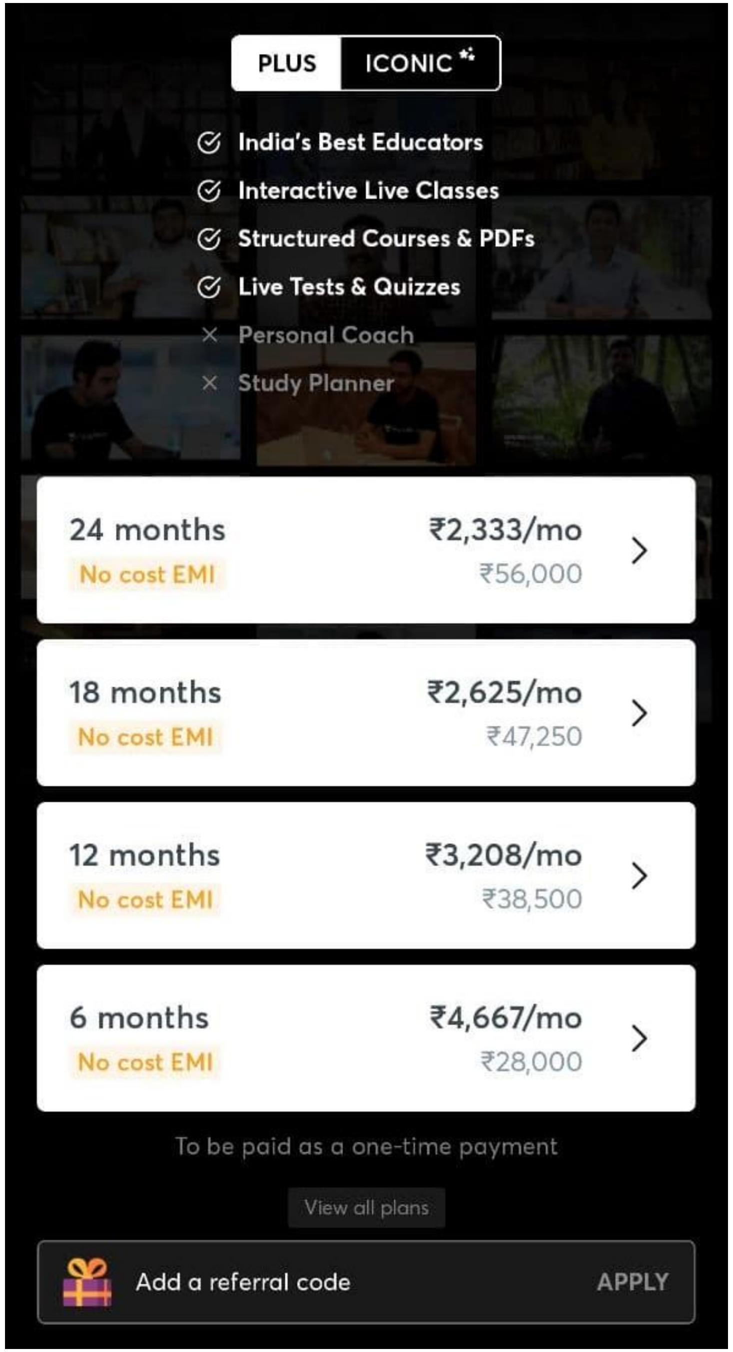
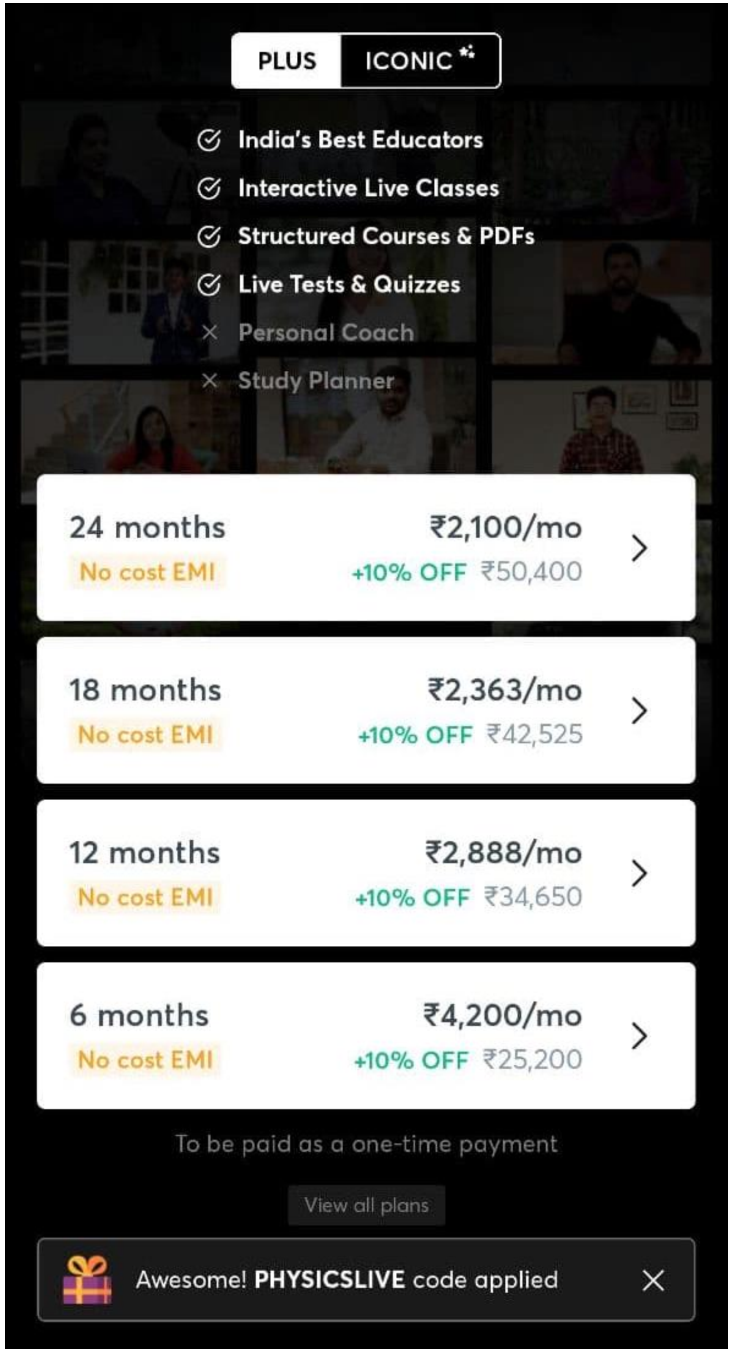
SIR PRATEEK JAIN

. 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.



PHYSICSLIVE



Use code PHYSICSLIVE to get 10% OFF on Unacademy PLUS.

For Video Solution of PYQs, Click on below link

Video Solution on Website:- https://physicsaholics.com/home/courseDetails/72

Video Solution on YouTube:- https://youtu.be/haMU7ZFn4v4

JEE Main PYQs Solution

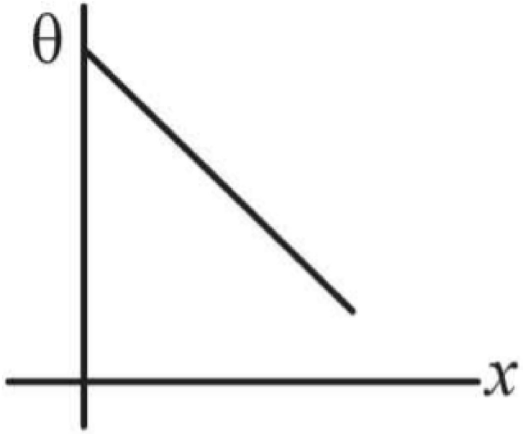
Heat Transfer

By Physicsaholics Team

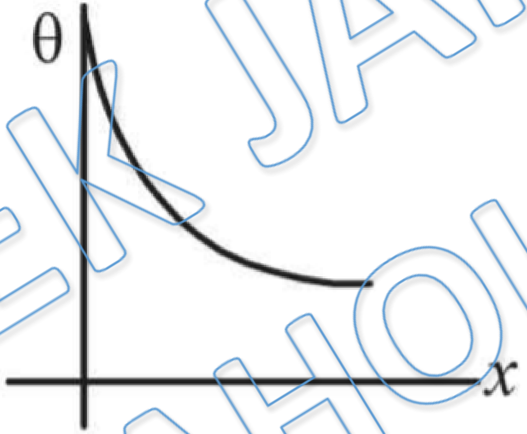
A long metallic bar is carrying heat from one of its ends to the other end under steady–state. The variation of temperature θ along the length *x* of the bar from its hot end is best described by which of the following figures? [2009]

JEE Main

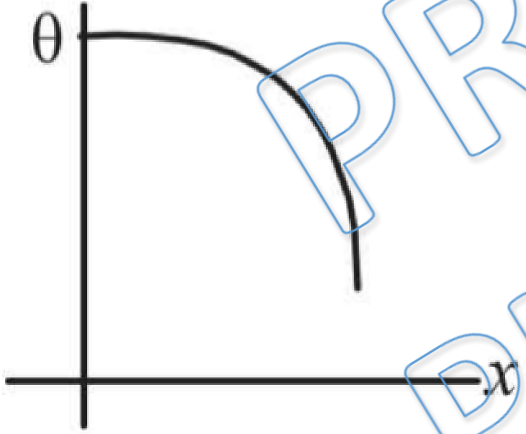
(a)



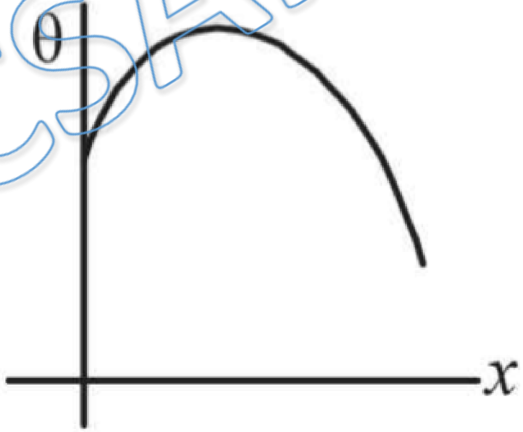
(b)



(c)



(d)



Ans.a

1) 

Ans (a)

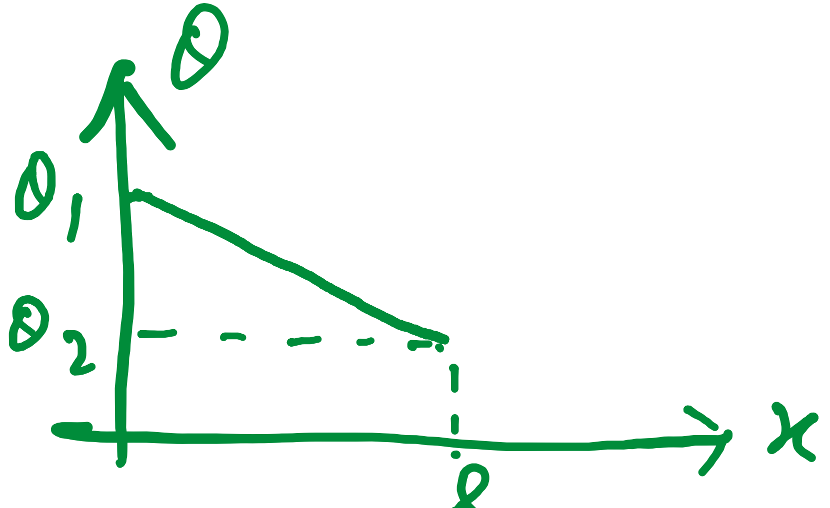
Let thermal [illegible] i.

for first x length of [illegible]

$$i = \frac{KA(\theta_1 - \theta)}{x} \Rightarrow \theta_1 - \theta = \frac{ix}{KA}$$

$$\Rightarrow \theta = \theta_1 - \frac{ix}{KA}$$

⇒ straight [illegible] graph

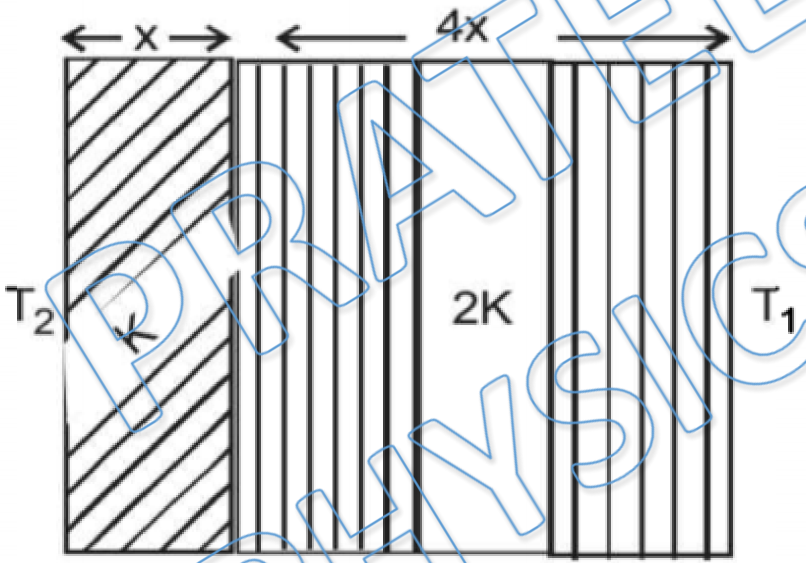


PYQs on Following Subtopic:

Combination of rods

. The temperature of the two outer surfaces of a composite slab, consisting of two materials having coefficients of thermal conductivity K and $2K$ and thickness x and $4x$, respectively, are T_2 and $T_1 (T_2 > T_1)$. The rate of heat transfer through the slab, in a steady state is $\left(\frac{A(T_2 - T_1)K}{x}\right) f$, with f equal to **[2004]**

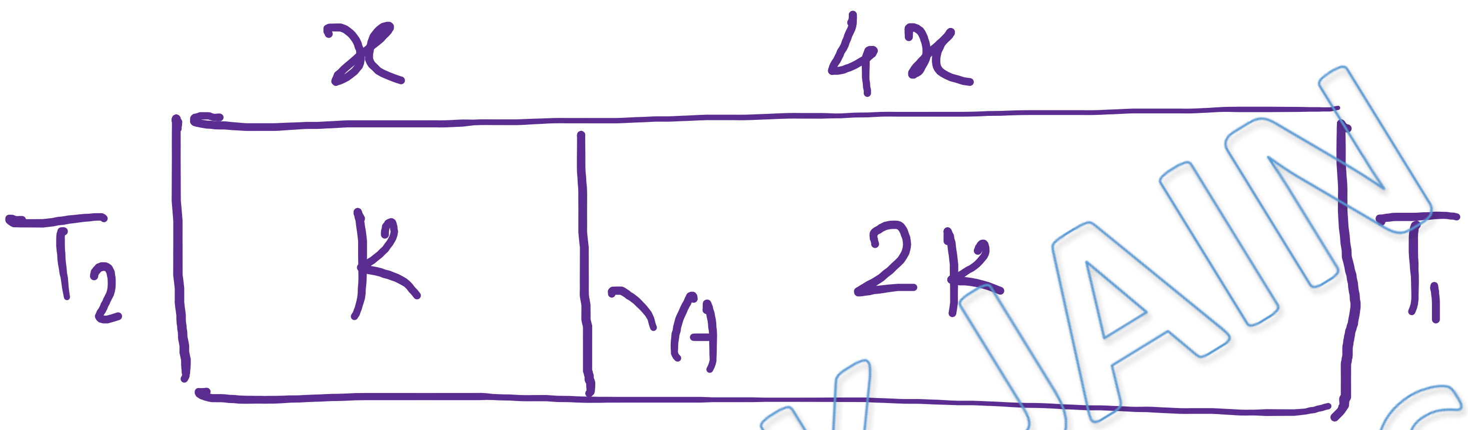
JEE Main



(a) $\frac{2}{3}$ (b) $\frac{1}{2}$ (c) 1 (d) $\frac{1}{3}$

Ans.d

2) ANS(d)



Thermal Resistance $R = R_1 + R_2$

$$= \frac{x}{KA} + \frac{4x}{2KA} = \frac{3x}{KA}$$

Thermal Current $= \frac{T_2 - T_1}{R} = \frac{(T_2 - T_1)KA}{3x}$

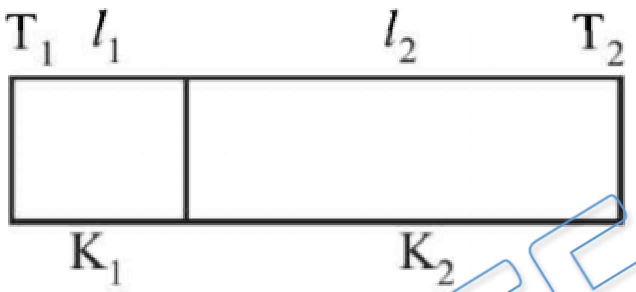
$\Rightarrow f = 1/3$

PYQs on Following Subtopic:

Kirchhoff's Law

One end of a thermally insulated rod is kept at a temperature T_1 and the other at T_2. The rod is composed of two sections of length l_1 and l_2 and thermal conductivities K_1 and K_2 respectively. The temperature at the interface of the two section is [2007]

JEE Main

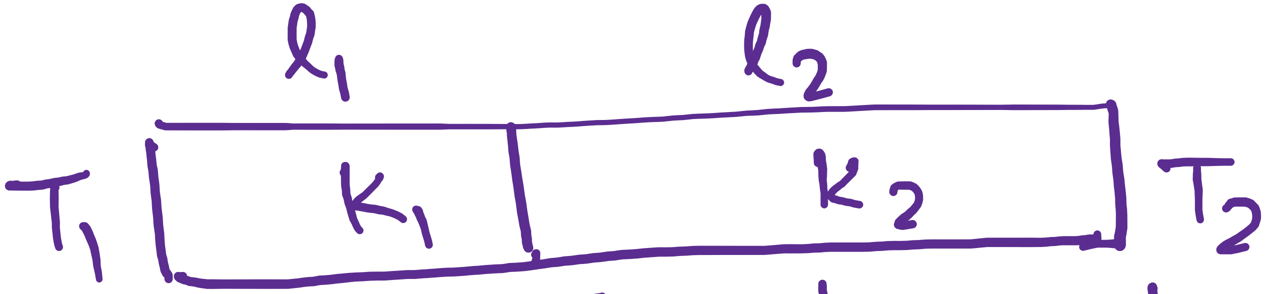


(a) $\dfrac{(K_1 l_1 T_1 + K_2 l_2 T_2)}{(K_1 l_1 + K_2 l_2)}$ (b) $\dfrac{(K_2 l_2 T_1 + K_1 l_1 T_2)}{(K_1 l_1 + K_2 l_2)}$

(c) $\dfrac{(K_2 l_1 T_1 + K_1 l_2 T_2)}{(K_2 l_1 + K_1 l_2)}$ (d) $\dfrac{(K_1 l_2 T_1 + K_2 l_1 T_2)}{(K_1 l_2 + K_2 l_1)}$

Ans.d

3)



$T \rightarrow$ temperature of junction

ANS (d)

Thermal Current $i = \frac{(T_1 - T)K_1 A}{l_1} = \frac{(T - T_2) K_2 A}{l_2}$

$\Rightarrow T_1 K_1 l_2 - T K_1 l_2 = T K_2 l_1 - T_2 K_2 l_1$

$\Rightarrow T_1 K_1 l_2 + T_2 K_2 l_1 = T(K_2 l_1 + K_1 l_2)$

$\Rightarrow T = \frac{T_1 K_1 l_2 + T_2 K_2 l_1}{K_2 l_1 + K_1 l_2}$

Three rods of Copper, Brass and Steel are welded together to form a Y shaped structure. Area of cross - section of each rod $= 4 cm^2$. End of copper rod is maintained at $100°C$ where as ends of brass and steel are kept at $0°C$. Lengths of the copper, brass and steel rods are 46, 13 and 12 cms respectively. The rods are thermally insulated from surroundings excepts at ends. Thermal conductivities of copper, brass and steel are 0.92, 0.26 and 0.12 CGS units respectively. Rate of heat flow through copper rod is: **[JEE Main 2014]**

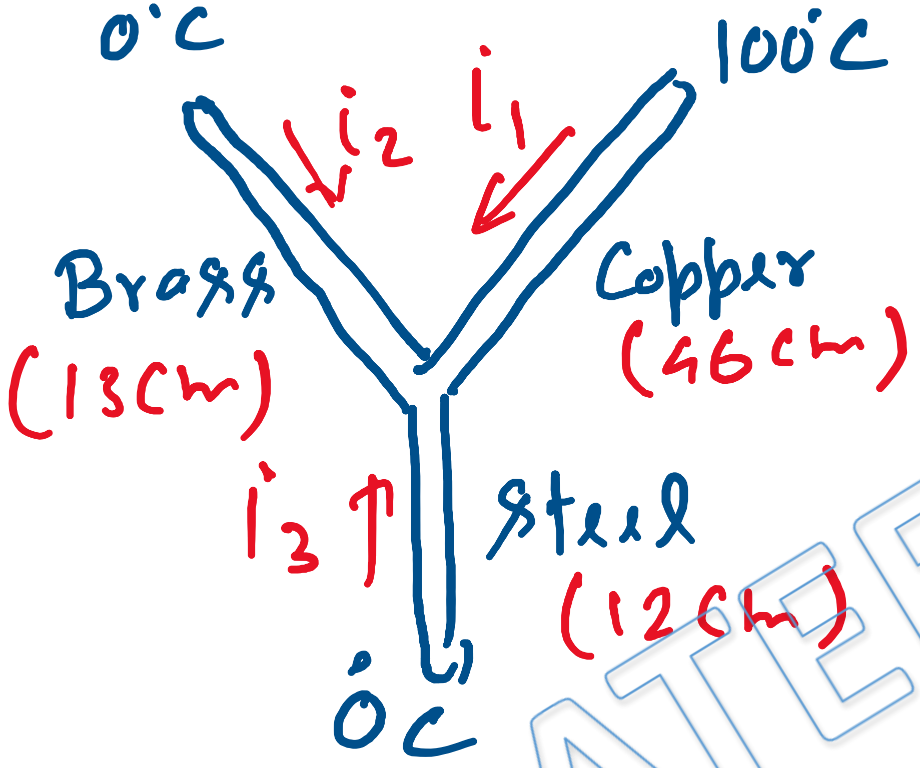
JEE Main

(a) 1.2 cal/s (b) 2.4 cal/s

(c) 4.8 cal/s (d) 6.0 cal/s

Ans.c

4)



Let T is temperature of junction.

$$i_1 + i_2 + i_3 = 0$$

$$\Rightarrow \frac{.92A(100-T)}{46\times10^{-2}} + \frac{.26A(0-T)}{13\times10^{-2}} + \frac{.12A(0-T)}{12\times10^{-2}} = 0$$

$$\Rightarrow 2(100-T) + 2(0-T) + 1(0-T) = 0$$

$$200 - 2T - 2T - T = 0 \Rightarrow T = 40^\circ C$$

$\Rightarrow$ thermal Current in Copper

$$= \frac{.92 \times 4 (100 - 40)}{46}$$

$$= .08 \times 60$$

$$= 4.8 \text{ Cal/s}$$

ANS (C)

PYQs on Following Subtopic:

Radial Flow of Heat

The figure shows a system of two concentric spheres of radii r_1 and r_2 are kept at temperatures T_1 and T_2, respectively. The radial rate of flow of heat in a substance between the two concentric spheres is proportional to **[2005]**

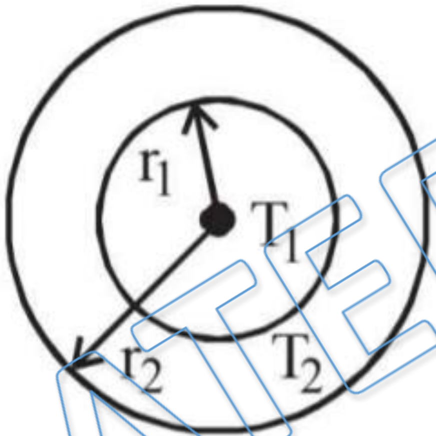
JEE Main

(a) $ln\left(\frac{r_2}{r_1}\right)$

(b) $\frac{(r_2 - r_1)}{(r_1 r_2)}$

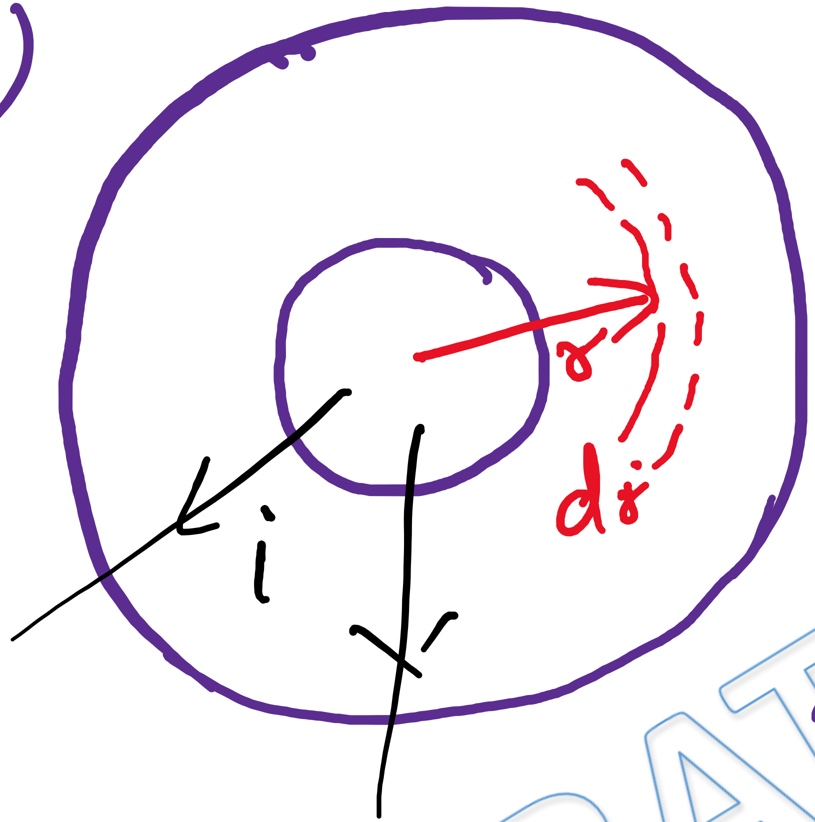
(c) $(r_2 - r_1)$

(d) $\frac{r_1 r_2}{(r_2 - r_1)}$



Ans.d

5)



Thermal resistance of differential shell of radius r

$$dR = \frac{dr}{K\,4\pi r^2}$$

Resistance of sphere

$$R = \int dR = \frac{1}{4\pi K}\int_{r_1}^{r_2}\frac{dr}{r^2} = \frac{1}{4\pi K}\left[\frac{1}{r_1} - \frac{1}{r_2}\right]$$

$$= \frac{r_2 - r_1}{4\pi K r_1 r_2}$$

thermal Current

$$i = \frac{T_1 - T_2}{R} \propto \frac{r_1 r_2}{r_2 - r_1}$$

Ans (d)

PYQs on Following Subtopic:

Black Body

Which of the following is more close to a black body?

(a) black board paint (b) green leaves [2002]

(c) black holes (d) red roses

JEE Main

Ans.a

6) Black colored objects absorb more radiation then objects having other colours. That is why black board paint is more close to black body.

Black holes are not made of atoms. Their radiation style is completely different then other objects.

Ans (a)

PYQs on Following Subtopic:

Stefan's Law

Two spheres of the same material have radii 1 m and 4 m and temperatures 4000 K and 2000 K respectively. The ratio of the energy radiated per second by the first sphere to that by the second is [2002]

JEE Main

(a) 1 : 1 (b) 16 : 1

(c) 4 : 1 (d) 1 : 9.

Ans.a

7)

$$u_1 = e\sigma\, 4\pi (1)^2 (4000)^4$$

$$u_2 = e\sigma\, 4\pi (4)^2 (2000)^4$$

$$\Rightarrow \frac{u_1}{u_2} = \frac{1}{16} \times 2^4 = 1$$

Ans (a)

PYQs on Following Subtopic:

Newton's Law of cooling

According to Newton's law of cooling, the rate of cooling of a body is proportional to $(\Delta\theta)^n$, where $\Delta\theta$ is the difference of the temperature of the body and the surroundings, and n is equal to |2003|

(a) two (b) three (c) four (d) one

JEE Main

Ans.d

8) $\left(-\frac{dT}{dt}\right) = bA(T - T_0) = bA\Delta\theta$

Rate of Cooling $\propto \Delta\theta$

$\Rightarrow n = 1$

Ans (d)

PYQs on Following Subtopic:

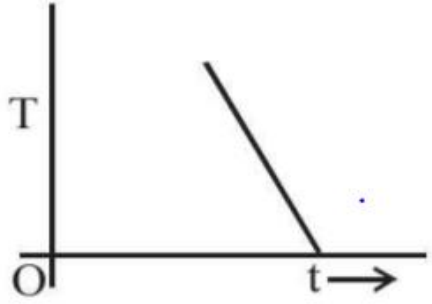
Cooling curve

If a piece of metal is heated to temperature θ and then allowed to cool in a room which is at temperature θ_0, the graph between the temperature T of the metal and time t will be closest to

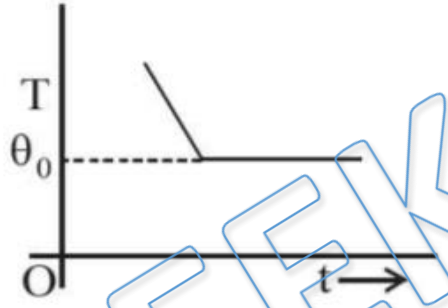
[JEE Main 2013]

JEE Main

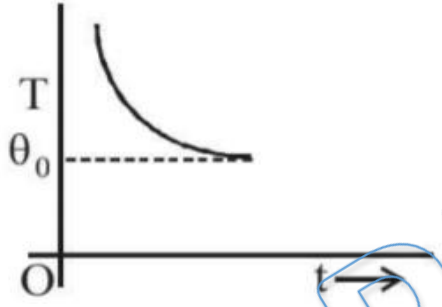
(a)



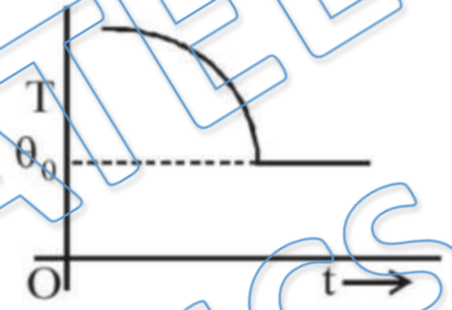
(b)



(c)



(d)



Ans.c

9)

$$-\frac{dQ}{dt} = e\sigma A(T^4 - T_0^4)$$

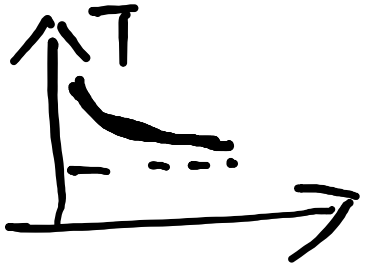
$$\Rightarrow -ms\frac{dT}{dt} = e\sigma A(T^4 - T_0^4)$$

$$\Rightarrow \left(-\frac{dT}{dt}\right) = \frac{e\sigma A}{ms}(T^4 - T_0^4)$$

$$\Rightarrow |\text{slope}| = \frac{e\sigma A}{ms}(T^4 - T_0^4)$$

as the T decreases |slope| also decreases.

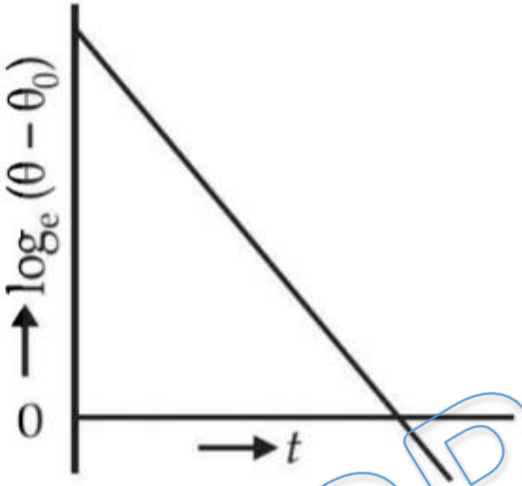
$\Rightarrow$ (C) is correct graph

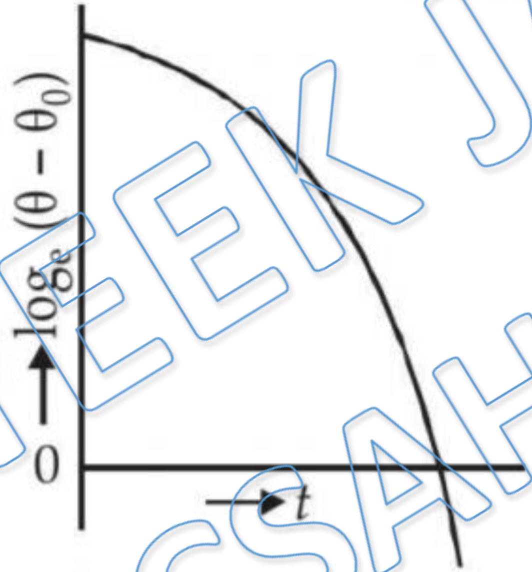


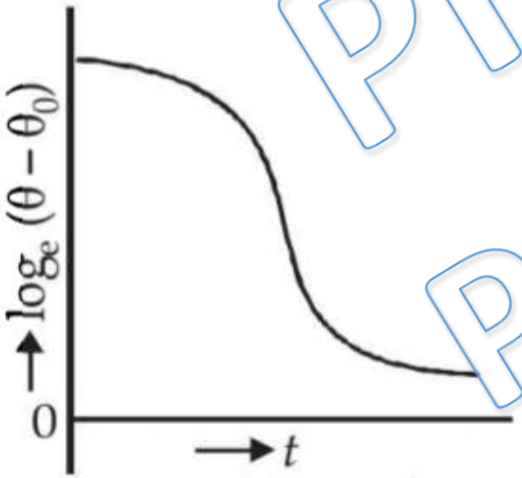
Ans(c)

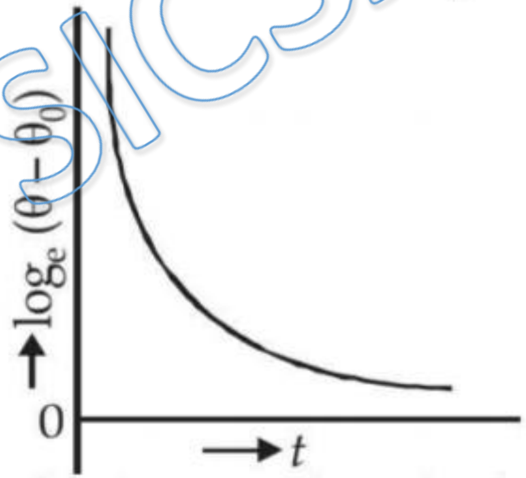
JEE Main

A liquid in a beaker has temperature $\theta(t)$ at time t and θ_0 is temperature of surroundings, then according to Newton's law of cooling the correct graph between $\log_e(\theta - \theta_0)$ and t is : [2012]

(a)


(b)


(c)


(d)


Ans.a

10)

$$-\frac{dT}{dt} = K(T - T_0)$$

$$\Rightarrow -\int_{T_i}^{T} \frac{dT}{T - T_0} = K\int_0^t dt$$

$$\Rightarrow \ln(T - T_0) - \ln(T_i - T_0) = -Kt$$

$$\Rightarrow \ln(T - T_0) = -Kt + \ln(T_i - T_0)$$

$\Rightarrow$ straight line graph, slope = −ve

$\Rightarrow$ (a) is right op

PYQs on Following Subtopic:

Power of sunlight falling on the surface of earth

Assuming the Sun to be a spherical body of radius R at a temperature of TK, evaluate the total radiant powerd incident of Earth at a distance r from the Sun [2006]

JEE Main

(a) $4\pi r_0^2 R^2 \sigma \frac{T^4}{r^2}$

(b) $\pi r_0^2 R^2 \sigma \frac{T^4}{r^2}$

(c) $r_0^2 R^2 \sigma \frac{T^4}{4\pi r^2}$

(d) $R^2 \sigma \frac{T^4}{r^2}$

where r_0 is the radius of the Earth and σ is Stefan's constant.

Ans.b

11) Ans (b)

Power emitted by sun

$$P = \sigma (4\pi R^2) T^4$$

Intensity of radiation on earth

$$I = \frac{P}{4\pi r^2} = \frac{\sigma (4\pi R^2) T^4}{4\pi r^2} = \frac{R^2 \sigma T^4}{r^2}$$

Power Incident on earth

$$= I (\pi r_0^2) = \frac{\pi r_0^2 R^2 \sigma T^4}{r^2}$$

πr_0^2 → Area of surface perpendicular to radiation.

If the temperature of the sun were to increase from T to $2T$ and its radius from R to $2R$, then the ratio of the radiant energy received on earth to what it was previously will be

(a) 32 (b) 16 [2004]

(c) 4 (d) 64

JEE Main

Ans.d

12) $U = e\sigma A T^4 = e\sigma(4\pi R^2)T^4$

on increasing R & T both to two times

Power radiated by sun increases to

$(2^2 \times 2^4)$ times, means 64 times.

$\Rightarrow$ Power received by earth

$\propto$ Power radiated by sun

$\Rightarrow$ Power received by earth increases

to 64 times.

Ans (d)

PYQs on Following Subtopic:

Spectrum

JEE Main

The earth radiates in the infra-red region of the spectrum. The spectrum is correctly given by [2003]

(a) Rayleigh Jeans law

(b) Planck's law of radiation

(c) Stefan's law of radiation

(d) Wien's law

Ans.d

13) According to wien's law →

$$\lambda_m T = b = 2.88 \times 10^{-3}\ m\text{-}K$$

Let temperature of earth is 27°C (300K)

$$\lambda_m = \frac{2.88 \times 10^{-3}}{300} m$$

$$= .96 \times 10^{-5}$$

$$= 9600\ nm$$ (Infrared region)

Ans(d)

PYQs on Following Subtopic:

Pyrometer

Infrared radiation is detected by

(a) spectrometer
(b) pyrometer
(c) nanometer
(d) photometer

JEE Main 2002

Ans.b

14) Knowledge based.

Ans (b)

For Video Solution of PYQs, Click on below link

Video Solution on Website:-

https://physicsaholics.com/home/courseDetails/72

Video Solution on YouTube:-

https://youtu.be/haMU7ZFn4v4

SUBSCRIBE

@Physicsaholics

@Physicsaholics_prateek

@NEET_Physics
@IITJEE_Physics

physicsaholics.com

Unacademy

CLICK

Links are also in the description of the video.

Chalo Niklo