Physics Booster 1

Topic - Thermodynamics

Important Points to remember (Sign Conventions) :-

a. *If temperature of an ideal gas increases, ΔU= + ve
*If temperature of an ideal gas decreases, ΔU= - ve

b. *If heat energy is given to the system, ΔQ= +ve

*If heat energy is taken away from system, ΔQ =- ve

c. *If Volume of System increases, ΔW =+ ve

* If Volume of system decreases, Δ W= - ve

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1. First Law of thermodynamics, ΔQ = ΔU + Δ W

2. Work done –

a. in an isothermal and reversible process =PΔV

b. in an isothermal and irreversible process –

W = 2.303nRT log V_2/V_1

OR

W = 2.303nRT log P_1/P_2

c. Work done in an adiabatic process i.e PV^{γ} = constant (where $\gamma = C_p/C_v$)

$$W = \frac{P1V1 - P2V2}{\gamma - 1} = \frac{nR(T1 - T2)}{\gamma - 1}$$

3. Adiabatic process can be represented by :-

- PV^{γ} = constant
- $TV^{\gamma-1}$ = constant
- $P^{1-r}\,T^{r}$ = constant

4. Work done in isothermal expansion > Adiabatic expansion.

5. Change in Internal energy is represented by :-

$$\Delta U = nC_v\Delta T = \frac{P_2V_2 - P_1V_1}{r-1} = f/2nR\Delta T = f/2(P_2V_2 - P_1V_1)$$

(where f is degree of freedom which is 3 for monatomic, 5 for diatomic and 6 for polyatomic)

6. Specific heat constant at const. Volume (C_v) = $\frac{R}{\gamma-1}$

At constant pressure (C_p) =$\frac{\gamma R}{\gamma-1}$

Where γ = 1+$\frac{2}{f}$ =$\frac{Cp}{Cv}$

And C_p-C_v = R

7. Heat energy supplied at constant pressure to monoatomic / diatomic gas. The part of this heat that goes to increase it's internal energy is given by

$$\frac{\Delta U}{\Delta Q} = \frac{nCv\Delta T}{nCp\Delta T} = \frac{Cv}{Cp} = \frac{1}{\gamma}$$

And part of this heat that goes to work done is given by-

$$\frac{\Delta W}{\Delta Q} = \frac{\Delta Q-\Delta U}{\Delta Q} = \frac{nCp\Delta T-nCv\Delta T}{nCp\Delta T} = \frac{Cp-Cv}{Cp} = 1-\frac{1}{\gamma}$$

8. Slope of adiabatic = γ ×slope of isotherm

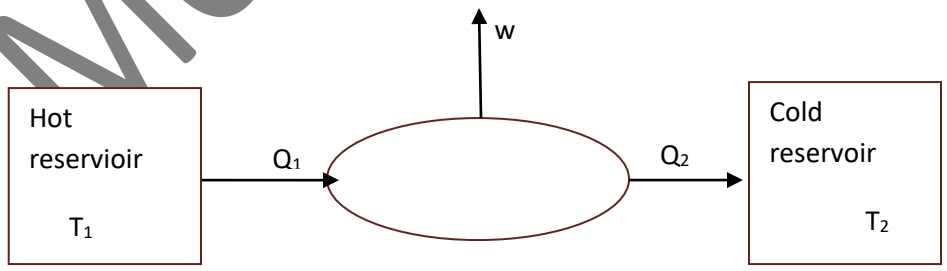
9. For polytropic Process

PV^N = constant

$$W = \frac{P_2V_2 - P_1V_1}{1-N}$$

Specific Heat, C = C_v + $\frac{R}{1-N}$

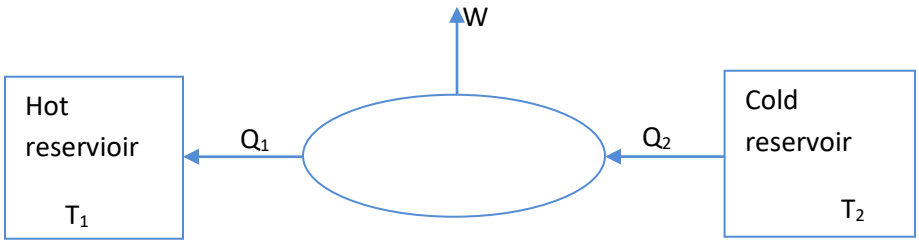
10. Heat engines



(Efficiency) η =$\frac{W}{Q1}$ = 1-$\frac{Q2}{Q1}$ = 1`-$\frac{T2}{T1}$

$(W = Q_1 - Q_2)$

11. Refrigerators



Efficiency (β) $= \frac{Q2}{W} = \frac{Q2}{Q1-Q2}$

12. Relation between β and η

$\beta = \frac{1-\eta}{\eta}$

13. Heat pumps are same as refrigerators

Efficiency (r) = $\frac{Q1}{W} = \frac{Q1}{Q1-Q2} = \frac{1}{\eta}$