THERMAL PROP OF MATTER

classmate
Date
Page

(I) TEMP. SCALES :

↪ $\dfrac{T - T_{ice\ pt.}}{T_{steam\ pt} - T_{ice\ pt}}$ = same for all scale
(u can put P/R in place of T ~~pres.~~ resistance)

↪ $\Rightarrow \dfrac{C-0}{100-0} = \dfrac{K-273}{373-273} = \dfrac{F-32}{212-32}$

$\Rightarrow K = C + 273$

$$\boxed{\frac{C}{5} = \frac{F-32}{9}}$$

↪ $\Delta T\ (\text{in } ^\circ C) = \Delta T\ (\text{in } K)$

$\Delta T\ (\text{in } ^\circ C) = \frac{5}{9} \Delta T\ (\text{in } F)$

(II) THERMAL EXPANSION IN SOLID

As temp↑, distance b/w any two points on solid always incs.

- Linear expansion :

↪ $\Delta L = \alpha L_0 \Delta T$ $(L' = L + \Delta L)$

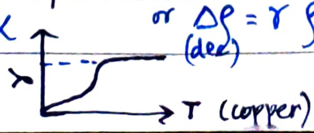
$\alpha \rightarrow$ coefficient of linear expansⁿ
unit = K^{-1}, $^\circ C^{-1}$

↪ Temp↑ ⇒ length ↑
∴ pendulum ka time period ↑
∴ strain $\left(\frac{\Delta l}{l}\right)$ produced.
$\left(\frac{F}{A}\right)$ Thermal stress = $Y \alpha \Delta T$

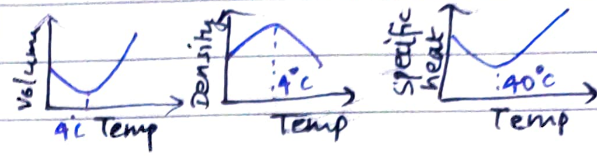
- Area expansion $\Delta A = \beta A_0 \Delta T$
$\beta = 2\alpha$ coeff. of areal expansⁿ

- Volume expansion (inc) $\Delta V = \gamma V_0 \Delta T$
$\gamma = 3\alpha$ or (dec) $\Delta \rho = \gamma \rho_0 \Delta T$

const only at high temp.



anomalous behaviour of water : when temp ↑ ⇒ Vol. first dec, then inc after (4°C)



> coefficient of volume expansion
for liq → temp independent (const)
for gas → depend on temp $\left(\gamma \propto \frac{1}{T}\right)$

$\gamma = \alpha_V = \frac{dV}{V}$

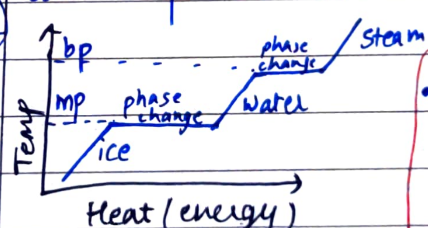
we know for ideal gas $\frac{\Delta V}{V} = \frac{\Delta T}{T} \Rightarrow \alpha_V = \frac{1}{T}$

(III) CALORIMETRY

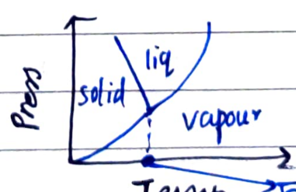
$\boxed{Q = mc\Delta T}$
Heat (absorbed/released) — specific heat capacity

SHC water
= 1 calorie/g°c
= 4.2 J/g°c
= 4200 J/kg°C
ice = ½ cal/g°C

state change at const temp mein heat $\boxed{Q = mL}$



latent heat :
- fusion/melting
= 80 cal/g
= 335 J/g
- vaporisatⁿ/steam
= 540 cal/g
= 225 J/g



Triple point of water = 0.01°c

(IV) HEAT TRANSFER

Modes of heat transfer :
1) Conductⁿ → molecule vibrate → transfer heat.
2) Convectⁿ → Fluid layer niche se upar
3) Radiatⁿ → EMW → no medium.

- Rate of heat transfer / Heat current (H)

$$\boxed{H = \frac{KA\Delta T}{l}}$$

- Amount of heat transferred $\boxed{Q = Ht}$

- Thermal resistance $\boxed{R_{th} = \frac{1}{K}\frac{l}{A}}$

- $\Delta V \approx \Delta T$

- Series : $(R_e H = \Delta T)$

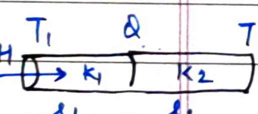
↳ $H_1 = H_2 = H$ (current same)

↳ $R_e = R_1 + R_2$ (R ka ulta)

↳ $\Rightarrow \frac{l_1 + l_2}{K_e} = \frac{l_1}{K_1} + \frac{l_2}{K_2}$ (Area same)

If $l_1 = l_2 = l$

$\Rightarrow \boxed{K_e = \frac{2K_1K_2}{K_1 + K_2}}$



↳ Junctⁿ temp $\frac{T_1 - \theta}{R_1} = \frac{\theta - T_2}{R_2}$

- Parallel

$H = H_1 + H_2$ $\frac{1}{R_e} = \frac{1}{R_1} + \frac{1}{R_2}$

$R \propto \frac{1}{KA}$ $\Rightarrow K_e(A_1 + A_2) = K_1A_1 + K_2A_2$

If A same $\Rightarrow \boxed{K_e = \frac{K_1 + K_2}{2}}$

RADIATION

- All body emit as well as absorb radiatⁿ at all temp.
- Amount of emission / absorbtn depend on temp & material.

Kirchhof law → good emitter are good absorber

Emission Power (E): Heat radiatⁿ emitted per unit area of body per unit time

$E = \frac{Q}{At}$ depend on temp, wavelength of radiatⁿ

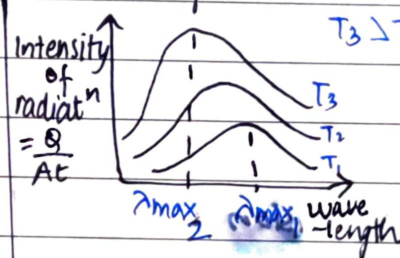
Absorbtive power (a) = $\frac{\text{Heat absorbed}}{\text{Heat incident}}$

Unitless.

Black body → Kissi bhi wavelength ki radiatⁿ ko absorb kr leti h at any temp

→ No one can emit radiatⁿ more than black body at that given temp.

Wien displacement law :→ Black body



$T_3 > T_1$

As temp ↑ radiatⁿ ↑ ⇒ Area ↑ under graph

$\boxed{\lambda_{max} \propto \frac{1}{T}}$ (in kelvin)

wavelength of radiatⁿ which has max. intensity / emissive power

$\boxed{\lambda_{max} T = b}$

wien's const

$\boxed{b = 2.8 \times 10^3 \text{ mK}}$

$\boxed{\approx 3 \times 10^3}$

Stefan's boltzman law

Intensity of Radiat^n $\left(\frac{Q}{At}\right)$ / $\propto T^4 \propto \frac{1}{\lambda_{max}^4}$

Rate of radiat^n (Power) $\left(\frac{Q}{t}\right)$

$\boxed{I = \sigma T^4}$

$\boxed{Q = \sigma A T^4 t}$ $\quad$ $\boxed{P = \sigma A T^4}$ $\Rightarrow P = \sigma A \frac{b^4}{\lambda_m^4}$

for body not black body $\quad P = e\sigma A T^4$

$\because e < 1 \Rightarrow P_{black\ body} > P_{other}$

Stefan's const $\boxed{\sigma = 6 \times 10^{-8}\ W/m^2K^4}$

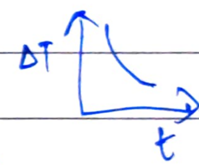
When surrounding temp is given

Power radiated $= \sigma A T^4$ $\qquad$ T $\quad$ T_0

Power absorbed $= \sigma A T_0^4$

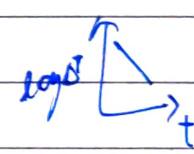
$\therefore$ Net power radiated $= \sigma A (T^4 - T_0^4)$

Newton's law of cooling :



- Rate of cooling $\propto$ ΔTemp b/w body & surrounding

$\frac{dT}{dt} = K(T - T_0)$ $\qquad$ $\boxed{\frac{T_1 - T_2}{t} = K\left[\frac{T_1 + T_2}{2} - T_0\right]}$



- Rate of cooling decreases with time.