Thermal Matter

Thermal Expansion

Linear Expansion	Areal Expansion	Volume Expansion
$\alpha = \dfrac{\Delta l}{l \Delta T}$	$\beta = \dfrac{\Delta A}{A \Delta T}$	$\gamma = \dfrac{\Delta V}{V \Delta T}$
α = coefficient of linear expansion Δl = change in length ΔT = rise in temp	β = coefficient of areal expansion ΔA = change in length	γ = coefficient of volume expansion ΔV = change in volume

Relation between α, β and γ	$\alpha = \dfrac{\beta}{2} = \dfrac{\gamma}{3}$
Measurement of Temperature	$\dfrac{C}{100} = \dfrac{F - 32}{180} = \dfrac{K - 273}{80}$
Construction of Thermometer If length of mercury column at 0° and 100° are l_0 *and* l_{100} respectively and at t° the length of mercury is l_t.	$\dfrac{l_t - l_o}{t} = \dfrac{l_{100} - l_o}{100}$
Resistance Thermometer If R_0 , R_{100} *and* R_t are the resistances of a platinum wire at temperature 0°C, 100°C and unknown temperature (t°C)	$\dfrac{R_t - R_0}{t} = \dfrac{l_{100} - R_0}{100}$

Specific Heat Capacity (S) Heat capacity per gram of substance	$Q = m\,S\,\Delta T$ m = mass of substance Q = Heat Required ΔT = Change in temperature
Specific Heat capacity of water = 4.184 J/g or 1 cal/g	
Molar Specific Heat Capacity	$c = \dfrac{\Delta Q}{\mu \Delta T}$ μ = No. of moles of substance
Latent Heat m= mass of substance L = Latent Heat of Substance Q= Heat required	$Q = m\,L$
Principle of Calorimetry When a hot body is mixed with cold body,then heat lost by hot body is equal to the heat gained by cold body.	$T_{mix} = \dfrac{m_1 c_1 T_1 + m_2 c_2 T_2}{m_1 c_1 + m_2 c_2}$

Transmission of Heat

Thermal Conductivity K = coefficient of thermal conductivity A = area of crossection l = length of rod t = time $\Delta\theta$ = temperature difference between the end of the rod	$Q = \dfrac{KA\Delta\theta t}{l}$

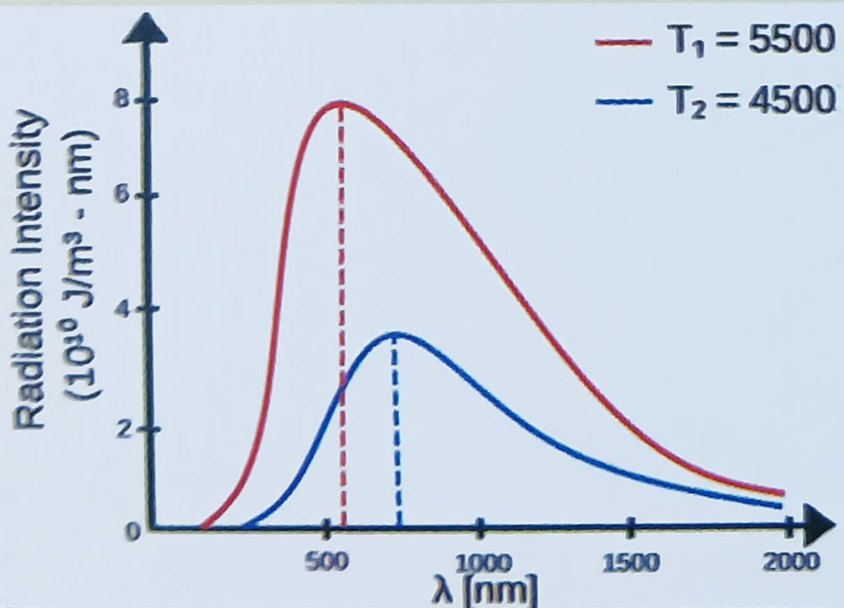
Thermal Resisitance	$R = \frac{l}{KA}$
Newton's Law of Cooling The rate of loss of liquid is directly proportional to the difference in Temp. of the liquid and its surroundings.	$-\frac{dT}{dt} \propto (T - T_0)$

Radiations

Wein's Displacement Law Wavelength corresponding to maximum emission decreases with increasing temperature	$\lambda_m T = \text{constant}\ (b)$ λ_m = wavelength corresponding to which max energy is radiated T = Absolute temperature b = Wein's constant = 2.898×10^{-3} mK

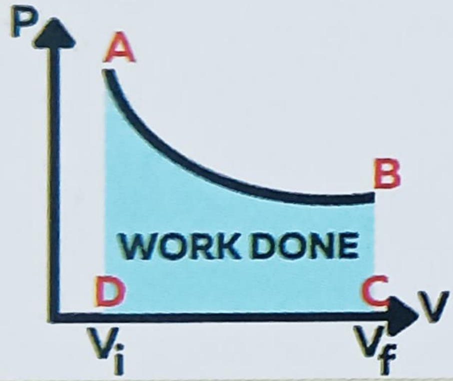
Stefan's Law	σ =Stefan's constant = $5.735 \times 10^{-8}\ Wm^{-2}\ K^{-4}$	$E \propto T^4$ $E = \sigma T^4$

Energy radiated by whole body in *t* time	$E = \sigma At\ T^4$



Thermodynamics

Work done by a thermodynamic system



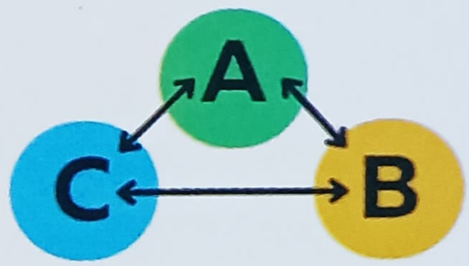
$$W = p \times \Delta V$$

Work done in process A-B

$$W = \int_{V_i}^{V_F} p\Delta V = \text{Area } ABCDA$$

Zeroth Law of Thermodynamics

According to this law, two systems in thermal equilibrium with a third system separately, are also in thermal equilibrium with each other.



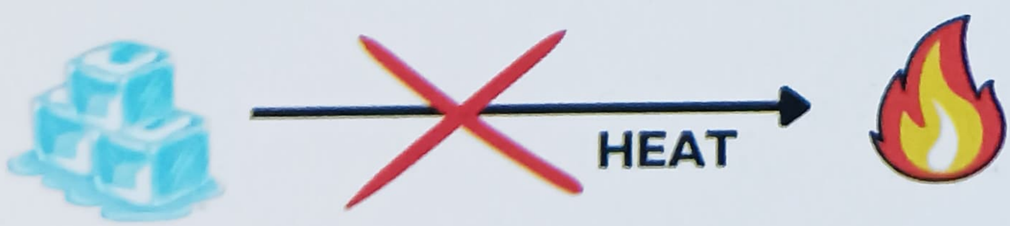
First Law of Thermodynamics

Heat given to a thermodynamic system (ΔQ) is partially utilised in doing work (ΔW) against the surrounding and the remaining part increases the internal energy (ΔU) of the system.

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

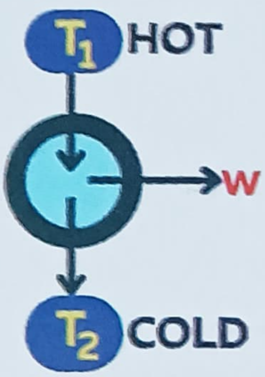
Second Law of Thermodynamics

It is impossible to transfer heat from a lower temperature body to a higher temperature bodywithout use of an external agency.



Entropy (Randomness)	$$dS = \frac{dQ_{rev}}{T}$$
Entropy At Constant Temp and Pressure or During a Phase Change L = Latent heat	$$dS = \frac{dQ_p}{T} = \frac{dH}{T} = \frac{mL}{T}$$

Heat engine



Thermal efficiency of a heat engine is given by

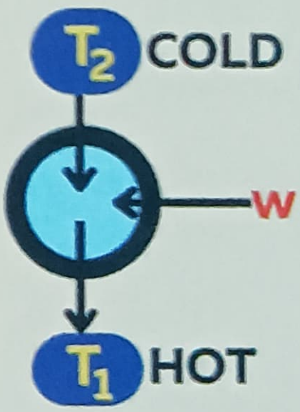
$$\eta = \frac{\textit{Work done}}{\textit{Total amount of heat absorved}}$$

$$\eta = 1 - \frac{Q_2}{Q_1} = 1 - \frac{T_2}{T_1}$$

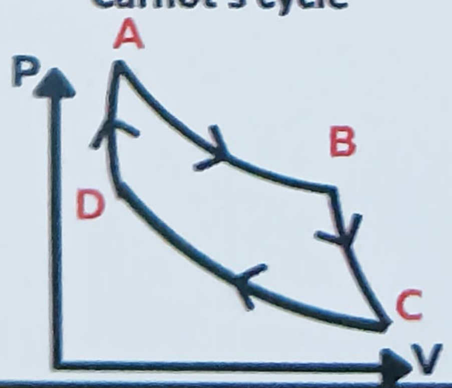
Refrigerator

$$\beta = \frac{Q_2}{W} = \frac{Q_2}{Q_1 - Q_2} = \frac{T_2}{T_1 - T_2}$$

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



Carnot's cycle



$$\frac{Q_2}{Q_1} = \frac{T_2}{T_1}$$

Efficiency,

$$\eta = 1 - \frac{T_2}{T_1}$$

Expansions

AB : Isothermal

BC : Adiabatic

Compressions

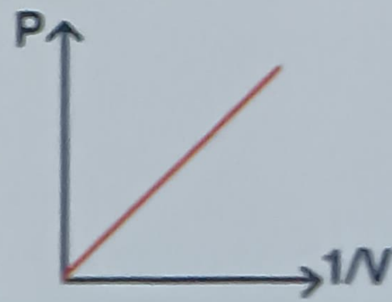
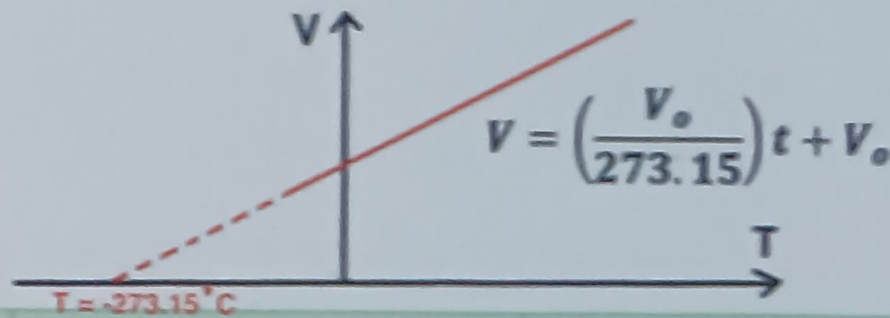
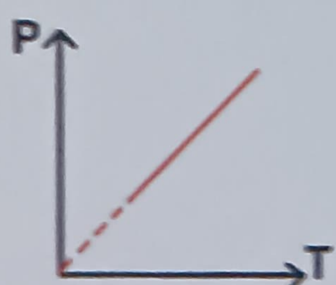
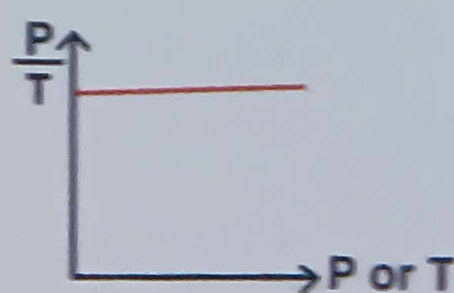
CD : Isothermal

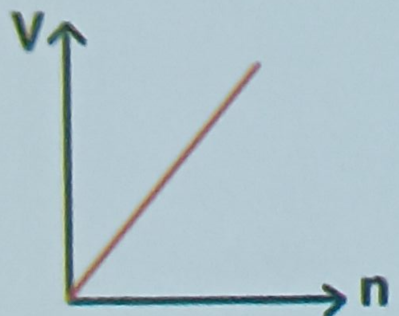
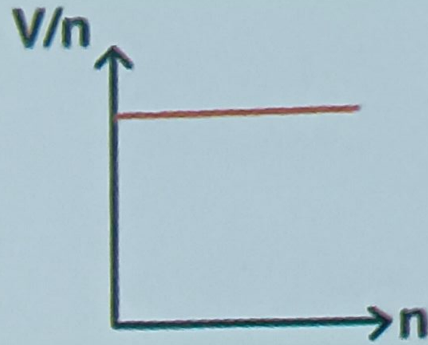
DA : Adiabatic

NEET 2023 PYQ'S (Chapter 9-11)

- The amount of energy required to form a soap bubble of radius 2 cm from a soap solution is nearly: **3.01×10^{-4} J**
- The venturi-meter works on : **Bernoulli's Principle**
- Let a wire be suspended from the ceiling (rigid support) and stretched by a weight Wattached at its free end. The longitudinal stress at any point of cross-sectional area A of the wire is : **W/A**
- A Carnot engine has an efficiency of 50% when its source is at a temperature 327∘C. The temp. of the sink is **27°C**

Gaseous State

Boyle's law	$P \propto \frac{1}{V}$	$P_1V_1 = P_2V_2$
Graphs		
Charles law	$V \propto T$	$\frac{V_1}{T_1} = \frac{V_2}{T_2}$
Graphs		
Gay Lussac's Law	$P \propto T$	$\frac{P_1}{T_1} = \frac{P_2}{T_2}$
Graphs		

Avogadro's Law	$V \propto n$	$\frac{V_1}{n_1} = \frac{V_2}{n_2}$
Graphs		

Ideal Gas Equation

Ideal Gas equation	$PV = nRT$
Combined Gas Law	$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$
Density relation	$PM = dRT$

Dalton's Law of Partial pressure

For a mixture of a gases	$P_{Total} = p_1 + p_2 + p_3 + \cdots$ $p = partial\ pressures$
Relation between p & $Mole\ Fraction$	$p = x \times P_{Total}$

Graham's Law of Diffusion

At Constant T & P If, $r = Rate\ of\ Diffusion of\ a\ gas$ $d = Density\ of\ gas$ $M = Molecular\ Mass$	$\frac{r_1}{r_2} = \sqrt{\frac{d_2}{d_1}} = \sqrt{\frac{M_2}{M_1}}$