THERMAL MATTER

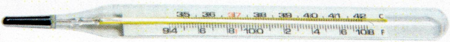
Thermal Expansion

Linear Expansion	Areal Expansion	Volume Expansion
$\alpha = \frac{\Delta l}{l \Delta T}$	$\beta = \frac{\Delta A}{A \Delta T}$	$\gamma = \frac{\Delta V}{V \Delta T}$
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	$\alpha = \frac{\beta}{2} = \frac{\gamma}{3}$
Measurement of Temperature	$\frac{C}{100} = \frac{F - 32}{180} = \frac{K - 273}{80}$

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 Lt	$\frac{l_t - l_0}{t} = \frac{l_{100} - l_0}{100}$



Specific Heat Capacity (S)

Heat capacity per gram of substance	$Q = mS\Delta T$ m=mass of substance Q=Heat Required ΔT=Change in temperature
Specific Heat capacity of water	4.184 J/g°c or 1 cal/g°c
Molar Specific Heat Capacity	$c = \frac{\Delta Q}{\mu \Delta T}$ μ=No. of moles of substance

Latent Heat

m=mass of substance L=Latent Heat of Substance Q=Heat required	$Q = mL$

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

$$T_{mix} = \frac{m_1 c_1 T_1 + m_2 c_2 T_2}{m_1 c_1 + m_2 c_2}$$

Transmission of Heat

Thermal Conductivity K=coefficient of thermal conductivity A=area of cross-section l=length of rod, t=time $\Delta\theta$=temperature difference b/w the end of the rod	$Q = \frac{KA\Delta\theta t}{l}$

Ideal Gas Equation

$PV = nRT$

Measurement of Temperature

Freezing point of water	Boiling point of water
0°C	100°C
32°F	212°F
273K	373K

$$\frac{T - T_{FP}}{T_{BP} - T_{FP}}$$

$$\frac{\text{Reading on scale} - \text{Lower fixed point}}{\text{Higher fixed point} - \text{Lower fixed point}} = \text{constant}$$

Specific Heat Capacity

$S_{water} = 1 cal/gC^{\circ}$

$S_{ice} = \frac{1}{2} cal/gC^{\circ}$

$S_{steam} = \frac{1}{2} cal/gC^{\circ}$

1 cal = 4.2 J

High specific heat capacity → Good Coolant

Latent Heat

$L_{fusion} = \text{solid} \leftrightarrow \text{liquid} = 80\ cal/g$

$L_{vap} = \text{liquid} \leftrightarrow \text{gas} = 540\ cal/g$

Thermal Stress

$\sigma = Y\alpha\Delta T$

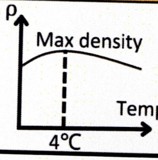
(σ=0, for freely expanding rod

Reading of scale

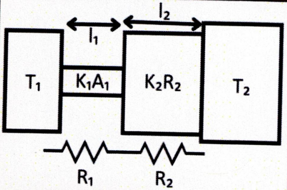
True lenght = Reading $[1 + (\alpha_s - \alpha_r)\Delta T]$

α_s = Thermal coefficient of linear expansion of scale

α_r = Thermal coefficient of linear expansion of rod

Anomolous behaviour of water	
Thermal gradient	$\Delta T/l$

Current in series



Here, $R_{eq} = R_1 + R_2$

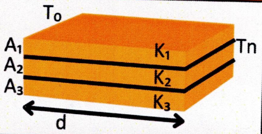
$$= \frac{l_1}{K_1A_1} + \frac{l_2}{K_1A_1}$$

Then,

$$I = \frac{T_1 - T_2}{R_{eq}}$$

Rate of heat loss	$\sigma eA(T^4 - T_0^4)$ where, e=emissivity $0<e\leq 1$
Emissive Power	$E = \dfrac{\text{Energy}}{\text{Area} \times \text{Time}}$
Variation of specific heat capacity of water with temperature	

Variation of time period of pendulum clocks	
Gain/Loss in time duration 't'	$\Delta t = \frac{1}{2}\alpha\Delta\theta . t$
$\Delta\theta=\theta-\theta_0$ θ_0=original temperature at time period T θ=increased temperature at time period T	
Cases $\theta<\theta_0$ T'>T • Clock becomes fast & gain time	$\theta>\theta_0$ T'>T • Clock becomes slow & loose time
Specific Heat & water equivalent	W=mS

Current in parallel	
	$I = \frac{(T_0 - T_n)(K_1A_1 + K_2A_2 + K_3A_3)}{d}$
Absorptive power	$a = \frac{\text{Energy absorbed}}{\text{Energy incident}}$
Spectral Emission Power	$E = \int_0^\infty E_\lambda d\lambda$