Calorimetry - Part III

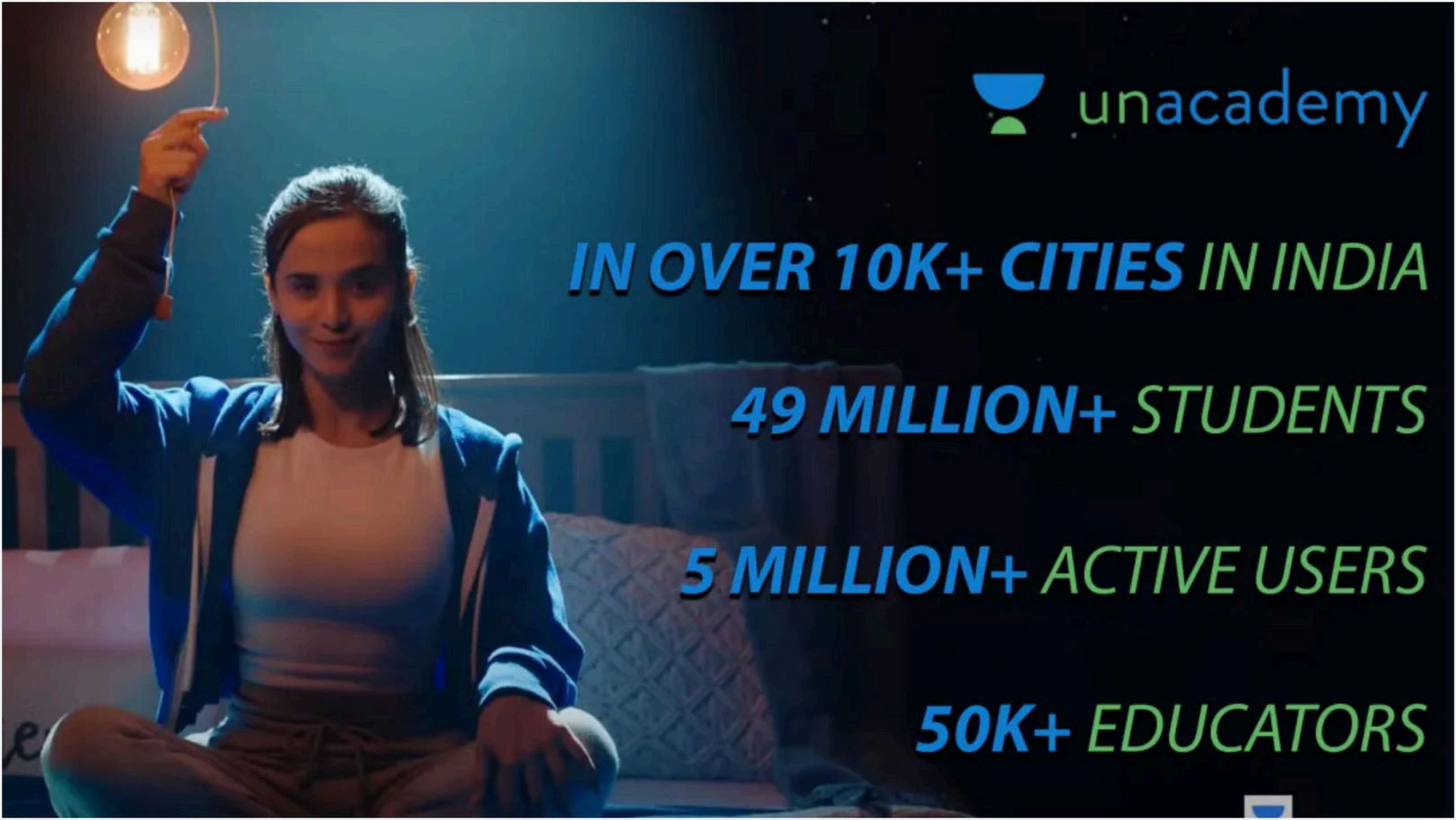
Detailed Course on Physics (Heat & Thermodynamics)

Prateek Jain • Lesson 3 • Aug 18, 2021

"आज PHYSICS में मचाते हैं।"

SIR PRATEEK JAIN

. Founder @ Physicsaholics
. Top Physics Faculty on Unacademy (IIT JEE & NEET)
. 8+ years of teaching experience in top institutes like FIITJEE (Delhi, Indore) , CP (KOTA) etc.
. Produced multiple Top ranks.
. Research work with HC Verma sir at IIT Kanpur
. Interviewed by International media.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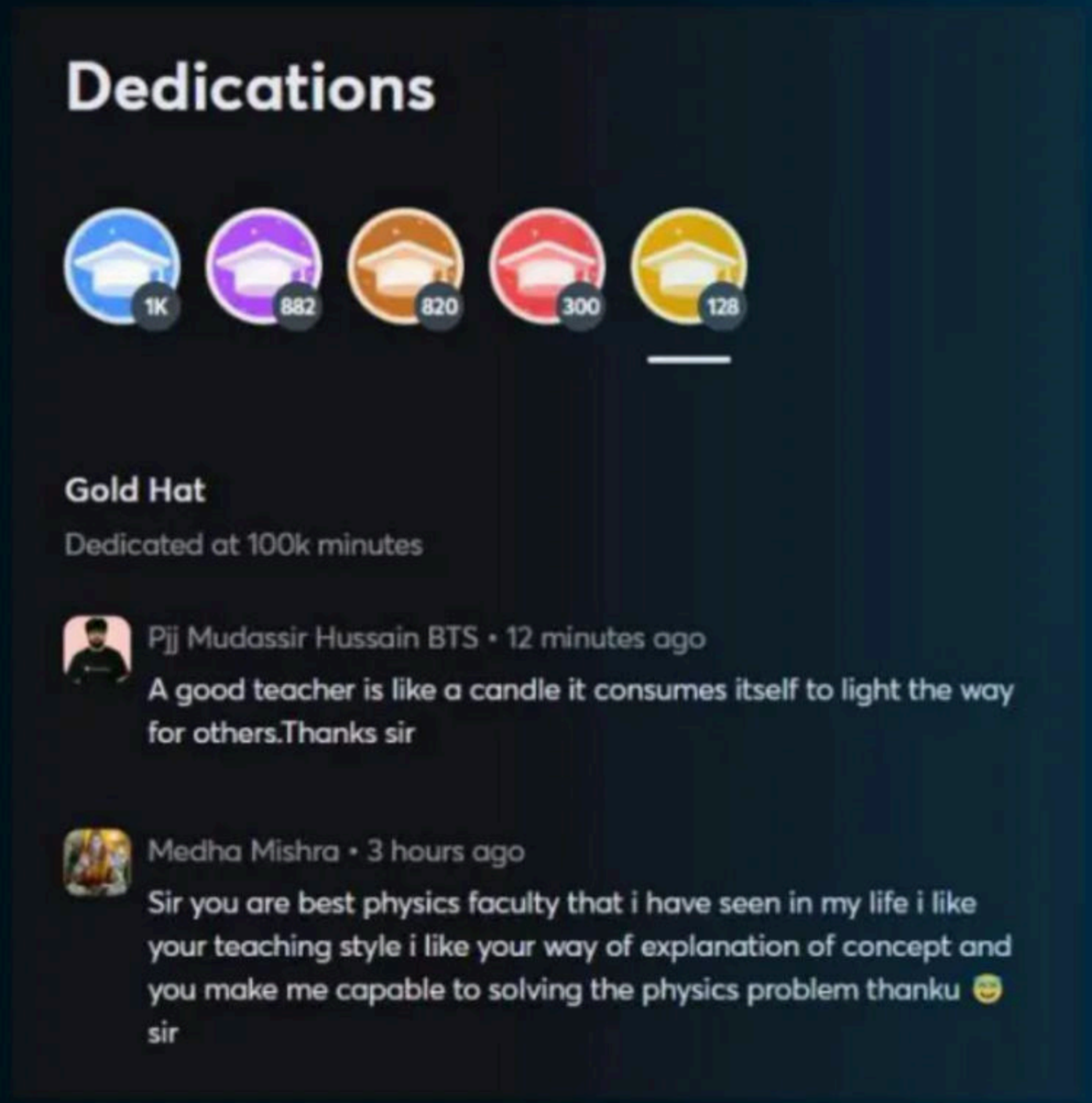
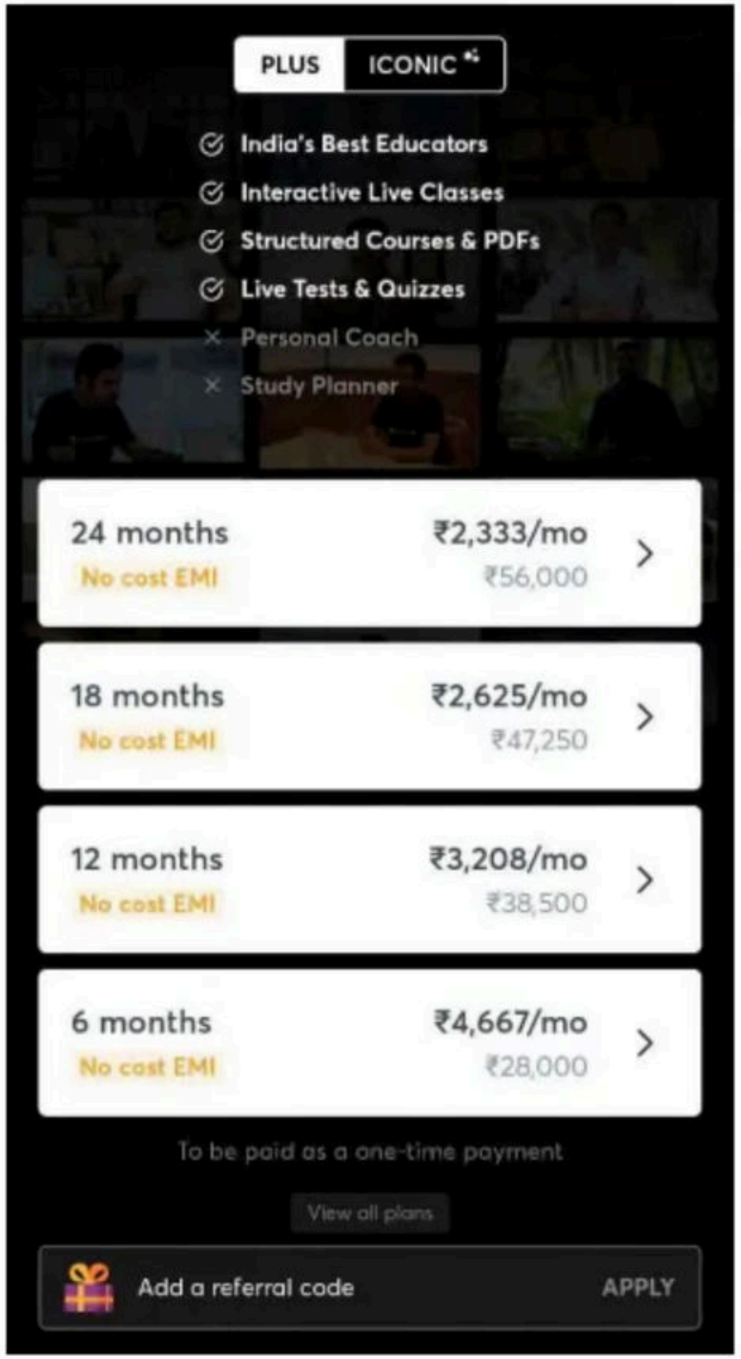


HIGHEST NO. OF GOLDEN HATS ON WHOLE UNACADEMY PLATFORM



PHYSICSLIVE

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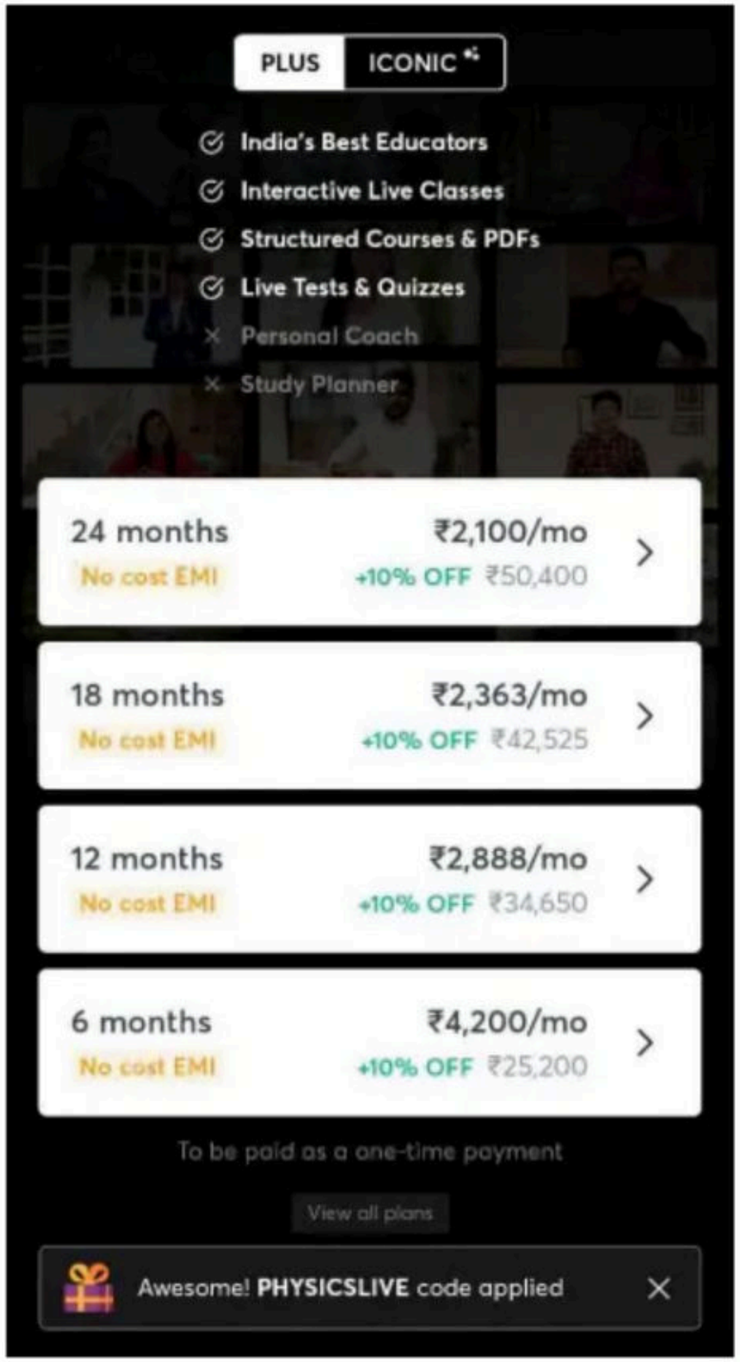
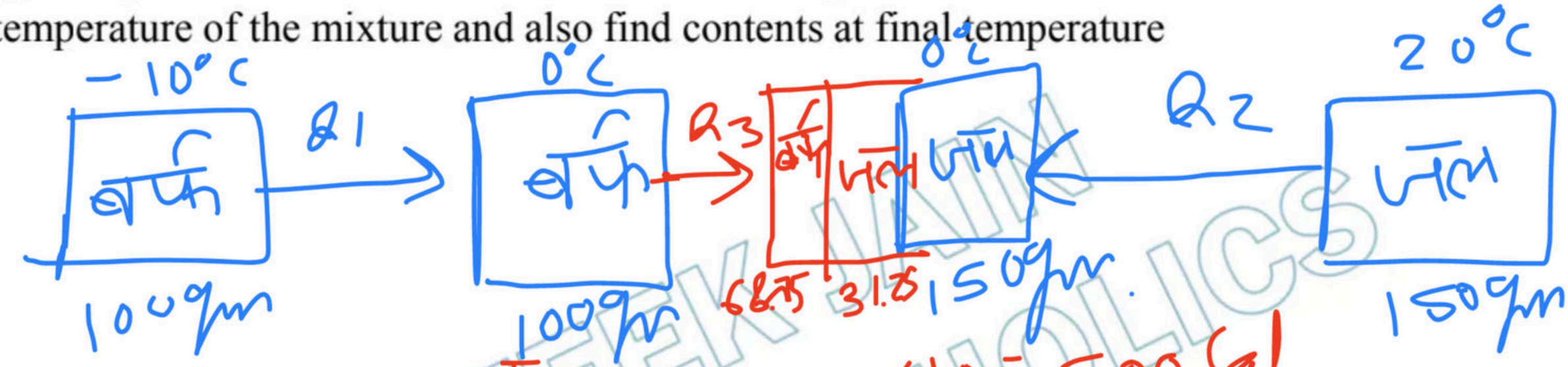


Q) 150 gram of water at 20 °C is mixed with 100 g of ice at -10 °C then calculate the final temperature of the mixture and also find contents at final temperature



$Q_1 = mS\Delta T = 100 \times 0.5 \times 10 = 500$ Cal.

$Q_2 = mS\Delta T = 150 \times 1 \times 20 = 3000$ Cal.

$Q_3 = 2500 = mL_f = m80$

$m = \frac{250\cancel{0}}{8\cancel{0}} = 31.25$

T_f :- 0°C

ice → 68.75gm. W → 181.25 gm.

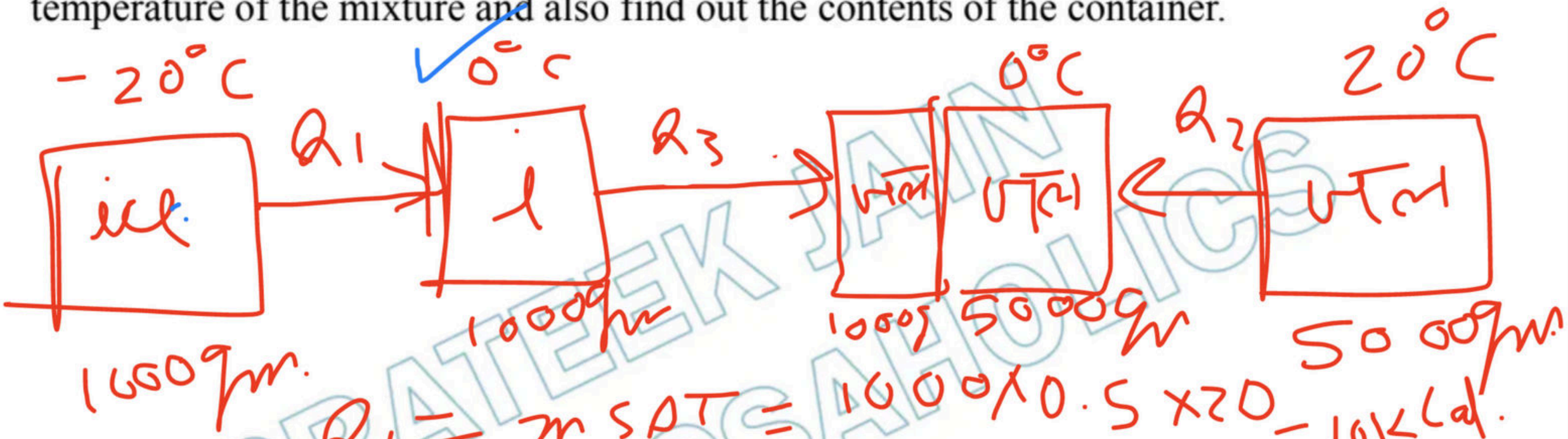
$T_f = 0^\circ C$

$m_{ice} = 68.75\ gm.$

$m_{water} = 181.25\ gm$

100 - 10 = 90 K Cal. - 80 K Cal = 10 K Cal.

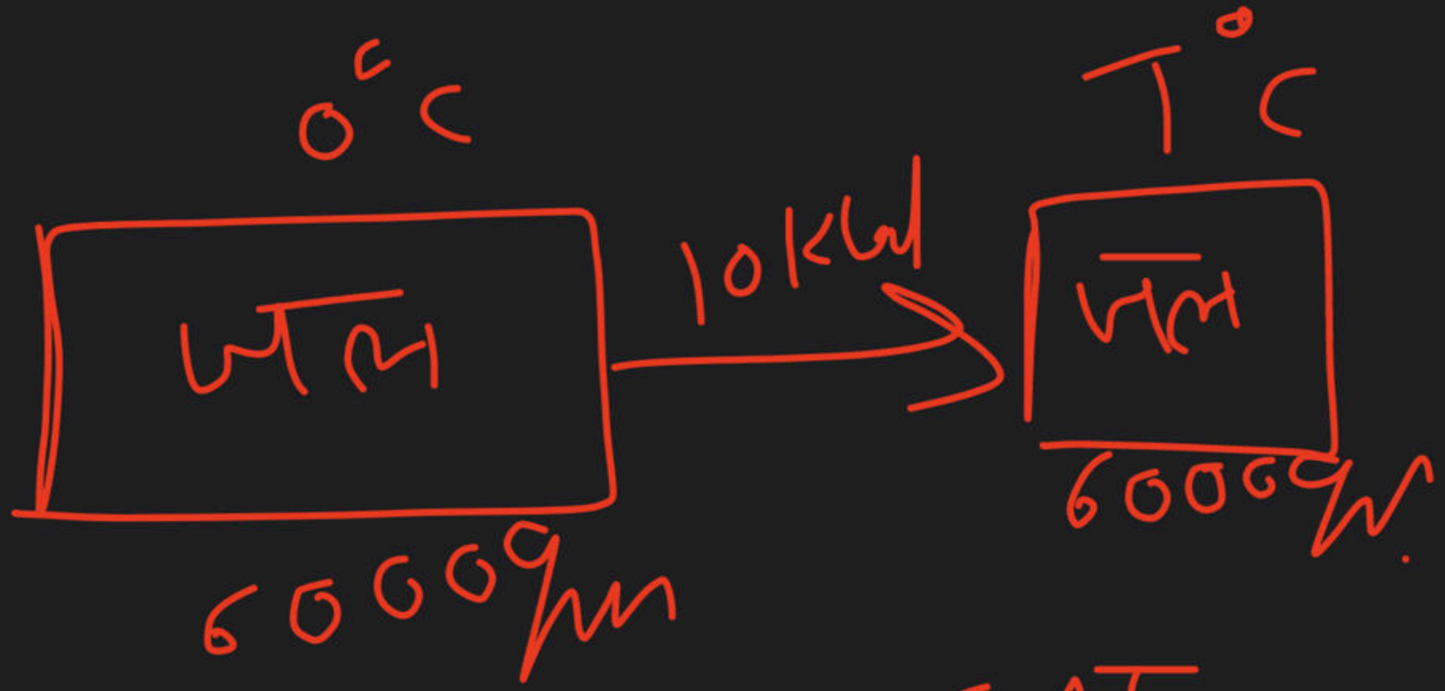
Q) 1 kg of ice at -20 °C is mixed with 5 kg of water at 20 °C then calculate the final temperature of the mixture and also find out the contents of the container.



$Q_1 = mS\Delta T = 1000 \times 0.5 \times 20 = 10 K Cal.$

$Q_2 = mS\Delta T = 5000 \times 1 \times 20 = 100 K Cal.$

$Q_3 = mL_f = 1000 \times 80 = 80 K Cal$



$$Q = mS\Delta T$$

$$10,000 = 6000 \times 1 \times (T - 0)$$

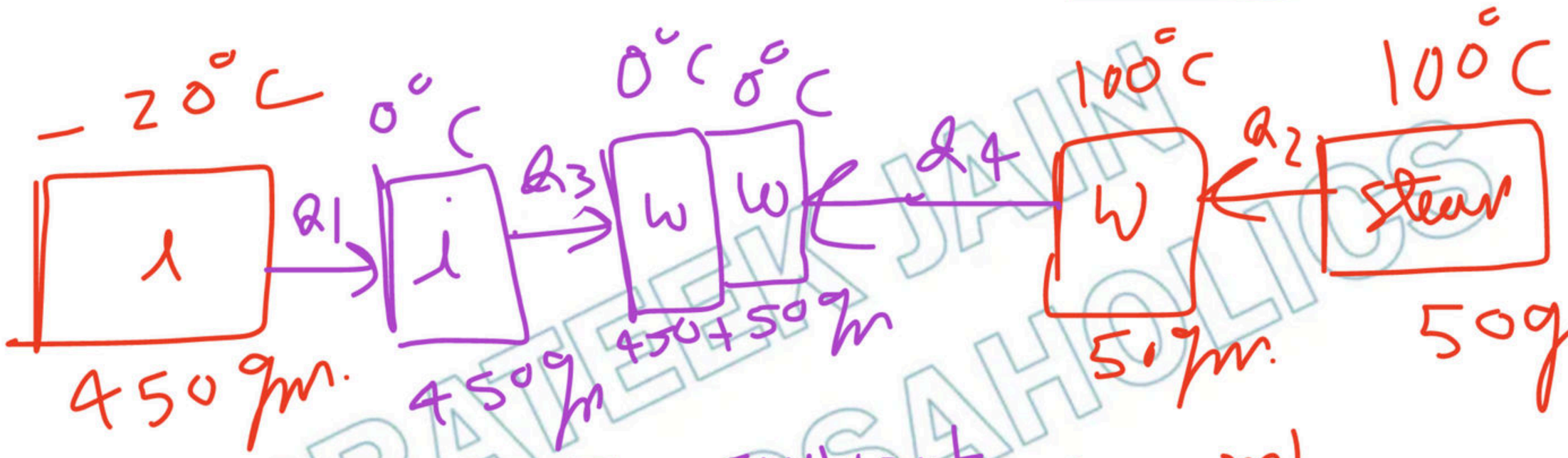
$$T = \frac{10^{\circ}C}{6} = 1.67^{\circ}C$$

$T_f = 1.67^{\circ}C$

$m_{ice} = 0gm$

$m_{water} = 612g$

Q) In an isolated container 0.05 kg steam at 373 K and 0.45 kg of ice at 253 K are mixed. Calculate final temperature of the mixture. (IIT JEE 2006)



$Q_1 = ms\Delta T = 450 \times 1 \times 20$

$Q_1 = 4500$ Cal.

$Q_3 = mL_f = 450 \times 80$

$= 36000$

$Q_2 = mL_v$

$= 50 \times 540$

$= 27000$ Cal.

$Q_4 = ms\Delta T$

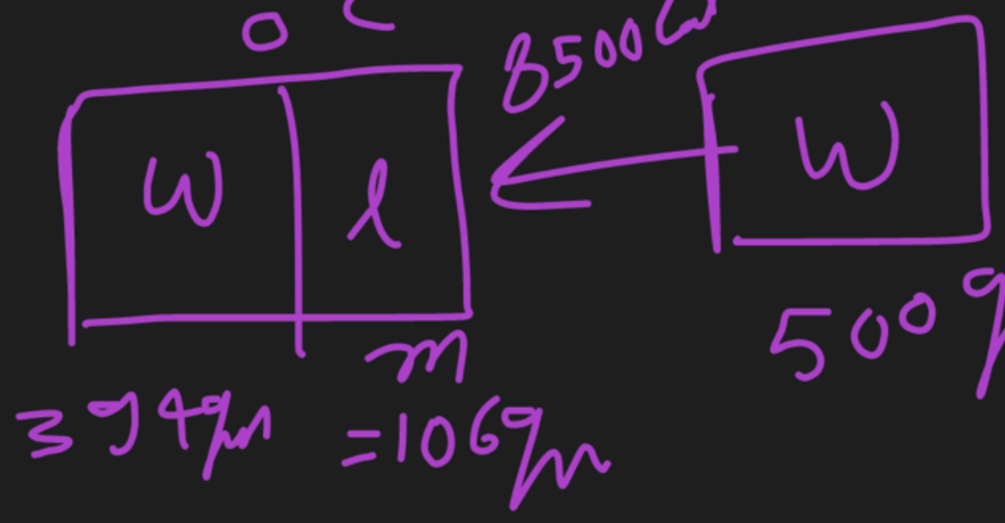
$= 50 \times 1 \times 100$

$= 5000$ Cal.

Available heat = $Q_2 + Q_4 = 32000$ Cal.

Required heat = $Q_1 + Q_3 = 40500$ Cal.

extra required = 8500 Cal.



$Q = mL_f$

$8500 = m\,80$

$m = \frac{8506}{80}$

$m = 106$ gm.

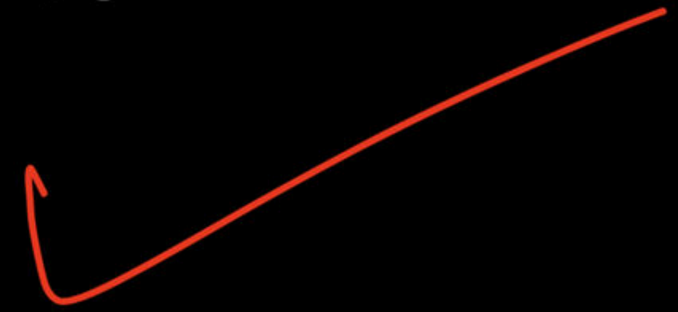
$T_f = 0^\circ C$

$m_{ice} = 106\ gm$

$m_{water} = 394\ gm.$

Q) M grams of steam at 100°C is mixed with 200 g of ice at its melting point in a thermally insulated container. If it produces liquid water at 40°C [heat of vaporization of water is 540 cal/g and heat of fusion of ice is 80 cal/g], the value of M is_____.

Ans. 40

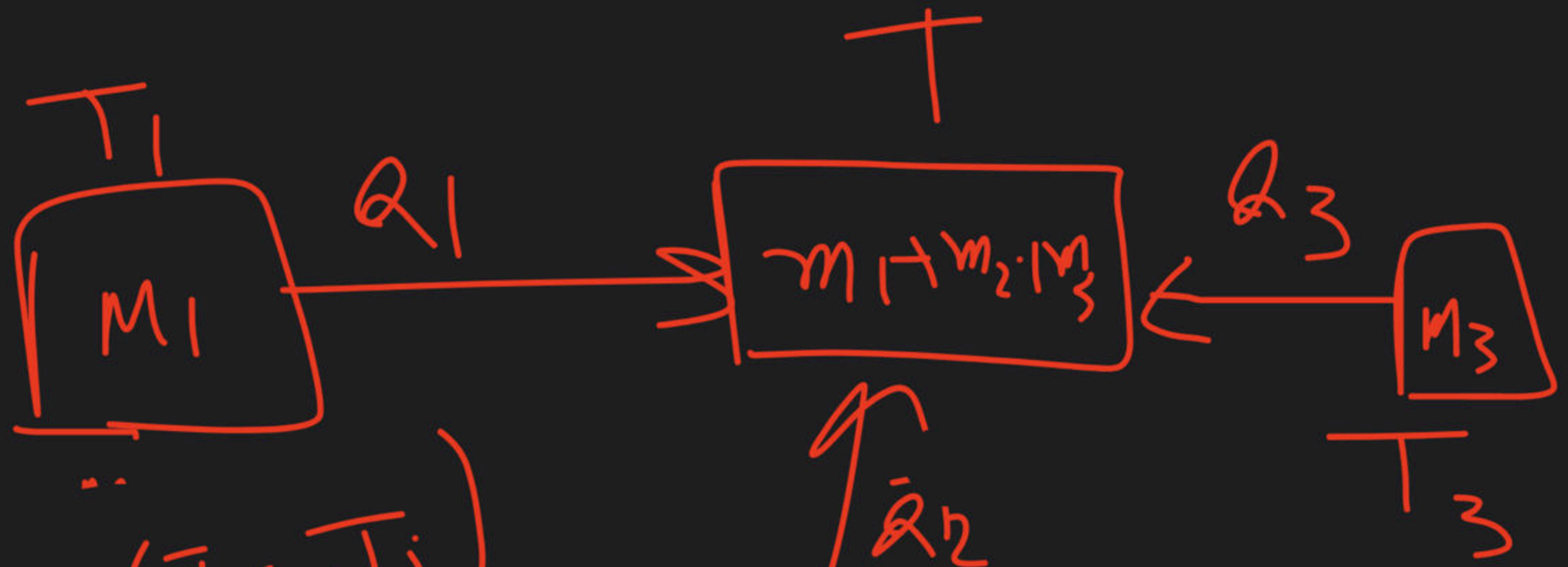


Q) Three containers C_1, C_2 and C_3 have water at different temperatures. The table below shows the final temperature T when different amounts of water (given in litres) are taken from each containers and mixed (assume no loss of heat during the process)

C_1	C_2	C_3	T
1l	2l	1l	60°C
2l	1l	2l	30°C
1l	2l	1l	60C°
1l	1l	1l	θ

The value of θ (in °C to the nearest integer) is .....

JEE Main 2020



$$Q = m s (T_f - T_i)$$

$$Q_1 + Q_2 + Q_3 = 0$$

$$\frac{M_1}{\rho} s (T - T_1) + \frac{M_2}{\rho} s (T - T_2) + \frac{M_3}{\rho} s (T - T_3) = 0$$

$$M = \rho V$$

$$V = \frac{M}{\rho}$$

$$V_1(T-T_1)+V_2(T-T_2)+V_3(T-T_3)=0$$

④ $\Rightarrow$ $1(\theta-T_1)+1(\theta-T_2)+1(\theta-T_3)=0$

$$\theta=\frac{T_1+T_2+T_3}{3}$$

① $\Rightarrow$ $1(60-T_1)+2(60-T_2)+0=0$

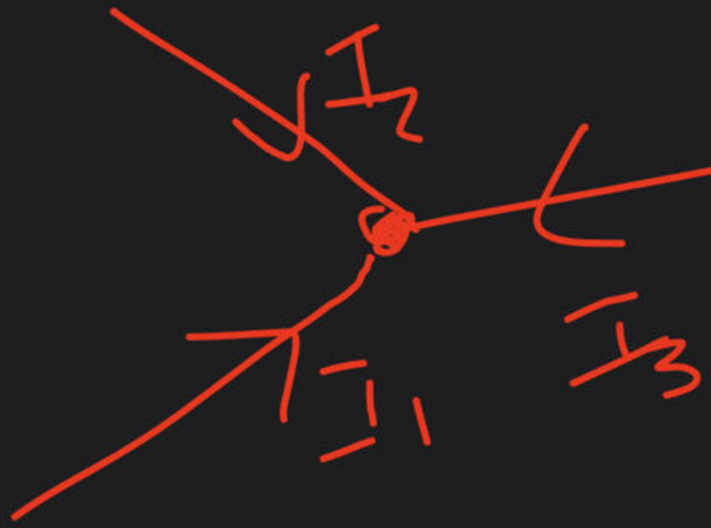
$$60-T_1+120-2T_2=0$$

$$T_1+2T_2=180 \rightarrow ①$$

(1)

$$I_1 + I_2 = I_3$$

(2)



$$I_1 + I_2 - I_3 = 0$$

Ans. 50

$$Q = (ms)\Delta T$$

$$Q = C\Delta T$$

Heat Capacity (C)

Heat capacity is defined as the amount of heat to be supplied to a given mass of a material to produce a unit change in its temperature. It is sometimes also called thermal capacity.

$S = \frac{Q}{m\Delta T}$ → $\frac{cal}{gm-^oC}$

$C = \frac{Q}{\Delta T}$ → $\frac{cal}{^oC}$

$$Q = C\Delta T$$

Q : Amount of Heat

C: Heat Capacity of substance

ΔT : Change in temperature.

SI unit : $\frac{J}{K}$

depends on mass

$C = MS$ → does not depends on mass

Relation between specific heat (S) and heat capacity (C)

$$C = mS$$

C : Heat Capacity

S : Specific Heat Capacity

m : mass of substance

$S_{water} = 1cal/g°C$

$S_{ice} = 0.5cal/g°C$

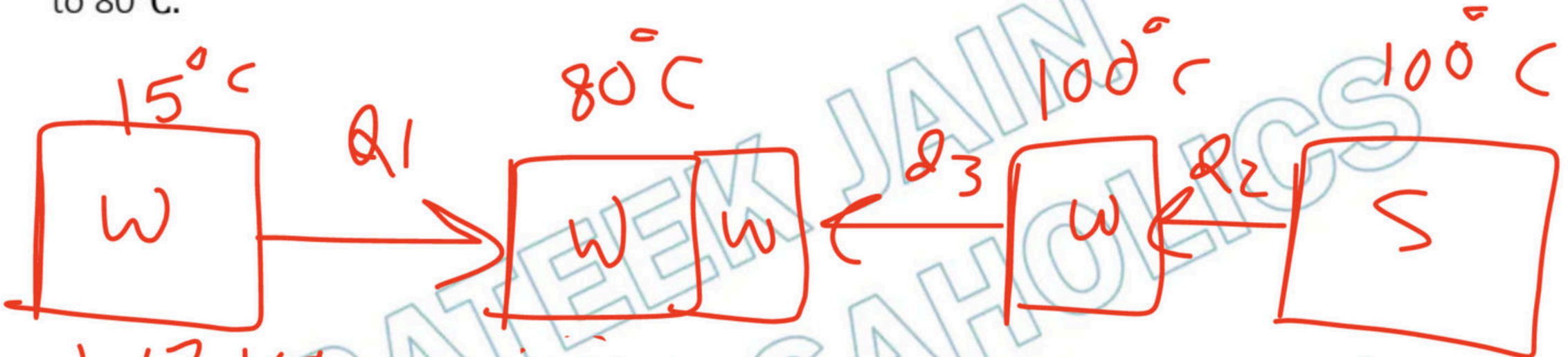
Physicsaholics point:- In such questions, names can be confusing so observe the units carefully.

Water Equivalent

Amount of water that would absorb same amount of heat as the calorimeter.

Note:- To solve questions, just add the water equivalent in the given mass of water.

Q) Steam at 100 °C is passed into the calorimeter in which 1.1 kg of water is filled and temperature of the container is 15°C. If the water equivalent of the calorimeter is 0.02 kg then calculate the mass of the steam required to raise the temperature of the container up to 80°C.



$Q_1 = Q_2 + Q_3$

$1120 \times 1 \times 65 = M\,540 + M \times 1 \times 20$

$2\,1120 \times 65 = 560\ M$

$M = 130$ gm.

Ans. 130 gm

Heat given to a body which raises its temperature by 1°C is

(a) water equivalent (b) thermal capacity [2002]

(c) specific heat (d) temperature gradient

JEE Main

$\frac{dT}{dx}$

JEE Main → 1, 2, 3

JEE M + JEE Adv. → 1, 2, 3

Sheet Ex-1

Ans.b

KTM

Chalo Niklo