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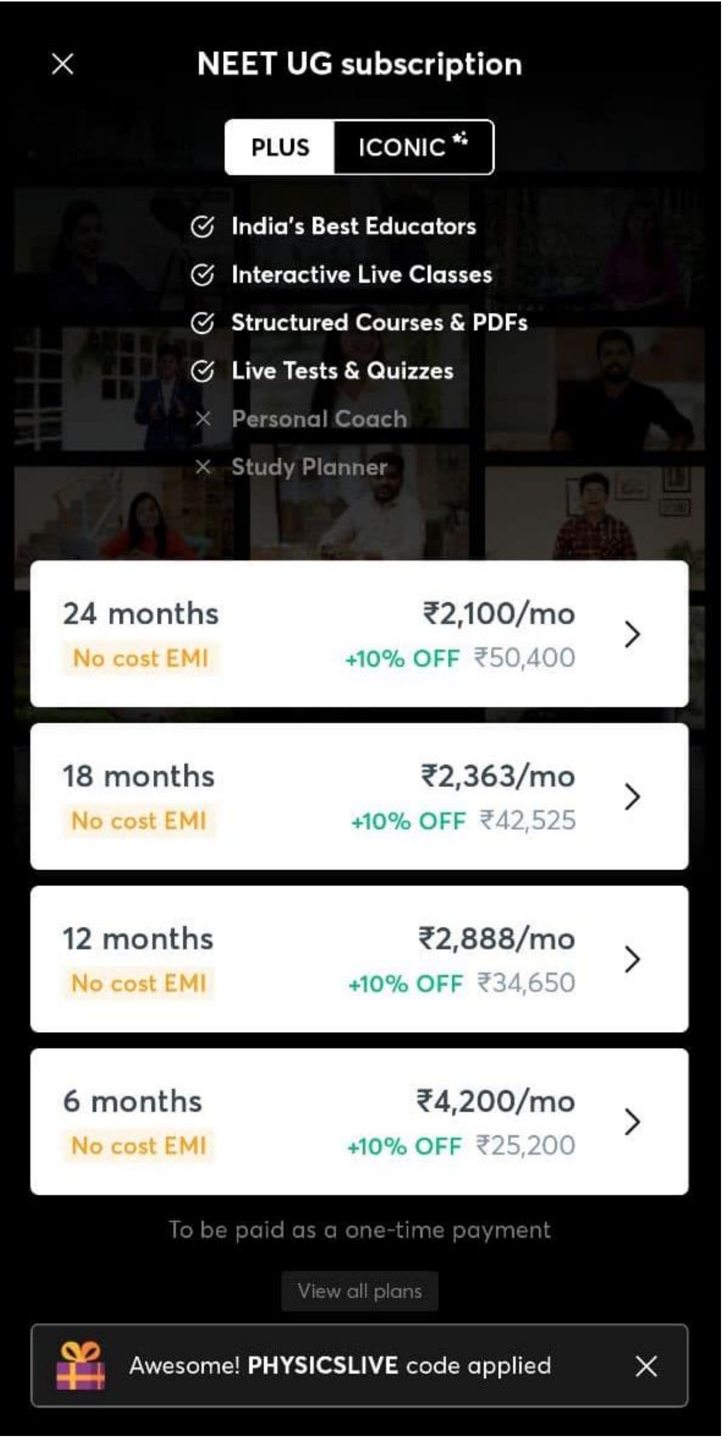

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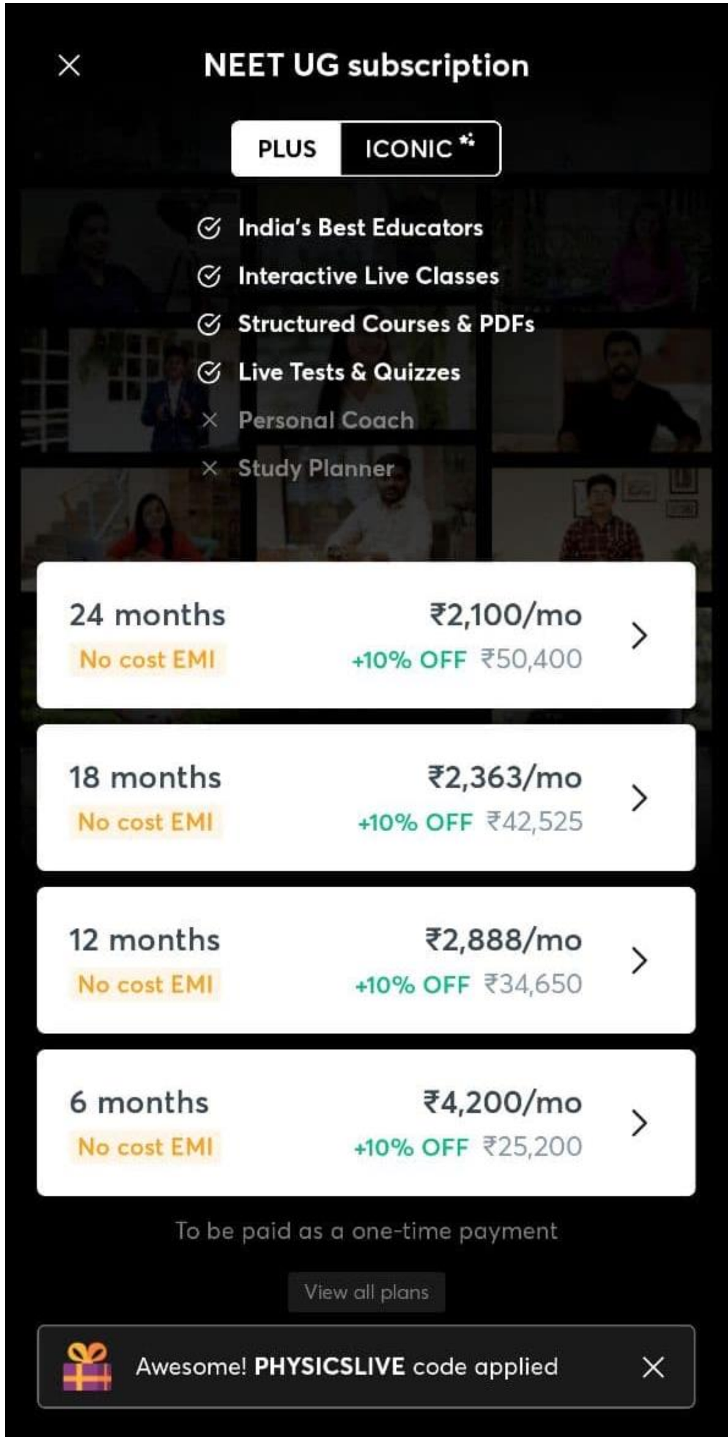

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NEET & JEE Main
Physics DPP

DPP-2 calorimetry

By Physicsaholics Team

Q) Ice at 0ºC is added to 200gm of water initially at 70°C in a vacuum flask. When 50 gm of ice has been added and has all melted, the temperature of flask and contents is 40ºC, When a further 80 gm of ice is added and has all melted, the temperature of whole becomes 10ºC. Neglecting heat lost to surroundings the latent heat of fusion of ice is :
(The specific heat of water is = 1 calorie/gram °C)

(A) 80 cal/gm
(B) 70 cal/gm
(C) 90 cal/gm
(D) 540 cal/gm

Ans. C

let Latent heat of fusion of ice = L

& heat capacity of flask = c
sp.
mass of flask = m.

given; Specific heat capacity of water = 1 cal/g-°C

Now; when 50 gm of ice at 0°C is mixed

final temp = 40°C.

$$\therefore 50 \times L + 50 \times 1 \times (40-0) = 200 \times 1 \times (70-40) + mc(70-40)$$

$$50L + 2000 = 6000 + 30mc$$

$$\boxed{50L = 4000 + 30mc} \quad — (1)$$

Now total mass of water = 200 + 50
= 250 gm.

Now; when 80 gm of ice at 0°C is mixed

final temperature = 10°C

$$\therefore 80 \times L + 80 \times 1 (10-0) = 250 \times 1 \times (40-10) + mc(40-10)$$

$$80L + 800 = 7500 + 30mc$$

$$\boxed{80L = 6700 + 30mc} \quad — (2)$$

$$(2)-(1) \Rightarrow \quad 30L = 2700 + 0$$

$$L = \frac{2700}{30}$$

$$\boxed{L = 90 \ \text{cal/gm.}}$$

Q) Water of volume 2 litre in a container is heated with a coil of 1 kW at 27ºC. The lid of the container is open and energy dissipates at rate of 160 J/s. In how much time temperature will rise from 27ºC to 77ºC ?

[Given specific heat of water is 4.2 kJ/K-kg]

(A) 8 min 20 s

(B) 7 min

(C) 6 min 2 s

(D) 14 min

Ans. a

Energy require to rise the temperature from 27°C to 77°C = Q

$Q = m s \Delta T$

$= (\rho_w V) s \Delta T$

$= (1000 \times (2 \times 10^{-3})) \times 4.2 \times 10^{3} \times (77 - 27°)$

$\left[\because \rho_w = 1000 \ kg/m^3 \ \& \ 1L = 10^{-3} m^3 \right]$

$\Rightarrow Q = 2 \times 4.2 \times 10^3 \times 50$

$Q = 420 \times 10^3 \ J.$

Power of heating coil = 1 kW

$= 10^3 \ J/s. = 1000 \ J/sec$

rate of energy dissipation = 160 J/s.

$\therefore$ rate of energy used to rise temp of water = 1000 − 160

= 840 J/s.

$\therefore t = \frac{420 \times 10^3}{840 \ 2}$

$t = \frac{10^3}{2} = \frac{1000}{2} = 500 \ sec$

$t = \frac{500}{60} = \frac{50}{6} \ min,$

$t = \frac{48}{6} + \frac{2}{6} = 8 \ min + \frac{2}{6} \ min$

$t = 8 \ min + \frac{2}{6} \times 60 \ sec$

$\boxed{t = 8 \ min \ 20 \ sec}$

Q) 2 kg ice at – 20ºC is mixed with 5 kg water at 20ºC in an insulating vessel having negligible heat capacity. Calculate the final mass of water remaining in container.

Given sp. heat water = 4.186 kJ K^{-1} kg^{-1}

sp. heat Ice = 2.092 kJ K^{-1} kg^{-1}

Latent heat of fusion of ice = 334.7 kJ kg^{-1}

(A) 7 kg

(B) 4 kg

(C) 6 kg

(D) 2 kg

Ans. C

ice	water
2 kg	5 kg
at $-20°C$	at $20°C$
$S_i = 2.092$ kJ/K-kg	$S_w = 4.186$ kJ/K-kg.

$L = 334.7$ kJ/kg.

heat required to take ice from $-20°C$ to ice at $0°C$

$$Q_1 = 2 \times (2.092) \times (20) = 83.68 \text{ kJ}$$

heat released in taking water from $20°C$ to water at $0°C$

$$Q_2 = 5 \times 4.186 \times (20) = 418.6 \text{ kJ}$$

Extra heat remaining $= 418.6 - 83.68$

$= 334.9$ kJ.

this heat will convert ice into water

let m mass of ice is melted to $0°C$ water

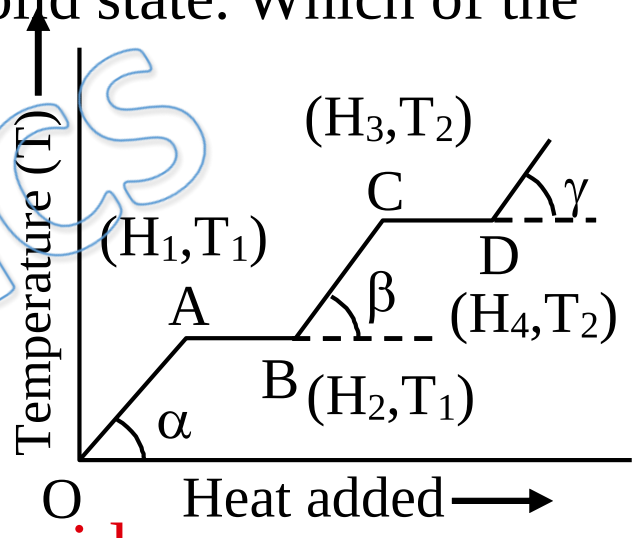
$$m \times 334.7 = 334.9$$

$$m \simeq 1 \text{ kg}$$

$\therefore$ Now Total mass of water $= 5 + 1$

Total mass of water = 6 kg

Q) The accompanying graph shows the variation of temperature (*T*) of one kilogram material with Heat (H) supplied to it. At O, the substance is in solid state. Which of the following interpretation from the graph is correct –



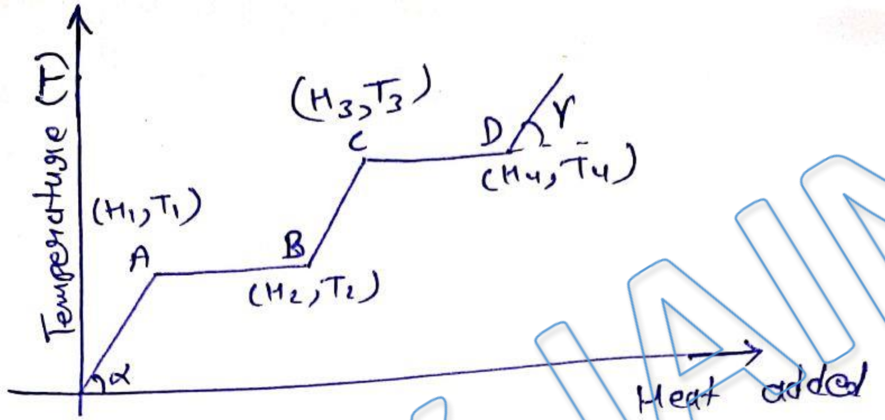
(A) T_2 is the melting point of the solid

(B) BC represents the change of state from solid to liquid.

(C) $(H_2 – H_1)$ represent the latent heat of fusion of the substance.

(D) $(H_3 – H_1)$ represents the latent heat of vaporisation of the liquid.

Ans. C



O → A
Temperature is increasing
at 'O' → substance is solid
so, 'OA' ⇒ substance is solid and is temperature is increasing To T_1

AB ⇒ Temperature is constant
[means substance will change its state from solid to liquid]
at A → solid
B → complete liquid
∴ AB ⇒ $H_2 - H_1$ = ~~heat~~ latent heat of fusion.

BC ⇒ Temperature increasing in liquid state

CD → substance is vaporizing

Q) Steam at 100ºC is passed into 1.1 kg of water contained in a calorimeter of water equivalent 0.02 kg at 15ºC, till the temperature of the calorimeter and its contents rises to 80ºC. The mass of steam condensed (in kg) is (Take latent heat of steam = 540 cal g^{-1}, sp. Heat of water = 4.2 kJ K^{-1} kg^{-1}) :

(A) 0.13

(B) 0.26

(C) 0.065

(D) 0.135

Ans. A

water equivalent of Calorimeter = 0.02 kg

So; The mass of water & the calorimeter = (1.1 + 0.02)

= 1.12 kg

Specific heat capacity of water = 4.2 kJ/kg-K

Heat gained by calorimeter / water is

$Q = 1.12 \times (4.2 \times 10^3) \times 65$

$Q = 305.76$ kJ or $\frac{305.76}{4.2} = 72.8$ kcal

let mass of steam condensed = m

$m \times 1 \times 20 + m \times 540 = 72.8 \times 10^3$ cal

$m = \frac{72.8}{560} \times 10^3$

$m = 0.13 \times 10^3$ gm

$m = 0.13$ kg

Q) When 10 gm of ice at –20 ºC is mixed with 10 gm of water at 50 ºC, the amount of ice melted is –

The latent heat of fusion for ice is 80 cal/gm, The specific heat of ice is 0.5 cal/gm°C, The specific heat of water is 1 cal/gm °C

(A) 2 gm

(C) 3 gm

(B) 4 gm

(D) 5 gm

Ans. D

heat gaind by ice to melt in water at 0°c

$$Q_1 = 10 \times 0.5 \times 20 + 10 \times 80$$

$$Q_1 = 900 \text{ J.}$$

heat released by water if it is taken to 0°c water

$$Q_2 = 10 \times 1 \times (50 - 0) = 500 \text{ J.}$$

$\because Q_1 > Q_2$
means all ice will not melt

$\therefore$ Let mass of ice melt = m (in gm)

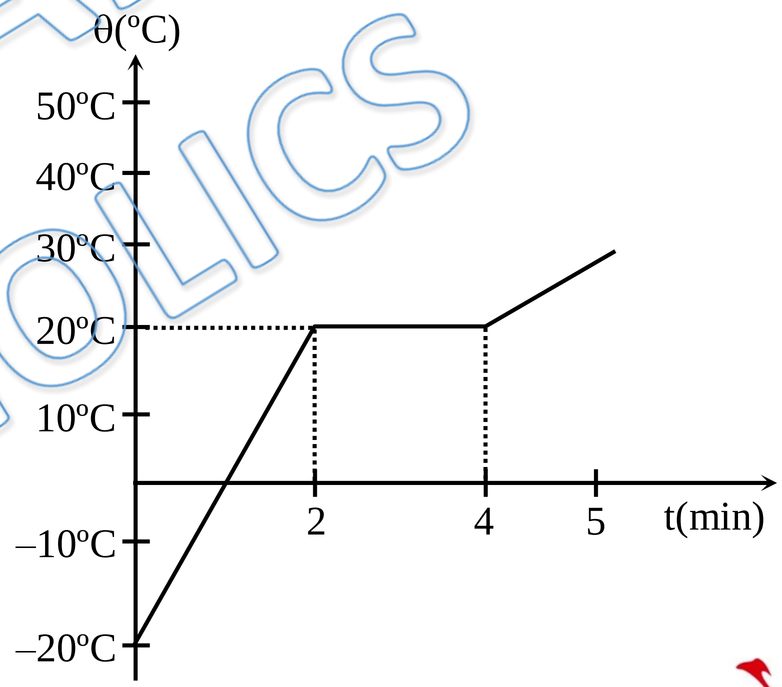
so, $10 \times 0.5 \times 20 + m \times 80 = 500$

$$100 + m \times 80 = 500$$

$$m = \frac{400}{80}$$

$$\boxed{m = 5 \text{ gm}}$$

Q) Heat is supplied to 2kg of solid (initially at –20ºC) at the constant rate of 5kJ/min. Temperature is plotted as a function of time as shown in the figure. Latent heat of fusion for solid is -



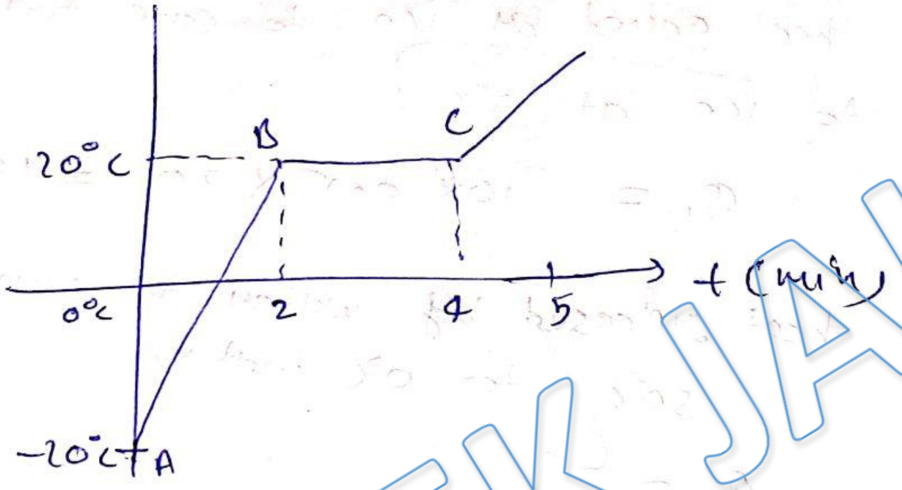
(A) 10 kJ/kg

(B) 5 kJ/kg

(C) 2.5 kJ/kg

(D) 7.5 kJ/kg

Ans. B



in process B to C substance is changing its state from solid to liquid.

∴ Latent heat of fusion = energy gained in time t = 2 min to t = 4 min (Δt = 2 min) for 1 kg.

(L) Latent heat of fusion = $\frac{5 \text{ kJ/min} \times 2 \text{ min}}{2 \text{ kg}}$

$= \frac{10}{2}$ kJ/kg.

$\boxed{L = 5 \text{ kJ/kg}}$

Q) An earthen pitcher loses 1 gm of water per minute due to evaporation. If the water equivalent of pitcher is 0.5 kg and pitcher contains 9.5 kg of water, calculate the time required for the water in pitcher to cool to 28ºC from original temperature of 30ºC. Neglect radiation effects. Latent heat of vaporization in this range of temperature is 580 Cal/gm and specific heat of water is 1 Cal/gmºC.

(A) 30.5 min
(B) 38.6 min
(C) 41.2 min
(D) 34.5 min

Ans. D

water equivalent of pitcher = 0.5 kg

mass of water of pitcher = 9.5 + 0.5
= 10 kg

heat to be extracted from (water + pitcher) for decreasing its temperature from 30° to 28°C is :

$Q_1 = 10 \times 1 \times (30-28)$

$Q_1 = 10 \times 1 \times 2$

$Q_1 = 20$ K cal

Heat extracted from the pitcher through evaporation in t-minutes.

$Q_2 = mL$

mass evaporated in time 't' will be

$m = 1 \times t = t$ gm,

$Q_2 = t \times 580$ cal

$Q_1 = Q_2$

20×10^3 cal $= t \times 580$ cal

$t = 34.48$ min

$t \simeq 34.5$ min

Q) A mixture of 250 gm of water and 200 gm of ice at 0°C is kept in calorimeter of water equivalent 50 gm. If 200 gm of steam at 100°C is passed through the mixture then the final amount of water in the mixture will be (Latent Heat of ice = 80 cal/gm, latent Heat of vaporisation of water = 540 cal/gm and specific heat of water = 1 cal/gm°C) -

(A) 450 gm

(B) 572 gm

(C) 622 gm

(D) 650 gm

Ans. B

water	ice	steam.
250gm	200 gm	200 gm.
(+ 50 gm. of water equivalant of calorimeter)	at 0°C	at 100°C
250 + 50 = 300gm at 0°C		

heat gained by ice to converted into water at 0°C

$Q_1 = 200 \times 80 = 16,000$ cal

heat gained by water + calorimeter to rise its temp from 0°C to 100°C

Total mass of water = 300 + 200 = 500 gm

$Q_2 = 500 \times 1 \times (100)$

$Q_2 = 50,000$ cal

Total heat gained $= Q = Q_1 + Q_2 = 66,000$ cal

Let 'm' mass of steam is converted in water at 100°C

so; $m \times 540 = 66000$ cal

$m = 122.22$ gm.

∴ 122 gm of 200gm steam is converted in to water

∴ mass of water = 500 + 122

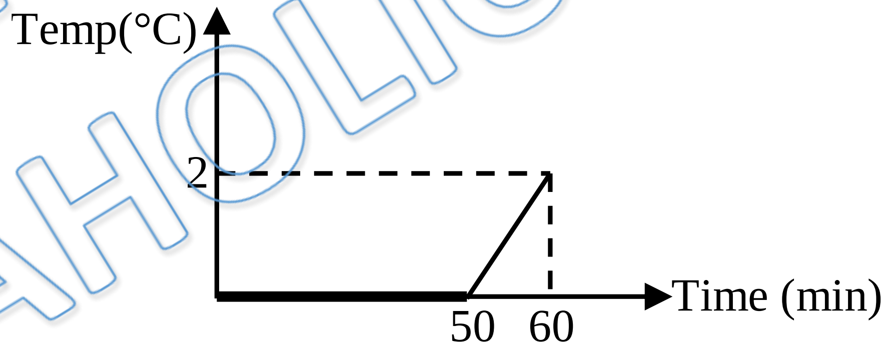
= 622 gm.

but in 622 gm 50 gm is of water equivalent of calorimeter

∴ Total mass of water = 622 − 50

= 572 gm.

Q) A bucket contains a mixture of water and ice and total mass of content is 10 kg. Now this mixture is provided heat at uniform rate. The temperature Vs time graph is plotted. The initial amount of ice in the bucket will be [specific heat of water = 4.2 kJ/kg-K and latent heat of ice = 340 kJ/kg] -



(A) 1.2 kg

(B) 2.4 kg

(C) 5 kg

(D) 3.6 kg

Ans. A

let; mass of water = m_1

mass of ice = m_2

$m_1 + m_2 = 10$ kg.

let; rat of heat = x J/min.

then heat gaind by ice in $t = 50$ min (to convert in water)

$= x \times 50 = 50x$ J.

$m_2 \times L = 50x$

$M_2 \times 340 = 50x$

$$\boxed{M_2 = \frac{50x}{340} \text{ kg}}$$

for $t = 50$ to $t = 60$

$\Delta t = 10$ min

in these 10 minuts heat gained by water is $= 10 \times x = 10x$ J.

rise in temp $= 2$ °C

$(m_1 + m_2) s \Delta T = 10x$

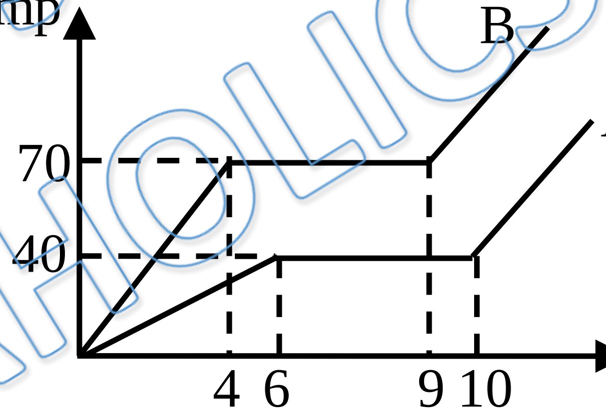
$10 \times 4.2 \times 2 = 10x$

$$\boxed{x = 8.4} \text{ J/min}$$

so; $m_2 = \frac{50}{340} \times 8.4$

$$\boxed{m_2 = 1.23 \text{ kg}}$$

Q) Two solid bodies of equal masses are heated at the same rate under identical condition. The change in temperature is shown graphically as a function of time. The ratio of specific heat in solid form should be (S_A/S_B) -



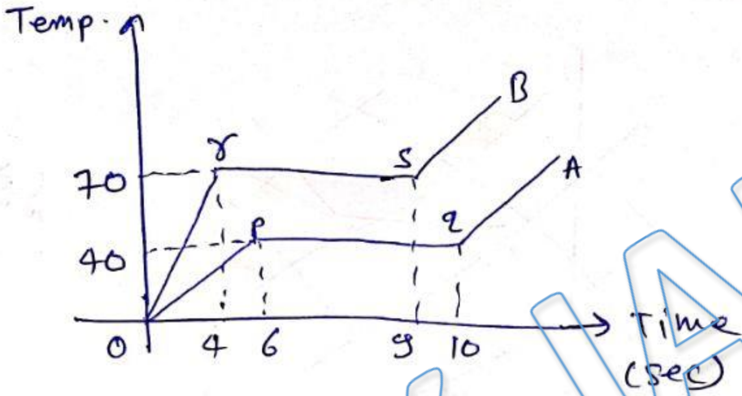
(A) 4/3

(C) 21/8

(B) 15/8

(D) 3/4

Ans. C



let mass of bodies = m

[let the rate of heat gain = x J/s]

$\Rightarrow$ melting point of A = 40°C
melting point of B = 70°C

for A

time in op state (solid state) 6 sec.

energy/heat gained = $6x$ J.

$$6x = m\, S_A (40 - 0) \quad \text{--- (1)}$$

for B

time in or state (solid state) = 4 sec

energy/heat gain = $4x$ J.

$$4x = m\, S_B (70 - 0) \quad \text{--- (2)}$$

$$\frac{(1)}{(2)} \Rightarrow \frac{6x}{4x} = \frac{m\, S_A (40)}{m\, S_B (70)}$$

$$\Rightarrow \frac{3}{2} = \frac{S_A}{S_B} \times \frac{4}{7}$$

$$\boxed{\frac{S_A}{S_B} = \frac{21}{8}}$$

Q) A body of mass 25 kg is dragged on a rough horizontal floor for one hour with a speed of 2 kmh^{-1}. The coefficient of friction for the surface in contact is 0.5 and half the heat produced is absorbed by the body. If specific heat of body is 0.1 cal g^{-1} ($^{o}C^{-1}$) and g = 9.8 ms^{-2}, then the rise in temperature of body is:

(A) 39 K

(B) 84.5 K

(C) 59.5 K

(D) 11.6 K

Ans. D

Heat Produced = |work done by friction| = $(\mu mg)(vt)$

Heat absorbed = $\frac{1}{2}\mu mgvt$

$$\Delta Q = m s \Delta T = \frac{\mu mg vt}{2} \Rightarrow \Delta T = \frac{\mu g v T}{2 s}$$

$$\Delta T = \frac{\cdot 5 \times 9\cdot 8 \times 2 \times \frac{5}{18} \times 3600}{2 \times 1\cdot 1 \times 4\cdot 2 \times 10^{3}} = \frac{25 \times 98 \times 200}{42 \times 1000}$$

$$= \frac{350}{30} = 11.6\,^{\circ}C$$

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