Calorimetry, Thermal expansion and conduction

① calorimetry

$1\,cal = 4.2\,J$ (mechanical eq. of heat)

① $\Delta Q = ms\Delta T$. (only temp. changes)

$\Delta Q = mL_F$ (solid to liquid state change)

$\Delta Q = mL_v$ (liquid to gas state change)

② $S_{water} = 1 \frac{cal}{gm^\circ c} = \frac{4.2\,J}{gm^\circ c} = 4200\,J/kg^\circ c$

$S_{ice} = \frac{1}{2} \frac{cal}{gm^\circ c} = 2.1\,J/gm^\circ c = 2100\,J/kg^\circ c$

$S_{steam} = \frac{1}{2}\,cal/gm^\circ c = 2.1\,J/gm^\circ c = 2100\,J/kg^\circ c$

③ $\boxed{\Delta Q = \int_{T_1}^{T_2} ms\,dT}$

④ $L_{ice} = 80\,cal/gm$ or $80 \times 4.2\,J/gm$

$L_{steam} = 540\,cal/gm = 540 \times 4.2\,J/gm$

⑤ If heat is supplied at const. Rate

$\boxed{Power = \frac{\Delta Q}{\Delta t} = const}$

⑥ simple trick to find out equilibrium temp, when bodies at diff. temp are mixed without changing state

$\boxed{T_{eq} = \frac{\Sigma ms T}{\Sigma ms}} = \boxed{\frac{\Sigma HT}{\Sigma H}}$

⑦ Heat capacity (H)

$\boxed{H = ms}$

⑧ water equivalent

$\boxed{m_{body} \times S_{body} = m_{eq} \times S_{eq}}$

$S_{eq} \rightarrow 1\,cal/g^\circ c$

$m_{eq} \rightarrow$ water eq. mass

⑨ Ice-water system

⑩ Ice-steam system

$\rightarrow$ refer notebook

⑪ conversion of mechanical to Heat energy

① potential energy to heat energy $\boxed{U = mgh \times 4200}$ (kg)

② K.E —"— K.E = $Q_{melting} = \frac{1}{2} mv^2 \times 4200$ kg

① P.E to Heat Energy : $mgh = m'L \times 4200$ (kg)

② K.E to —"— : $\frac{1}{2}mv^2 = m'L \times 4200$ (kg)

joule

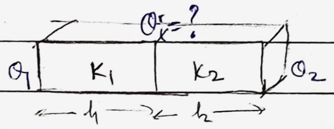
CH-2 : Heat transfer

① In steady state rate of flow of Heat energy,

$\boxed{\frac{\Delta Q}{\Delta t} = \frac{kA\Delta\theta}{l}}$

$\Delta\theta \rightarrow$ temp. diff.

② temp. of interference of composite bar.



use milliman's theorem $\boxed{\theta_i = \frac{\Sigma \theta/R}{\Sigma 1/R}}$

Radiation

① Intensity $\propto 1/d^2$

② $Q = Q_a + Q_r + Q_t$

③ $\boxed{1 = a + r + t}$

a = Absorptive power or Absorptance

r = reflectance or reflecting power

t = transmittance or transmitting power

④ perfectly black body $\boxed{a = 1,\ r = 0,\ t = 0}$

⑤ Emissive power (E) (Intensity)

$\boxed{E = \frac{\Delta Q_{radiated}}{\Delta t \times A}}$ watt/m²

⑥ Prevost theory of Heat exchange

$\boxed{\frac{E_1}{a_1} = \frac{E_2}{a_2} = \frac{E_3}{a_3}}$ all are in thermal eqm with each other.

⑦ Kirchoff's law

$\boxed{\left(\frac{E}{a}\right)_{Gen\ body} = E_{black\ body}}$

⑧ stefan's law

$\boxed{E_{blackbody} = \sigma T^4 = \frac{\Delta Q}{\Delta t \cdot A}}$ or $\boxed{\sigma(T^4 - T_0^4)}$

$\boxed{E_{Gen\ body} = \boxed{e\sigma T^4} = \frac{\Delta Q}{\Delta t A}}$

$e \rightarrow$ emissivity

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

$$\boxed{\Delta Q = ms\Delta\theta}$$

⑨ For general body

$$\boxed{\text{emissivity } (e) = \frac{\text{energy radiated by Gen. body}}{\text{energy radiated by ideal Black body}}}$$

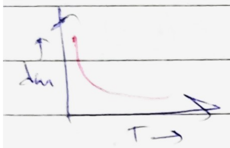
⑩ rate of cooling

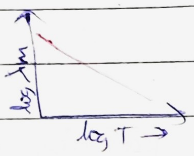
$$\boxed{\frac{\Delta\theta}{\Delta t} = \frac{e\sigma A}{ms}\left(T^4 - T_0^4\right)}$$

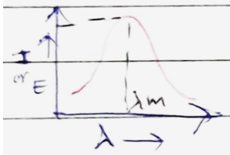
⑪ Wien's law

$$\boxed{\lambda_m = b/\text{Temp}}$$

$b = 3\times10^{-3}$ or 2.93×10^{-3} K-m







⑫ Newton's law of cooling.

$$\frac{\Delta\theta}{\Delta t} = \frac{e\sigma A}{ms}\left(T^4 - T_0^4\right)$$

simple method (Av. tech. method)

$$\boxed{\left(\frac{\theta_2-\theta_1}{\Delta t}\right) = -K\left[\left(\frac{\theta_1+\theta_2}{2}\right)-\theta_0\right]}$$

$\Delta\theta$ = change in temp. of body in time Δt.

θ = average temp. of body.

θ_0 = surrounding temp

$$\boxed{\frac{\Delta\theta}{\Delta t} = -K\left(\overset{\text{av. temp}}{\theta} - \theta_0\right)}$$

~~not~~ ~~only~~ for graphs

$$\Delta\theta_f = \Delta\theta_1 e^{-Kt}$$

⑬ Solar const

$$\boxed{S = 2\,\frac{\text{cal}}{\text{cm}^2\text{-min}} = 1.4\,\frac{\text{kW}}{\text{m}^2}}$$