Calorimetry

① Amount of heat exchanged (dQ or ΔQ) can cause temperature change and state change in a substance.

② <u>During temp. change:</u> $\boxed{dQ = msdT}$

where s = specific heat capacity of subs.
(in J/kg°C or J/kgK or Cal/kg°C) etc.

③ <u>During phase (or state) change:</u>

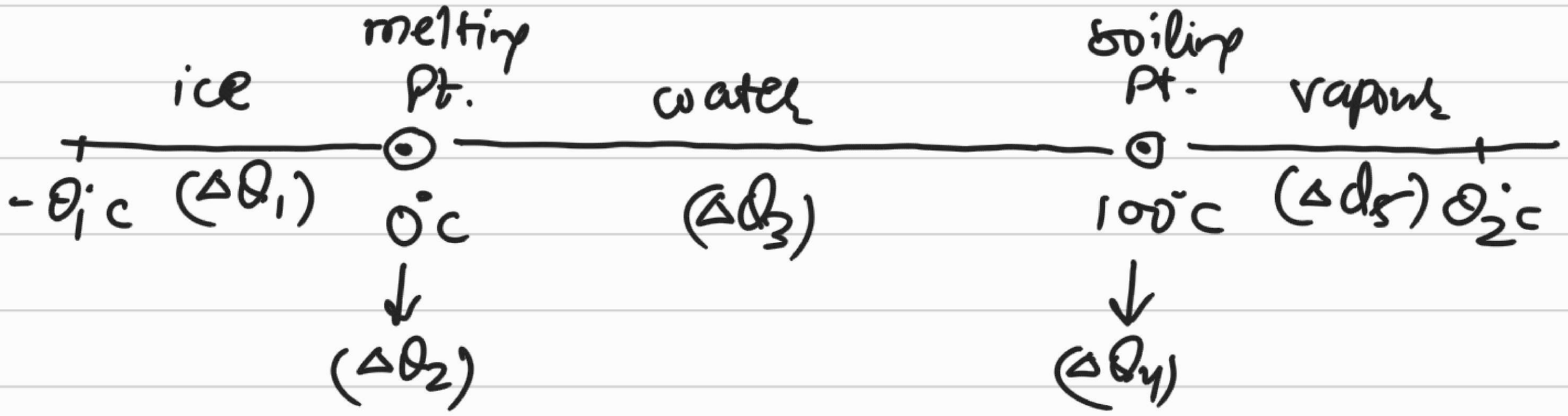
$\boxed{dQ = mL}$ where L = Latent heat (in J/kg or Cal/kg)

④ <u>Law of calorimetry</u>:

When two or more substances at diff. temperatures are mixed with each other then (provided no energy lost to surroundings),

$\boxed{\text{the amount of heat taken} = \text{Amount of heat given}}$

⑤ Since water is generally used, so for water:



Let ice at $-\theta_1^\circ C$ converts to steam at $\theta_2^\circ C$

$\therefore$ Heat required $= \Delta Q_1 + \Delta Q_2 + \Delta Q_3 + Q_4 + \Delta Q_5$

$\rightarrow \Delta Q_1 = m s_{ice}(0 - (-\theta_1^\circ C)) = m s_{ice} \theta_1$

$\rightarrow \Delta Q_2 = m L_f \Rightarrow$ ice to water at $0^\circ C$

L_f = Latent heat of fusion.

$\rightarrow \Delta Q_3 = m s_w (100 - 0^\circ C) = m s_w (100)$.

$\rightarrow \Delta Q_4 = m L_v \Rightarrow$ water to steam at $100^\circ C$

L_v = Latent heat of vaporisation.

$\rightarrow \Delta Q_5 = m s_w (\theta_2 - 0^\circ C) = m s_w \theta_2$

⑥. For water:

$\cdot s_w = 1 \text{ cal/gm-}^\circ C = 1 \text{ kcal/kg-}^\circ C = 4.2 \text{ J/gm-}^\circ C$

$[1 \text{ cal} \approx 4.2 \text{ J}]$

- $S_{ice} \approx S_{vapour} \approx \frac{1}{2} S_w = 0.5 \text{ cal/gm}^\circ\text{c}$

$= 2.1 \text{ J/gm}^\circ\text{c}$

- $L_f = 80 \text{ cal/gm} = 80 \text{ kcal/kg}$

- $L_v = 540 \text{ cal/gm} = 540 \text{ kcal/kg}$

⑦. Heat capacity $(C) = ms = \frac{dQ}{dT}$ or $\frac{\Delta Q}{\Delta T}$

Unit: J/°c or J/K

⑧. <u>Water equivalent of a substance</u> :

$\Delta Q = m S \Delta T = m_w S_w \Delta T$

$\therefore \quad ms = m_w S_w \Rightarrow \boxed{m_w = \frac{ms}{S_w}}$

<u>ie</u>. The mass (m_w) of water when given equal amount of heat as substance results in same amount of temp rise.

[Used for temp. range $(0^\circ c \leq \theta \leq 100^\circ c)$]

(9). Mechanical equivalent of heat (J) :

$$W = JH$$

W → work in Joules

H → Heat in calories

$$J = 4.186 \text{ J/cal} \simeq 4.2 \text{ J/cal}.$$

(10). When different substances are mixed : Heat exchange continues till equilibrium.

Heat given	Heat taken

(i) Final temp. should be same on both sides.

(ii) Amount of heat should be equal.

Cal Questions :

Q① 1 kg steam at 200°C gets converted to ice at −20°C. Find amount of Heat released in Kcal.

Q2. Equal masses of three different liquids A, B & C are given at temp. 40°C, 20°C and 10°C respectively.

Temp. on mixing A and B is 30°C.

Temp. on mixing B and C is 16°C.

Find equilibrium temp. on mixing A & C.

Q3. Find equilibrium temp. and mixture composition on mixing

(a) 1gm ice at -40°C with 4gm steam at 200°C.

(b) 5gm ice at -40°C with 3gm water at 60°C.

(c) 1 kg ice at -20°c with 1 kg steam at 200°C.

Q(4). 10gm ice at 0C is kept in calorimeter of water equivalent 10gm. How much heat (in cal) should be supplied to evaporate the water formed?

Q5: Heat is being supplied at const. rate to a sphere of ice melting at 0.1 gm/sec. It melts completely in 100 sec. Rate of temp. rise thereafter will be: (in °C/sec)

Hint: $\left[\frac{dQ}{dt} = ms\frac{dT}{dt} = \Delta T\, s\frac{dm}{dt}\right]$

& $\left[\frac{dQ}{dt} = L\frac{dm}{dt}\right]$

Q6. 2100 W continuous flow geyser has water inlet at 10°C while water flows out through outlet at 20 gm/sec. Find outlet temperature.

THERMAL EXPANSION

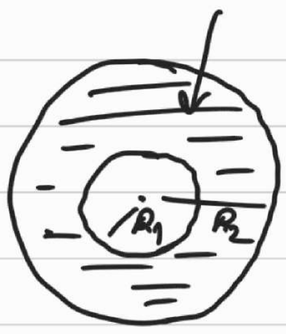
(1). In this chapter we are studying about substances having expansion on providing heat to them ex: metals.

(2). On providing heat to material, since Amplitude of vibration also increases in small amount along with temp. rise, so molecular separations increase by small amounts leading to thermal expansion.

(3). Distance between any two particles increases in given thermally expandable substance (on providing heat to it)

α, β, γ : +ve → expansion, −ve → contract on providing heat

Q① Metal disc with hole as shown:



On providing heat to it:

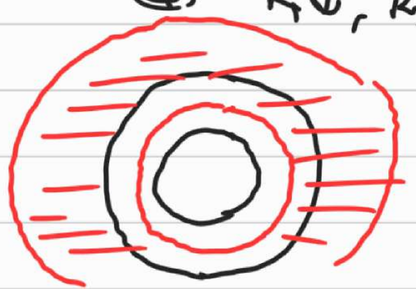
(A) $R_1 \uparrow$, $R_2 \uparrow$, $(R_2 - R_1) \downarrow$

(B) $R_1 \downarrow$, $R_2 \uparrow$, $(R_2 - R_1) \uparrow$

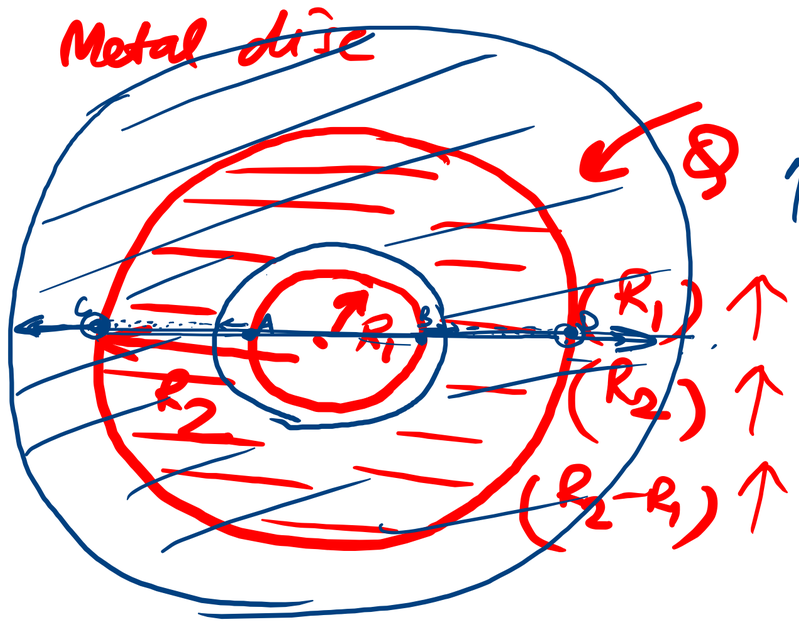
(C) $R_1 \uparrow$, $R_2 \uparrow$, $(R_2 - R_1) \uparrow$

(D) $R_1 \downarrow$, $R_2 \downarrow$, $(R_2 - R_1) \uparrow$

Ans: (C).



exp. is more in larger distance particles.



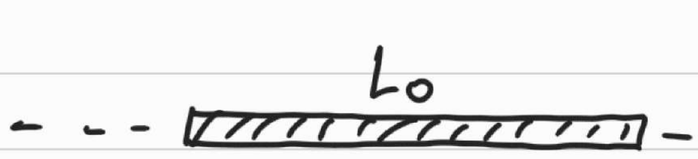
(2) :



On providing Heat to this sheet.

Soln: $R_1 \uparrow,\ R_2 \uparrow,\ d \uparrow$

(4). Linear expansion in solids :



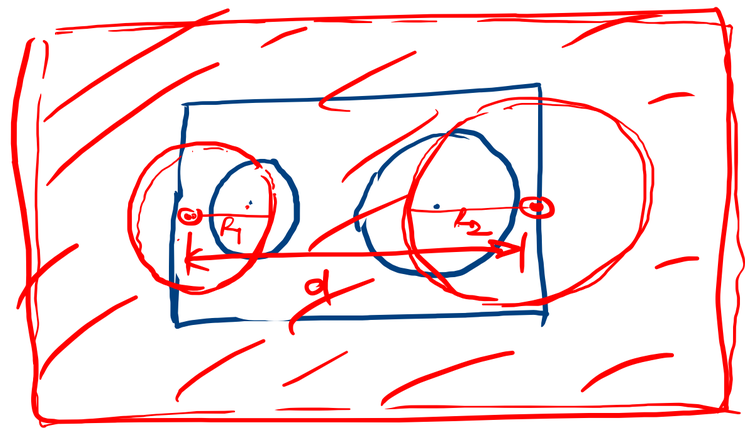
Experimentally : $\frac{dL}{L} \propto dT$

ie $\frac{dL}{L} = \alpha\, dT \Rightarrow \int_{L_i}^{L_f} \frac{dL}{L} = \int_{T_i}^{T_f} \alpha\, dT$

α → Linear exp. coefficient

$$\ln\left(\frac{L_f}{L_i}\right) = \int_{T_i}^{T_f} \alpha\, dT \Rightarrow L_f = L_i\, e^{\int_{T_i}^{T_f} \alpha\, dT}$$

- For general temp differences, α has negligible change.. (ΔT ranges of upto 500°C - 1000°C)



$$\alpha = \frac{dL}{L\, dT}$$

$$\frac{L_f}{L_i} = e^{\int \alpha\, dT}$$

$$\therefore \quad L_f = L_i e^{\alpha \int dT}$$

$$\boxed{L_f = L_i e^{\alpha \Delta T}}$$

$e^x \approx (1+x)$

Now, for $\alpha \Delta T << 1 \Rightarrow e^{\alpha \Delta T} \approx (1+\alpha \Delta T)$

$(\because \; e^x \approx (1+x)$ for $x << 1)$

Hence finally: $\boxed{L_f = L_i (1+\alpha \Delta T)}$ ★★

Provided $\alpha \Delta T << 1$

So, $L_f = L_i + L_i(\alpha \Delta T)$

$L_f - L_i = \Delta L = L_i(\alpha \Delta T)$

$\boxed{\frac{\Delta L}{L_i} = \alpha \Delta T} \Rightarrow \frac{\Delta L}{L_i} \propto \Delta T$

Applicable for small length slice in given thin solid rod.

⑤. For area or superficial expansion of surfaces :

$$\frac{\Delta A}{A_i} = \beta \Delta T \quad ; \text{where } \beta = \text{Coeff. of Area expansion.}$$

$$A_f - A_i = A_i \beta \Delta T$$

$$\boxed{A_f = A_i (1 + \beta \Delta T)}$$

⑥ For Volume expansion (S, L, G) :

$$\frac{\Delta V}{V_i} = \gamma \Delta T \quad ; \gamma = \text{Coeff of volume expansion.}$$

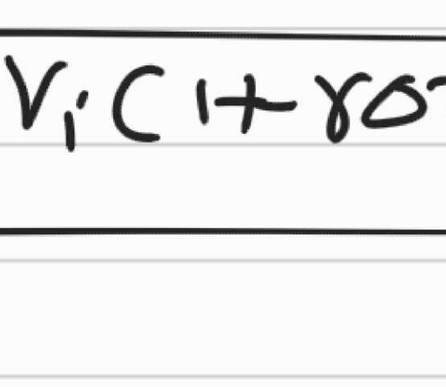
$$V_f - V_i = V_i \cdot \gamma \Delta T \Rightarrow \boxed{V_f = V_i (1 + \gamma \Delta T)}$$

⑦. For isotropic solids : (Having symmetric construction and same uniform material)

Ex. Cube :

$$\beta \approx 2\alpha$$

$$\gamma \approx 3\alpha$$



*

$\rightarrow l_f = l(1 + \alpha \Delta T)$

$\rightarrow A_f = A(1 + \beta \Delta T) = l^2 (1 + \beta \Delta T)$

$l_f^2 = l^2 (1 + \beta \Delta T) \Rightarrow \cancel{l^2} (1 + \alpha \Delta T)^2 = \cancel{l^2} (1 + \beta \Delta T)$

$$\approx (1+2\alpha\Delta T) = (1+\beta\Delta T) \Rightarrow \boxed{\beta \approx 2\alpha}$$

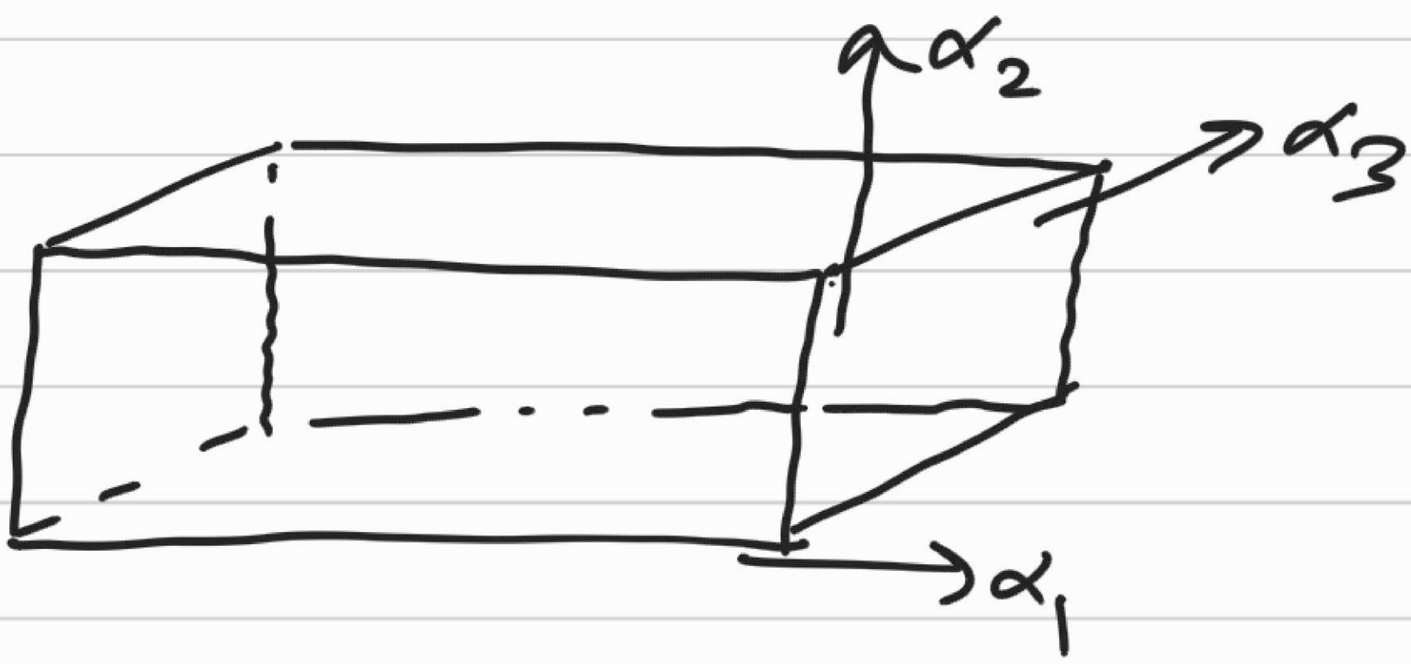
(Binomial th.)

* $V_f = V(1+\gamma\Delta T) \Rightarrow \ell_f^3 = \ell^3(1+\gamma\Delta T)$

$$\ell^3(1+\alpha\Delta T)^3 = \ell^3(1+\gamma\Delta T)$$

$$\approx (1+3\alpha\Delta T) = (1+\gamma\Delta T) \Rightarrow \boxed{\gamma \approx 3\alpha}$$

⑧ For non isotropic materials such as: (made of same material)



$\beta \approx (\alpha_1+\alpha_2)$ or $(\alpha_2+\alpha_3)$ or $(\alpha_2+\alpha_1)$

$\gamma \approx (\alpha_1+\alpha_2+\alpha_3)$

Q(7): 1 kg ice at $-10^{\circ}C$ is mixed with 4.4 kg water at $30^{\circ}C$. Find final temp. of mixture.

Ans: $8.2^{\circ}C = \left(\frac{47}{5.4}\right)^{\circ}C$

Soln:

Heat Given	Heat taken
$4.4 \times 1 \times (30 - T)$	$1 \times \frac{1}{2} \times 10$ (ice (-10°C) to ice (0°C))
	$+ 1 \times 80$ (ice - water)
	$+ 1 \times 1 \times (T - 0)$ (water 0 to T°C)

$\therefore \quad \Delta Q_1 = \Delta Q_2$

$\therefore \quad 4.4(30 - T) = 5 + 80 + T$

$132 - 4.4T = 85 + T$

$5.4T = 47$

$T = \frac{47}{5.4} = 8.7^{\circ}C$

Q(8): Find amount of heat supplied to decrease the volume of ice water mixture by $1 cm^3$ without temp. change.
[Given $\rho_{ice} = 0.9 \rho_w$]

Ans: 720 cal.

Soln: i) $m = \rho_{ice} V_{ice} = \rho_w V_w$

$\Rightarrow 0.9 \rho_w V_{ice} = \rho_w V_w$

$\therefore V_{ice} = \frac{V_w}{0.9}$

ii) Now volume of ice-water mixture ↓ by $1 cm^3$ due to conversion of ice to water.

ie. $V_{ice} - V_w = 1 cm^3$

$V_{ice} - 0.9 V_{ice} = 1 cm^3 \Rightarrow \boxed{V_{ice} = 10 cm^3}$

ie $10 cm^3$ of ice has melted.

$\therefore$ Heat = $\Delta Q = m_{ice} \times L_f = \rho_{ice} \times V_{ice} \times L_f$

$= 0.9 \rho_w \times 10 \times 80 = 0.9 \times 1 \times 10 \times 80$

$= 720$ cal.

$\rho_i < \rho_w$
$m = \rho V \uparrow$

$- m = \rho_i V_i = \rho_w V_w$

$0.9 \rho_w V_i = \rho_w V_w$

$\underline{0.9 V_i = V_w}$

$\rightarrow \underline{V_i} - \underline{V_w} = 1 cm^3$

$V_i - 0.9 V_i = 1 cm^3$

$\boxed{V_i = 10 cm^3}$

$\rightarrow \Delta Q = m_i L_f = \rho_i V_i \times L_f$

$= 0.9 \rho_w . V_i \times L_f$

$= 0.9 \times 1 \times 10 \times 80 =$

Q①: A continuous flow water heater has electrical power rating of 30 kw and efficiency of conversion of electricity to heat equal to 75%. If water flows in it at 200 cc/sec with an inlet temp of 8°C, then find the outlet temp.

Ans: 34.286°C (Approx)

Soln:

$$30000 \times \frac{75}{100} = (T-8)\frac{dm}{dt} \times 5 = (T-8)\rho_w \cdot \frac{dV}{dt} \times 4.2$$

$$300 \times 75 = (T-8) \times 1 \times 200 \times 4.2$$

$$(T-8) = 26.7857\ ^\circ C$$

$$T = 34.7857\ ^\circ C$$

$$m = \rho V$$

$$\frac{dm}{dt} = \rho \cdot \frac{dV}{dt}$$

Q(10). Some steam at 100°C is passed into 1.5 kg of water contained in a calorimeter of water equivalent 0.04 kg at 20°C so that temp. of calorimeter and its contents rises to 50°C. Find mass of steam condensing in gm.

Ans: 78.3 gm.

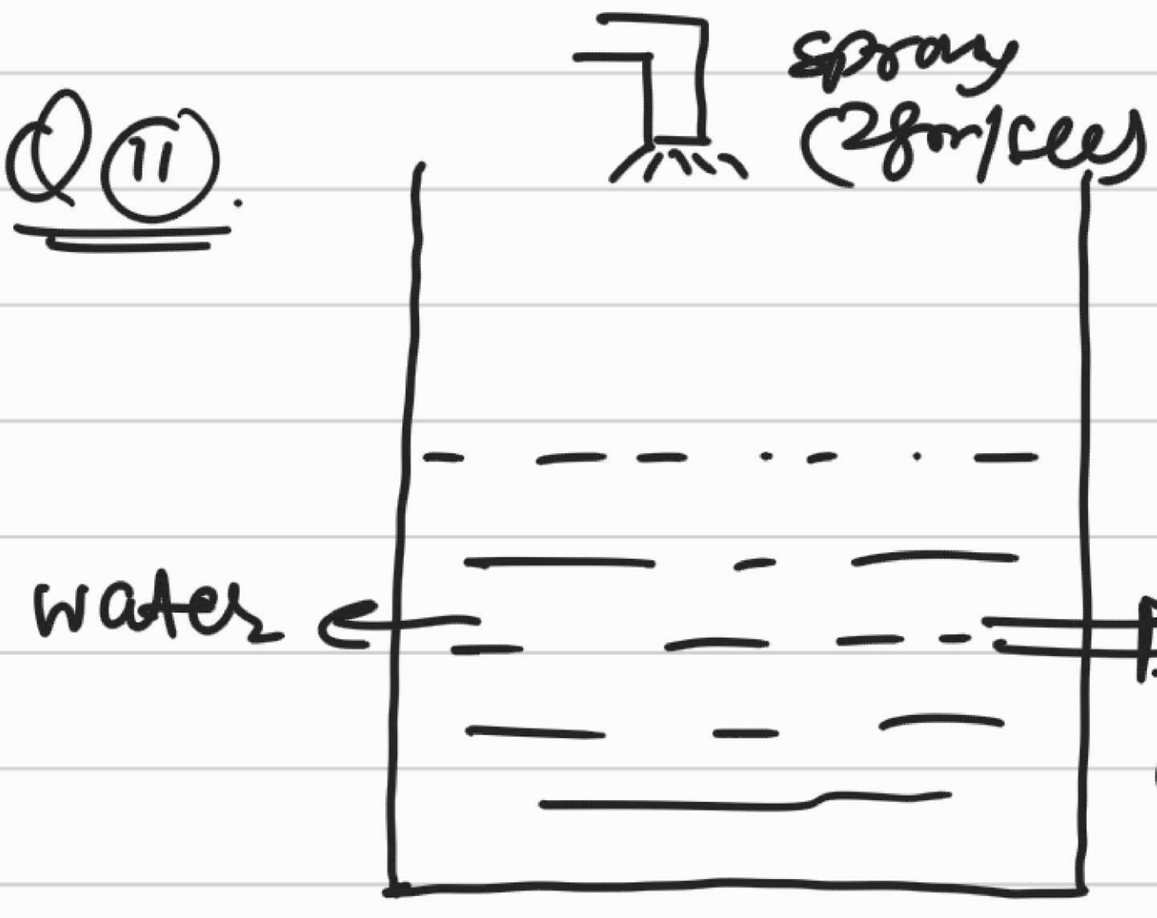
Soln:

Heat Given	Heat taken
S-W (100°C)	(W+cal → 20 to 50°C)
W: 100°C to 50°C	
$m \times 540 + m \times 1 \times (100 - 50)$	$(1.5+0.04) \times 1000 \times 1 \times (50-20)$

$m \times 590 = 1540 \times 30$

$m = 78.3$ gm

Q (11).



A container of negligible Heat capacity has 50 gm water at 0°C. If Heat H is removed per second from system, water will freeze in 10 seconds.

Now if spray is operating at 2gm/sec then it takes time t_1 seconds for water to freeze. Find t_1.

Ans: $\frac{50}{3}$ sec

Soln: (i) $H \times 10 = 50 \times 80 \Rightarrow H = 400$ cal/sec

(ii) $(50 + 2t_1) \times 80 = H \times t_1 = 400 \times t_1$

On solving: $t_1 = \frac{50}{3}$ seconds

Q(12): On heating a liquid by 90c, the extra increase in volume of liquid is $\frac{1}{50}$ of remaining liquid. Apparent γ of liquid is :

Ans: $2.22 \times 10^{-4}/^{\circ}C = \frac{1}{4500}/^{\circ}C$

Soln: $\gamma = \frac{\Delta V}{V \Delta T} = \frac{\frac{1}{50}V}{V \times 90} = \frac{1}{4500}/^{\circ}C$

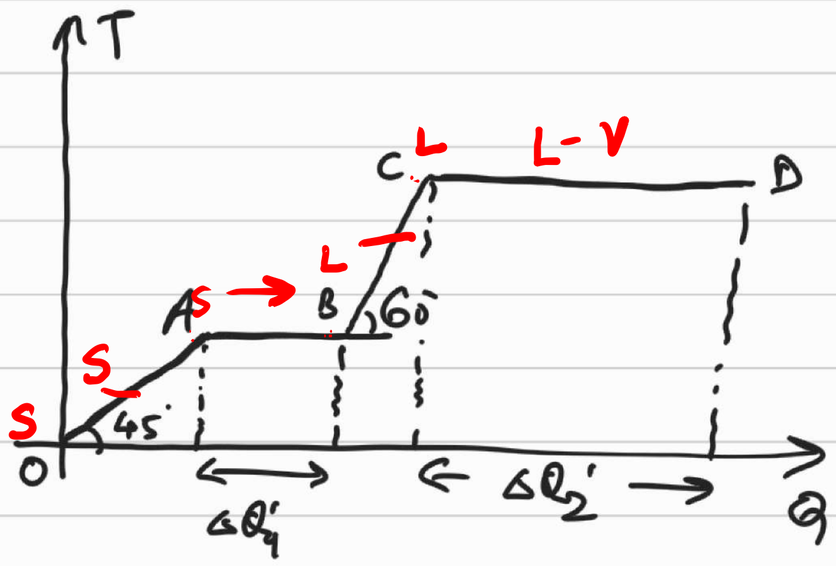
$= 2.22 \times 10^{-4}/^{\circ}C$

$\alpha = \left(\frac{\Delta l}{l \Delta T}\right)$

$\beta = \left(\frac{\Delta A}{A \Delta T}\right)$

$\gamma = \left(\frac{\Delta V}{V \Delta T}\right)$

Q(13).



A substance is given in solid state at O and in gaseous state at D. Given $\Delta Q_2' > \Delta Q_1'$

Choose the correct options for above temp V/s heat graph.

(A) $S_S > S_L$ (B) $S_S < S_L$ (C) $L_V > L_f$ (D) $L_V < L_f$

Ans: (A, C)

Soln:

- $dQ = ms\,dT \quad \therefore \quad \frac{dT}{dQ} = \frac{1}{ms}$

ie slope $\propto \frac{1}{s} \quad \therefore \quad S_S > S_L$

- Similarly A to B and C to D

$\Delta Q' = mL$

$\therefore \quad \Delta Q_2' > \Delta Q_1' \quad \therefore \quad L_V > L_f$

$(\Delta Q_1' = mL_f$
$\Delta Q_2' = mL_V)$

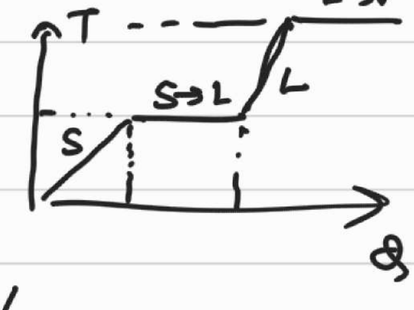
$$\frac{dT}{dQ} = \frac{1}{ms} = \frac{1}{\text{heat cap}}$$

$L_V > L_f$

$\uparrow \tan\theta = \frac{1}{ms} \downarrow$

L

$S_L < S_S$



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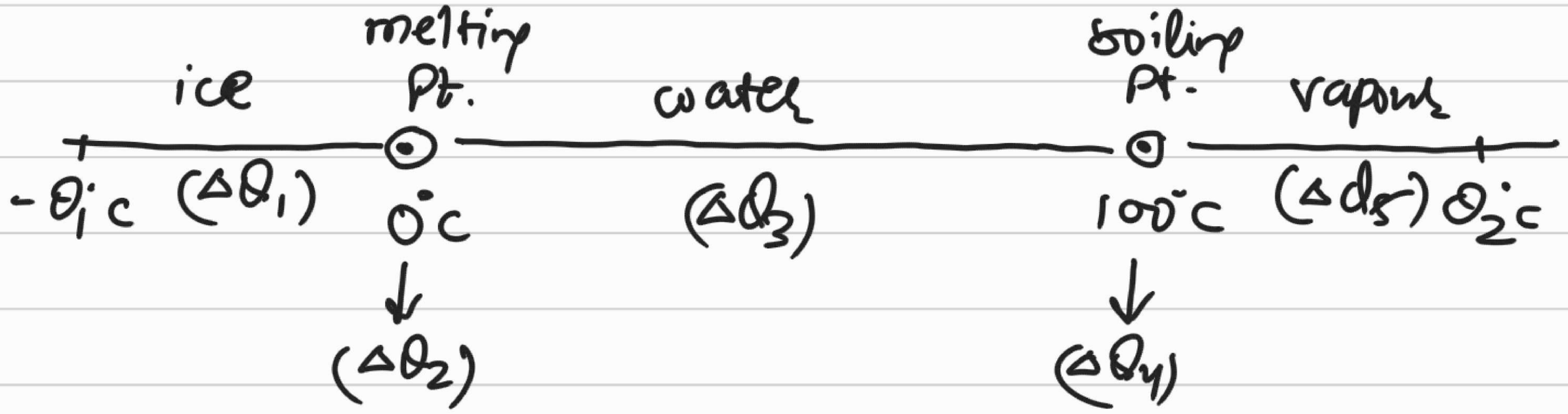
$\boxed{dQ = mL}$ where L = Latent heat (in J/kg or Cal/kg)

④ <u>Law of calorimetry</u>:

When two or more substances at diff. temperatures are mixed with each other then (provided no energy lost to surroundings),

the amount of heat taken = Amount of heat given

⑤ Since water is generally used, so for water:



Let ice at $-\theta_1 c$ converts to steam at $\theta_2 c$

$\therefore$ Heat required $= \Delta Q_1 + \Delta Q_2 + \Delta Q_3 + Q_4 + \Delta Q_5$

$\rightarrow \Delta Q_1 = m S_{ice}(0 - (-\theta_1 c)) = m S_{ice} \theta_1$

$\rightarrow \Delta Q_2 = m L_f \Rightarrow$ ice to water at 0°c

L_f = Latent heat of fusion.

$\rightarrow \Delta Q_3 = m S_w (100 - 0°c) = m S_w (100)$.

$\rightarrow \Delta Q_4 = m L_v \Rightarrow$ water to steam at 100°c

L_v = Latent heat of vaporisation.

$\rightarrow \Delta Q_5 = m S_v (\theta_2 - 100°c) = m S_v (\theta_2 - 100)$

⑥. For water:

$\cdot S_w = 1 \text{ cal/gm-°c} = 1 \text{ kcal/kg-°c} = 4.2 \text{ J/gm-°c}$

[1 cal $\approx$ 4.2 J]

- Sice ≈ $S_{vapour} \approx \frac{1}{2} S_w = 0.5 \text{ cal/gm·c}$

$= 2.1 \text{ J/gm·c}$

- $L_f = 80 \text{ cal/gm} = 80 \text{ kcal/kg}$

- $L_v = 540 \text{ cal/gm} = 540 \text{ kcal/kg}$

⑦. Heat capacity (C) = $ms = \frac{dQ}{dT}$ or $\frac{\Delta Q}{\Delta T}$

Unit: J/°c or J/K

⑧. <u>Water equivalent of a substance</u> :

$\Delta Q = m S \Delta T = m_w S_w \Delta T$

$\therefore \quad m S = m_w S_w \Rightarrow \boxed{m_w = \frac{m S}{S_w}}$

<u>ie</u>. The mass (m_w) of water when given equal amount of heat as substance results in same amount of temp rise.

[Used for temp. range ($0°c \leq \theta \leq 100°c$)]

(9) Mechanical equivalent of heat (J):

$$W = JH$$

W → work in Joules

H → Heat in calories

$$J = 4.186 \text{ J/cal} \simeq 4.2 \text{ J/cal}.$$

(10) When different substances are mixed:

Heat exchange continues till equilibrium.

Heat given	Heat taken

(i) Final temp. should be same on both sides.

(ii) Amount of heat should be equal.

Cal Questions :

Q①. 1 kg steam at 200°C gets converted to ice at −20°C. Find amount of Heat released in Kcal.

Ans: 780 Kcal

Soln:

$(1 \times \frac{1}{2} \times 100) \longrightarrow$ S (200°C to 100°C)

+

$(1 \times 540) \longrightarrow$ S → W (100°C)

+

$(1 \times 1 \times 100) \longrightarrow$ W (100°C to 0°C)

+

$(1 \times 80) \longrightarrow$ W → ice (0°C)

$(1 \times \frac{1}{2} \times 20) \longrightarrow$ ice (0°C to −20°C)

$= 50 + 540 + 100 + 80 + 10$

$= 780$ Kcal.

Q2 Equal masses of three different liquids A, B & C are given at temp. 40°C, 20°C and 10°C respectively.

Temp. on mixing A and B is 30°C.

Temp. on mixing B and C is 16°C.

Find equilibrium temp. on mixing A & C.

Ans: 28°C

Soln: A+B: $m S_A (40-30) = m S_B (30-20)$

$$\frac{S_A}{S_B} = 1$$

B+C: $m S_B (20-16) = m S_C (16-10)$

$$\frac{S_B}{S_C} = \frac{6}{4} = \frac{3}{2}$$

$$\therefore \frac{S_A}{S_C} = \frac{S_A}{S_B} \times \frac{S_B}{S_C} = \frac{3}{2}$$

A+C: $m S_A (40-T) = m S_C (T-10)$

$$\Rightarrow \frac{S_A}{S_C} = \frac{T-10}{40-T} = \frac{3}{2} \Rightarrow T = 28°C$$

Q3. Find equilibrium temp. and mixture composition on mixing

(a) 1gm ice at -40°C with 4gm steam at 200°C.

(b) 5gm ice at -40°C with 3gm water at 60°C.

(c) 1kg ice at -20°C with 1kg steam at 200°C.

(a)

Heat Given	Heat taken
$S(200 \to 100°C)$	$i(-40°C \text{ to } 0°C)$
$4 \times \frac{1}{2} \times (200-100)$	$1 \times \frac{1}{2} \times (0-(-40))$
$= 200$ cal	$+ \; i \to w \; (0°C)$
	1×80
	$+ \; w(0°C \text{ to } 100°C)$
	$1 \times 1 \times (100-0)$
	$= 200$ cal

(a) 100°C, 1gm water, 4gm steam

① $\Delta Q = ms\Delta T = ms(T_f - T_i)$

$T_f > T_i \Rightarrow \Delta Q = +ve$ (Heat taken)

$T_f < T_i \Rightarrow \Delta Q = -ve$ (Heat given out)

Heat taken $= ms(T_f - T_i)$

Heat given $= ms(T_i - T_f)$

② ΔQ → 100 — 0

(b) 0°C, 4gm water, 4gm ice

(c) 100°C, $\frac{20}{27}$ kg steam, $\frac{34}{27}$ kg water

Hence, final temp = 100°c and comp is

4gm steam + 1gm water

5gm ice at −40°c
38m water at 60°c

(b):

Heat Given (3gm W at 60c)	Heat taken (5gm ice at −40°c)
• W (60° → 0°c)	• i (−40°c to 0°c)
3×1×60 = 180	5 × ½ × 40 = 100
	+ • x gm i → ω (0°c)
	x × 80 = 80x

Hence finally $180 = 100 + 80x$

$80 = 80x \Rightarrow \boxed{x = 1\text{gm}}$

ie Final temp = 0°c

Final comp = 4gm W + 4gm ice

(c)

Heat Given	Heat taken
1 kg steam at 200°c	1 kg ice at −20°c
(i) Steam 200c to 100°c	(i) ice (−20c to 0c)
1 × ½ × 100 = 50 Kcal	1 × ½ × 20 = 10 kcal

(ii) S → W (100°C)
(x kg)

$x \times 540 = 540x$ kcal

(ii) ice → water (0°C)

$1 \times 80 = 80$ kcal

(iii) water (0°c to 100°C)

$1 \times 1 \times 100 = 100$ kcal

Finally $50 + 540x = 190$

$x = \frac{140}{540}$ kg $= \frac{7}{27}$ kg

$\therefore$ Final temp $= 100°C$

Final composition $\Rightarrow$ steam $= (1 - x)$

$= \left(1 - \frac{7}{27}\right) = \frac{20}{27}$ kg steam

water $= 1 + x = 1 + \frac{7}{27} = \frac{34}{27}$ kg water

Q(4). 10gm ice at 0C is kept in calorimeter of water equivalent 10gm. How much heat (in cal) should be supplied to evaporate the water formed?

Ans: 8200 cal.

Soln:

$\Delta Q = 10 \times 80 \rightarrow (i \rightarrow w)\ 0^\circ C$

$+ \quad 10 \times 1 \times (100 - 0) \rightarrow w\ (0^\circ C \text{ to } 100^\circ C)$

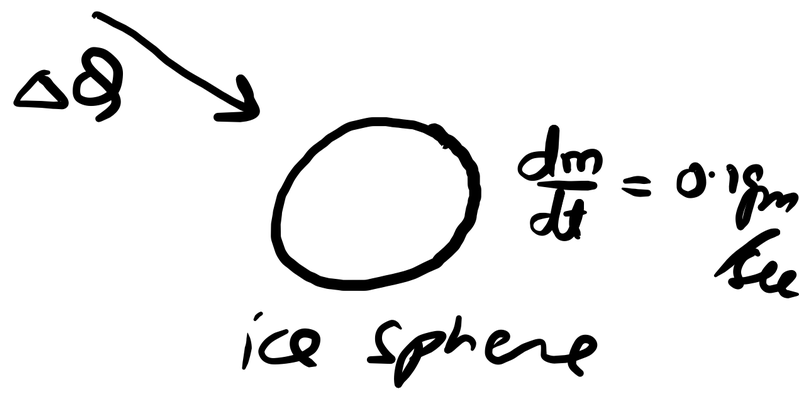
$+ \quad 10 \times 1 \times (100 - 0) \rightarrow (\text{Cal } 0^\circ C \text{ to } 100^\circ C)$

$+ \quad 10 \times 540 \rightarrow (w \rightarrow \text{steam})\ \text{at } 100^\circ C$

$= 800 + 1000 + 1000 + 5400$ cal

$= 8200$ cal.

Q5: Heat is being supplied at const. rate to a sphere of ice melting at 0.1 gm/sec. It melts completely in 100 sec. Rate of temp. rise thereafter will be: (in °C/sec)



$$\frac{dQ}{dt} = L_f \cdot \frac{dm}{dt}$$

Hint: $\left[\frac{dQ}{dt} = ms\frac{dT}{dt} = \Delta T\, s \frac{dm}{dt}\right]$

& $\left[\frac{dQ}{dt} = L\frac{dm}{dt}\right]$

Ans: 0.8 °C/sec

Soln: • $\frac{dQ}{dt} = L_f \frac{dm}{dt} = 80 \times 0.1 = 8$ cal/sec

• $m_{sphere} = \frac{dm}{dt} \times time = 0.1 \times 100 = 10$ gm

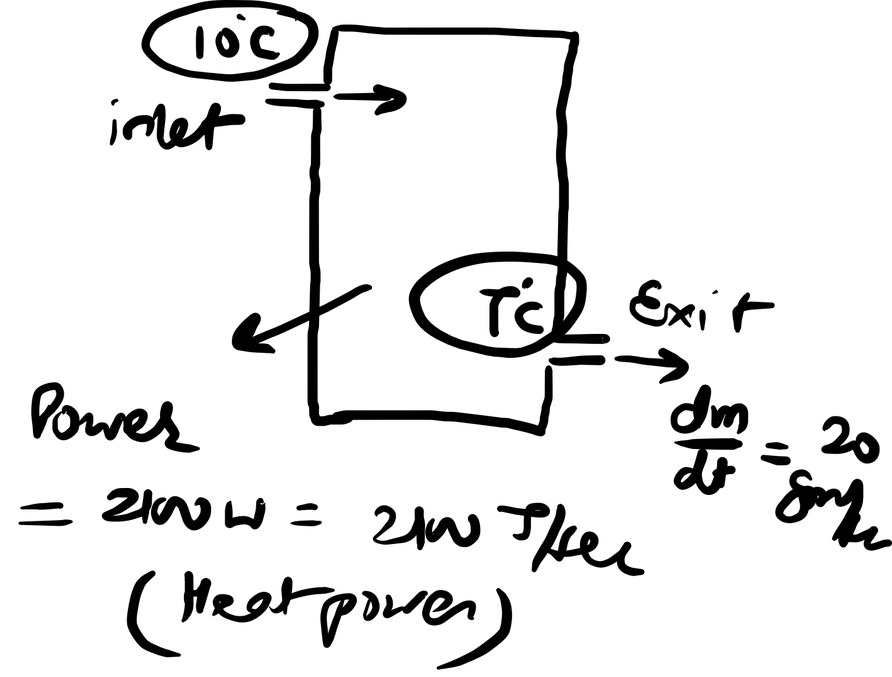
• $8 = \frac{dQ}{dt} = ms\frac{dT}{dt}$ (thereafter)

$\therefore \quad 8 = 10 \times 1 \times \frac{dT}{dt}$

$\Rightarrow \quad \frac{dT}{dt} = 0.8$ °C/sec

Q6. 2100 W continuous flow geyser has water inlet at 10°C while water flows out through outlet at 20 gm/sec. Outlet temp. ?

Ans: 35°C



Soln: $\frac{dQ}{dt} = 2100 = \Delta T . S . \frac{dm}{dt}$

$\Rightarrow 2100 = (T-10)(4.2)(20)$

*** Since Power is in Watts ie J/sec
so S water has to be used in J/gm-°C

$\therefore T-10 = \frac{2100}{4.2 \times 20} = 25$

$\therefore T = 35°C$