During a cycle, the sum of all heat transfer is −170 KJ. The system completes 100 cycles per min. Complete the following table showing the method for each item, and compute the net rate of work output in KW.

Process	Q (KJ/min)	W (KJ/min)	ΔE (KJ/min)
a-b	0	2170	—
b-c	21,000	0	—
c-d	−2100	—	−36,600
d-a	—	—	—

<u>Solution</u> :-

Process a-b.

$Q = \Delta E + W$

$0 = \Delta E + 2170$

$\Delta E = -2170$ KJ/min

Process b-c

$Q = \Delta E + W$

$21,000 = \Delta E + 0$

$\Delta E = 21,000$ KJ/min

Process c-d

$Q = \Delta E + W$

$-2100 = -36600 + W$

$W = 34,500$ KJ/m

Process d-a,

$\sum_{cycle} Q = -170$ KJ.

The system completes 100 cycles/min,

$Q_{ab} + Q_{bc} + Q_{cd} + Q_{da} = -170 \times 100$ KJ/min.

$0 + 21,000 - 2100 + Q_{da} = -17000$ KJ/min.

$Q_{d-a} = -35,900$ KJ/min.

Cyclic integral of any property is zero.

$\Delta E_{a-b} + \Delta E_{b-c} + \Delta E_{c-d} + \Delta E_{d-a} = 0$.

$-2170 + 21,000 - 36,600 + \Delta E_{d-a} = 0$.

$\Delta E_{d-a} = 17,770$ KJ/min.

$W_{d-a} = Q_{d-a} - \Delta E_{d-a}$.

$= -35,900 - 17,770$

$W_{d-a} = -53,670$ KJ/min.

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Application of first Law of thermodynamics.

1. Applied to Closed system (or). Control
2. Applied to open system (or) control.

closed system :-

8 Type of process.

1. Constant pressure process (or) Isobaric process.
2. Constant volume process. (or) Isochoric process.
3. Constant Temperature process (or) Isothermal process.
4. Isentropic (or) Reversible adi'abatic process
5. Polytropic process
6. Hyperbolic process
7. Trottling
8. Free expansion.

characteristic gas equation.

$$\frac{PV}{T} = C.$$

$$PV = mRT.$$

$$\text{Work done} = \int_1^2 p.dv.$$

Specific heat :-

The amount of heat required to raise the temperature of the 1kg of gas to 1°c.

For gas : $C_p = 1.005$ KJ/kgK.

$C_v = 0.487$ KJ/kgK.

The ratio of two specific heat is denoted by γ.

$$\therefore \gamma = \frac{C_p}{C_v} = \frac{1.005}{0.7187} = 1.4$$

The difference between two specific heat is denoted by R.

$$R = C_p - C_v = 1.005 - 0.7187 = 0.287 \text{ KJ/kgK}.$$