10

Thermal Properties of Matter

TOPIC 1
Thermometry and Thermal Expansion

01 A copper rod of 88 cm and an aluminium rod of unknown length have their increase in length independent of increase in temperature. The length of aluminium rod is **[NEET (National) 2019]**

(a) 113.9 cm
(b) 88 cm
(c) 68 cm
(d) 6.8 cm

Ans. *(c)*

Due to change in temperature, the thermal strain produced in a rod of length L is given by

$$\frac{\Delta L}{L} = \alpha\, \Delta T$$

$\Rightarrow \quad \Delta L = L\, \alpha\, \Delta T$

where l = original length of rod and α = coefficient of liner expansion of solid rod

As the change in length (Δl) of the given two rods of copper and aluminium are independent of temperature change, i.e. ΔT is same for both copper and aluminium.

$$L_{Cu}\alpha_{Cu} = L_{Al}\alpha_{Al} \quad \text{...(i)}$$

Here, $\alpha_{Cu} = 1.7\times 10^{-5}\ K^{-1}$

$\alpha_{Al} = 2.2\times 10^{-5}\ K^{-1}$

and $L_{Cu} = 88$ cm

Substituting the given values in Eq. (i), we get

$$L_{Al} = \frac{L_{Cu}\alpha_{Cu}}{\alpha_{Al}} = \frac{1.7\times 10^{-5}\times 88}{2.2\times 10^{-5}} \simeq 68\text{ cm}$$

02 Coefficient of linear expansion of brass and steel rods are α_1 and α_2. Lengths of brass and steel rods are l_1 and l_2 respectively. If $(l_2 - l_1)$ is maintained same at all temperatures, which one of the following relations holds good ? **[NEET 2016]**

(a) $\alpha_1 l_2^2 = \alpha_2 l_1^2$
(b) $\alpha_1^2 l_2 = \alpha_2^2 l_1$
(c) $\alpha_1 l_1 = \alpha_2 l_2$
(d) $\alpha_1 l_2 = \alpha_2 l_1$

Ans. *(c)*

According to question,

Coefficient of linear expression of brass $= \alpha_1$

Coefficient of linear expression of steel $= \alpha_2$

Length of brass and steel rods are l_1 and l_2 respectively.

As given difference increase in length $(l_2' - l_1')$ is same for all temperature.

So, $l_2' - l_1' = l_2 - l_1$

$\Rightarrow \quad l_2(1+\alpha_2\Delta t) - l_1(1+\alpha_1\Delta t) = l_2 - l_1$

$\Rightarrow \quad l_2\alpha_2 = l_1\alpha_1$

03 The value of coefficient of volume expansion of glycerin is $5\times 10^{-4}\ K^{-1}$. The fractional change in the density of glycerin for a rise of 40°C in its temperature is **[CBSE AIPMT 2015]**

(a) 0.015 (b) 0.020 (c) 0.025 (d) 0.010

Ans. *(b)*

Given, the value of coefficient of volume expansion of glycerin is $5\times 10^{-4}\ K^{-1}$.

As, orginal density of glycerin,

$$\rho = \rho_0(1+Y\Delta T)$$

$\Rightarrow \quad \rho - \rho_0 = \rho_0 Y\Delta T$

Thus, fractional change in the density of glycerine for a rise of 40°C in its temperature,

$$\frac{\rho-\rho_0}{\rho_0} = Y\Delta T = 5\times 10^{-4}\times 40$$

$$= 200\times 10^{-4} = 0.020$$

04 On a new scale of temperature (which is linear) and called the W scale, the freezing and boiling points of water are 39°W and 239°W respectively. What will be the temperature on the new scale, corresponding to a temperature of 39°C on the celsius scale ? **[CBSE AIPMT 2008]**

(a) 78°W
(b) 117°W
(c) 200°W
(d) 139°W

Ans. *(b)*

The relation between true scale and new scale of temperature is given by

$$\left(\frac{t-\text{LFP}}{\text{UFP}-\text{LFP}}\right)_{\text{true}} = \left(\frac{t-\text{LFP}}{\text{UFP}-\text{LFP}}\right)_{\text{faulty}}$$

$$\frac{39^\circ C - 0^\circ C}{100^\circ C - 0^\circ C} = \frac{t - 39^\circ W}{239^\circ W - 39^\circ W}$$

$\Rightarrow \quad t = 117^\circ W$

05 The coefficients of linear expansions of brass and steel are α_1 and α_2 respectively. When we take a brass rod of length l_1 and a steel rod of length l_2 at 0°C, then the difference in their lengths $(l_2 - l_1)$ will remain the same at all temperatures, if **[CBSE AIPMT 1999]**

(a) $\alpha_1 l_1 = \alpha_2 l_2$
(b) $\alpha_1 l_2 = \alpha_2 l_1$
(c) $\alpha_1^2 l_2 = \alpha_2^2 l_1$
(d) $\alpha_1 l_2^2 = \alpha_2 l_1^2$

Ans. *(a)*

Coefficient of linear expansion

$$= \frac{\text{Change in length}}{\text{Original length} \times \text{rise in temperature}}$$

i.e. $\alpha = \frac{\Delta l}{lt}$

or $\Delta l = l \alpha t$

For brass rod, $\Delta l_1 = l_1 \alpha_1 t$

For steel rod, $\Delta l_2 = l_2 \alpha_2 t$

Since, $l_2 - l_1 = \text{constant}$ (given)

So, $\Delta l_2 - \Delta l_1 = 0$

or $\Delta l_2 = \Delta l_1$

$\therefore$ $l_2 \alpha_2 t = l_1 \alpha_1 t$

As $t \neq 0$, hence $l_2 \alpha_2 = l_1 \alpha_1$

06. Mercury thermometer can be used to measure temperature upto **[CBSE AIPMT 1992]**

(a) 260°C (b) 100°C
(c) 360°C (d) 500°C

Ans. *(c)*

Mercury thermometer is a liquid thermometer and it is based upon the uniform variation in volume of a liquid with temperature. Mercury is opaque and bright and therefore can be easily seen in the glass tube and it is good conductor of heat and attains the temperature of the hot bath quickly. A mercury thermometer can be used to measure temperature upto 300°C or so, as before boiling at 367°C, the vaporisation of mercury will start.

07. A Centigrade and a Fahrenheit thermometer are dipped in boiling water. The water temperature is lowered until the Fahrenheit thermometer registers 140°. What is the fall in temperature as registered by the Centigrade thermometer? **[CBSE AIPMT 1990]**

(a) 80° (b) 60° (c) 40° (d) 30°

Ans. *(c)*

Relation between Celsius scale and Fahrenheit scale is

$$\frac{C}{100} = \frac{F - 32}{180}$$

Putting value of $F = 140°$

$$\therefore \quad \frac{C}{100} = \frac{140 - 32}{180} = 0.6$$

$$\therefore \quad C = 60°$$

Hence, fall in temperature = Temperature of boiling water − final temperature

$100°C - 60°C = 40°C$

TOPIC 2

Specific Heat Capacity, Calorimetry and Change of State

08 The quantities of heat required to raise the temperature of two solid copper spheres of radii r_1 and r_2 $(r_1 = 1.5\, r_2)$ through 1 K are in the ratio **[NEET (Sep.) 2020]**

(a) $\frac{9}{4}$ (b) $\frac{3}{2}$ (c) $\frac{5}{3}$ (d) $\frac{27}{8}$

Ans. *(d)*

Since, heat required, $Q = mc\Delta T$

$$= \left(\frac{4}{3}\pi r^3 \cdot \rho\right) c\Delta T \qquad [\because m = V_{\text{sphere}}\, \rho]$$

Since, π, ρ, c and T are constants.

$$\Rightarrow \quad Q \propto r^3 \text{ or } \frac{Q_1}{Q_2} = \frac{r_1^3}{r_2^3}$$

$$= \left(\frac{r_1}{r_2}\right)^3 = \left(\frac{1.5\, r_2}{r_2}\right)^3 = \frac{27}{8}$$

Hence, correct option is (d).

09 A piece of ice falls from a height h so that it melts completely. Only one-quarter of the heat produced is absorbed by the ice and all energy of ice gets converted into heat during its fall. The value of h is [Latent heat of ice is 3.4×10^5 J/kg and $g = 10$ N / kg] **[NEET 2016]**

(a) 544 km (b) 136 km
(c) 68 km (d) 34 km

Ans. *(b)*

According to question as conservation of energy, energy gained by the ice during its fall from height h is given by

$$E = mgh$$

As given, only one quarter of its energy is absorbed by the ice.

$$\text{So,} \quad \frac{mgh}{4} = mL_f \;\Rightarrow\; h = \frac{mL_f \times 4}{mg}$$

$$= \frac{L_f \times 4}{g} = \frac{3.4 \times 10^5 \times 4}{10}$$

$$= 13.6 \times 10^4 = 136000 \text{ m} = 136 \text{ km}$$

10 Two identical bodies are made of a material for which the heat capacity increases with temperature. One of these is at 100°C, while the other one is at 0°C. If the two bodies are brought into contact, then assuming no heat loss, the final common temperature is **[NEET 2016]**

(a) 50°C
(b) more than 50°C
(c) less than 50°C but greater than 0°C
(d) 0°C

Ans. *(b)*

Heat lost by Ist body = heat gained by IInd body. Body at 100°C temperature has greater heat capacity than body at 0°C so final temperature will be closer to 100°C. So, $T_c > 50°$ C.

11 Steam at 100°C is passed into 20 g of water at 10°C. When water acquires a temperature of 80°C, the mass of water present will be [Take specific heat of water = 1 cal $g^{-1}\,°C^{-1}$ and latent heat of steam = 540 cal g^{-1}] **[CBSE AIPMT 2014]**

(a) 24 g (b) 31.5 g (c) 42.5 g (d) 22.5 g

Ans. *(d)*

Concept Apply principle of calorimetry.

According to principle of calorimetry

Heat lost by steam = Heat gained by water

Let m' be the amount of steam that converts into water.

$$m' \times L + m' s\, \Delta T = ms\, \Delta t$$

$$\begin{bmatrix} s = \text{Specific heat of water} \\ L = \text{Latent heat of water} \end{bmatrix}$$

$$m' \times 540 + m' \times 1 \times (100 - 80) = 20 \times 1 \times (80 - 10)$$

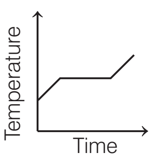
$$m' = \frac{20 \times 70}{560} = 2.5 \text{ g}$$

Now, net mass of water

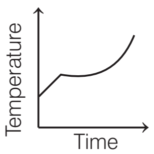
$$= 20 + 2.5 = 22.5 \text{g}$$

12 Liquid oxygen at 50 K is heated to 300 K at constant pressure of 1 atm. The rate of heating is constant. Which one of the following graphs represents the variation of temperature with time? **[CBSE AIPMT 2012]**

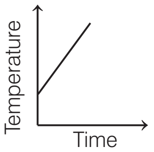
(a)



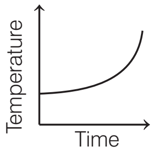
(b)



(c)



(d)



Ans. *(a)*

Graph (a) shows the variation of temperature with time. At first temperature will increase then there will be state change from liquid to gas.

13 When 1 kg of ice at 0°C melts to water at 0°C, the resulting change in its entropy, taking latent heat of ice to be 80 cal/°C, is **[CBSE AIPMT 2011]**

(a) 8×10^4 cal/K (b) 80 cal/K
(c) 293 cal/K (d) 273 cal/K

Ans. *(c)*

Change in entropy is given by

$$\Delta S = \frac{ml}{T} = \frac{1000\times80}{273} = 293 \text{ cal K}^{-1}$$

14 If 1 g of steam is mixed with 1 g of ice, then the resultant temperature of the mixture is **[CBSE AIPMT 1999]**

(a) 270°C (b) 230°C (c) 100°C (d) 50°C

Ans. *(c)*

Heat required by 1g ice at 0°C to melt into 1g water at 0°C,

$$Q_1 = mL \quad (L = \text{latent heat of fusion})$$
$$= 1\times 80 = 80 \text{ cal} \quad (L = 80 \text{ cal/g})$$

Heat required by 1g of water at 0°C to boil at 100°C,

$$Q_2 = mc\Delta\theta$$
$$(c = \text{specific heat of water})$$
$$= 1\times1(100-0) \quad (c = 1 \text{ cal/g°C})$$
$$= 100 \text{ cal}$$

Thus, total heat required by 1g of ice to reach a temperature of 100°C,

$$Q = Q_1 + Q_2 = 80 + 100 = 180 \text{ cal}$$

Heat available with 1 g of steam to condense into 1g of water at 100°C,

$Q' = mL'$ (L' = latent heat of vaporisation)

$$= 1\times 536 \text{ cal} \quad (L' = 536 \text{ cal/g})$$
$$= 536 \text{ cal}$$

Obviously, the whole steam will not be condensed and ice will attain temperature of 100°C. Thus, the temperature of mixture is 100°C.

15 Thermal capacity of 40 g of aluminium ($s = 0.2$ cal/g-K) is **[CBSE AIPMT 1990]**

(a) 168 J/°C (b) 672 J/°C
(c) 840 J/°C (d) 33.6 J/°C

Ans. *(d)*

Thermal capacity of a body is defined as the amount of heat required to raise the temperature of the (whole) body through 1°C or 1 K.

Amount of heat energy required (ΔQ) to raise the temperature of mass m of a body through temperature range (ΔT) is

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

where, s is specific heat of the body,

when $\Delta T = 1\text{K}$, ΔQ = thermal capacity

$\therefore$ Thermal capacity $= s\times m\times 1$

$= ms$

Here, $m = 40$ g, $s = 0.2$ cal/g K

$\therefore$ Thermal capacity $= 40\times0.2 = 8$ cal/°C

$= 4.2\times 8$ J/°C $= 33.6$ J/°C

16 Two containers A and B are partly filled with water and closed. The volume of A is twice that of B and it contains half the amount of water in B. If both are at the same temperature, the water vapour in the containers will have pressure in the ratio of **[CBSE AIPMT 1988]**

(a) 1 : 2 (b) 1 : 1 (c) 2 : 1 (d) 4 : 1

Ans. *(b)*

Vapour pressure of a substance is independent of amount of substance. It depends only on temperature. So they have ratio of 1:1.

17 10 g of ice cubes at 0°C are released in a tumbler (water equivalent 55 g) at 40°C. Assuming that negligible heat is taken from the surroundings, the temperature of water in the tumbler becomes nearly ($L = 80$ cal/g) **[CBSE AIPMT 1988]**

(a) 31°C (b) 22°C (c) 19°C (d) 15°C

Ans. *(b)*

Let θ be the temperature when thermal equilibrium has reached.

Heat gained by ice to be converted to water at θ°C

$$= mL + m\times s\times(\theta - 0)$$
$$= 10\times80 + 10\times1\times\theta$$

Heat lost by tumbler and its contents

$$= 55\times(40-\theta)$$

Using principle of calorimetry that

heat gained = heat lost

$$10\times80 + 10\times1\times\theta = 55\times(40-\theta)$$
$$65\theta = 2200 - 800 = 1400$$
$$\theta = \frac{1400}{65} \approx 21.5\text{°C} \approx 22\text{°C}$$

TOPIC 3
Heat Transfer

18 A cup of coffee cools from 90°C to 80°C in t minutes, when the room temperature is 20°C. The time taken by a similar cup of coffee to cool from 80°C to 60°C at a room temperature same at 20°C, is **[NEET 2021]**

(a) $\frac{13}{10}t$ (b) $\frac{13}{5}t$
(c) $\frac{10}{13}t$ (d) $\frac{5}{13}t$

Ans. *(b)*

In first conditions;

Given, the initial temperature of the cup of coffee, $T_i = 90°$C

The final temperature of the cup of coffee, $T_f = 80°$C

The time taken to drop the temperature 90°C to 80°C is t.

The temperature of the surrounding, $T_0 = 20°$C

Using the Newton's law of cooling,

$$\text{rate of cooling} = \frac{dT}{dt} = K\left[\frac{T_i + T_f}{2} - T_0\right]$$

Substituting the values in the above equation, we get

$$\frac{90-80}{t} = K\left[\frac{90+80}{2} - 20\right]$$
$$\Rightarrow \quad \frac{10}{t} = K[65] \quad \Rightarrow \quad K = \frac{2}{13t}$$

In second conditions;

The initial temperature of the cup of coffee, $T_i' = 80°$C

The final temperature of the cup of coffee, $T_f' = 60°$C.

Using the Newton's law of cooling,

$$\text{rate of cooling} = \frac{dT}{dt} = K\left[\frac{T'_i + T'_f}{2} - T_0\right]$$

Substituting the values in the above equation, we get

$$\frac{80-60}{t_1} = \frac{2}{13t}\left[\frac{60+80}{2} - 20\right]$$
$$\frac{20}{t_1} = \frac{2}{13t}[50] \quad \Rightarrow \quad t_1 = \frac{13}{5}t$$

19 Three stars A, B, C have surface temperatures T_A, T_B, T_C, respectively. Star A appears bluish, start B appears reddish and star C yellowish. Hence **[NEET (Oct.) 2020]**

(a) $T_A > T_B > T_C$ (b) $T_B > T_C > T_A$
(c) $T_C > T_B > T_A$ (d) $T_A > T_C > T_B$

Ans. *(d)*

According to Wein's displacement law,

$$\lambda = \frac{b}{T}$$

i.e., $\lambda \propto \frac{1}{T}$ ...(i)

We know that,

$$\lambda_{\text{bluish}} < \lambda_{\text{yellowish}} < \lambda_{\text{reddish}}$$

Hence, using Eq. (i), we have

$$T_A > T_C > T_B$$

20 An object kept in a large room having air temperature of 25°C takes 12 minutes to cool from 80°C to 70°C.

The time taken to cool for the same object from 70°C to 60°C would be nearly **[NEET (Odisha) 2019]**

(a) 10 min (b) 12 min
(c) 20 min (d) 15 min

Ans. *(d)*

Key Idea From Newton's law of cooling, the time taken (t) by a body to cool from T_1 to T_2 when placed in a medium of temperature T_0 can be calculated from relation

$$\frac{T_1 - T_2}{t} = \frac{1}{K}\left(\frac{T_1 + T_2}{2} - T_0\right)$$

When the object cool from 80°C to 70°C in 12 minutes, then from Newton's law of cooling,

$$\frac{80-70}{12} = \frac{1}{K}\left(\frac{80+70}{2} - 25\right) [\because T_0 = 25^\circ \text{C}]$$

$$\frac{5}{6} = \frac{1}{K}50 \quad \text{...(i)}$$

Similarly, when object cool from 70°C to 60°C we get

$$\frac{70-60}{t} = \frac{1}{K}\left(\frac{70+60}{2} - 25\right)$$

$$\frac{10}{t} = \frac{1}{K}40 \quad \text{...(ii)}$$

Divide Eq. (i) and (ii), we get

$$\frac{5}{6} \times \frac{t}{10} = \frac{50}{40}$$

$$\Rightarrow \quad t = \frac{5}{4} \times 12 = 15 \text{ minutes}$$

21 A deep rectangular pond of surface area A, containing water (density $= \rho$, specific heat capacity $= s$), is located in a region where the outside air temperature is a steady value at the -26°C. The thickness of the frozen ice layer in this pond, at a certain instant is x.

Taking the thermal conductivity of ice as K, and its specific latent heat of fusion as L, the rate of increase of the thickness of ice layer, at this instant would be given by **[NEET (Odisha) 2019]**

(a) $26K/\rho r(L-4s)$ (b) $26K/(\rho x^2 - L)$
(c) $26K/(\rho x L)$ (d) $26K/\rho r(L+4s)$

Ans. *(c)*

Key Idea If area of cross-section of a surface is not uniform or if the steady state condition is not reached, the heat flow equation can be applied to a thin layer of material perpendicular to direction of heat flow.

The rate of heat flow by conduction for growth of ice is given by,

$$\frac{d\theta}{dt} = \frac{KA(\theta_0 - \theta_1)]}{x}$$

where, $d\theta = \rho A dx L$, $\theta_0 = 0$ and $\theta_1 = -\theta$

Given, $\theta_0 = 0°\text{C}$, $\theta_1 = -26°\text{C}$

The rate of increase of thickness can be calculated from Eq.

$$\frac{d\theta}{dt} = \frac{KA(\theta_0 - \theta_1)}{x}$$

$$\Rightarrow \quad \frac{\rho A dx L}{dt} = \frac{KA(\theta_0 - \theta_1)}{x}$$

$$\Rightarrow \quad \frac{dx}{dt} = \frac{KA(\theta_0 - \theta_1)}{\rho A x L}$$

$$= \frac{K[0-(-26)]}{\rho x L} = \frac{26K}{\rho x L}$$

22 The power radiated by a black body is P and it radiates maximum energy at wavelength, λ_0. If the temperature of the black body is now changed, so that it radiates maximum energy at wavelength $\frac{3}{4}\lambda_0$, the power radiated by it becomes nP. The value of n is **[NEET 2018]**

(a) $\frac{256}{81}$ (b) $\frac{4}{3}$
(c) $\frac{3}{4}$ (d) $\frac{81}{256}$

Ans. *(a)*

According to Wien's law,

$$\lambda_{\max} \propto \frac{1}{T}$$

i.e. $\lambda_{\max} T = \text{constant}$

where, $\lambda_{\max}$ is the maximum wavelength of the radiation emitted at temperature T.

$$\therefore \quad \lambda_{\max_1} T_1 = \lambda_{\max_2} T_2$$

or $\frac{T_1}{T_2} = \frac{\lambda_{\max_2}}{\lambda_{\max_1}}$ ...(i)

Here, $\lambda_{\max_1} = \lambda_0$ and $\lambda_{\max_2} = \frac{3}{4}\lambda_0$

Substituting the above values in Eq. (i), we get

$$\frac{T_1}{T_2} = \frac{\frac{3}{4}\lambda_0}{\lambda_0} = \frac{3}{4}$$

or $\frac{T_1}{T_2} = \frac{3}{4}$ ...(ii)

As we know that, from Stefan's law, the power radiated by a body at temperature T is given as

$$P = \sigma A e T^4$$

i.e. $P \propto T^4$

($\because$ the quantity σAe is constant for a body)

$$\Rightarrow \quad \frac{P_1}{P_2} = \frac{T_1^4}{T_2^4} = \left(\frac{T_1}{T_2}\right)^4$$

From Eq. (i), we get

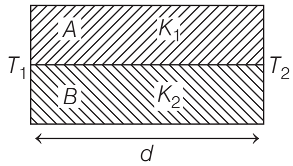
$$\frac{P_1}{P_2} = \left(\frac{3}{4}\right)^4 = \frac{81}{256}$$

Given, $P_1 = P$ and $P_2 = nP$

$$\Rightarrow \quad \frac{P_1}{P_2} = \frac{P}{nP} = \frac{81}{256}$$

or $n = \frac{256}{81}$

23 Two rods A and B of different materials are welded together as shown in figure. Their thermal conductivities are K_1 and K_2. The thermal conductivity of the composite rod will be **[NEET 2017]**



(a) $\frac{K_1 + K_2}{2}$ (b) $\frac{3(K_1 + K_2)}{2}$
(c) $K_1 + K_2$ (d) $2(K_1 + K_2)$

Ans. *(a)*

In parallel arrangement of n rods

Equivalent thermal conductivity is given by

$$K_{eq} = \frac{K_1A_1 + K_2A_2 + \ldots + K_nA_n}{A_1 + A_2 + \ldots + A_n}$$

If rods are of same area, then

$$K_{eq} = \frac{K_1 + K_2 + \ldots + K_n}{n}$$

Now, in the question, it is not given that rods are of same area. But we can judge that from given diagram.

∴ Equivalent thermal conductivity of the system of two rods

$$\Rightarrow \quad K_{eq} = \frac{K_1 + K_2}{2}$$

24 A spherical black body with a radius of 12 cm radiates 450 watt power at 500 K. If the radius were halved and the temperature doubled, the power radiated in watt would be **[NEET 2017]**

(a) 225 (b) 450
(c) 1000 (d) 1800

Ans. *(d)*

Radiated power of a black body,

$$P = \sigma A T^4$$

where, A = surface area of the body

T = temperature of the body

and σ = Stefan's constant

When radius of the sphere is halved, new area,

$$A' = \frac{A}{4}$$

∴ Power radiated,

$$P' = \sigma\left(\frac{A}{4}\right)(2T)^4 = \frac{16}{4}\cdot(\sigma A T^4)$$

$$= 4P = 4 \times 450 = 1800 \text{ watts}$$

25 A black body is at a temperature of 5760 K. The energy of radiation emitted by the body at wavelength 250 nm is U_1, at wavelength 500 nm is U_2 and that at 1000 nm is U_3. Wien's constant, $b = 2.88 \times 10^6$ nmK. Which of the following is correct ? **[NEET 2016]**

(a) $U_3 = 0$ (b) $U_1 > U_2$
(c) $U_2 > U_1$ (d) $U_1 = 0$

Ans. *(c)*

Given, temperature, $T_1 = 5760$ K

Since, it is given that energy of radiation emitted by the body at wavelength 250 nm in U_1, at wavelength 500 nm is U_2 and that at 1000 nm is U_3.

∵ According to Wien's law, we get

$$\lambda_m T = b$$

where, b = Wien's constant = 2.88×10^6 nmK

$$\Rightarrow \quad \lambda_m = \frac{b}{T}$$

$$\Rightarrow \quad \lambda_m = \frac{2.88 \times 10^6 \text{ nmK}}{5760 \text{ K}}$$

$$\Rightarrow \quad \lambda_m = 500 \text{ nm}$$

∵ λ_m = wavelength corresponding to maximum energy, so, $U_2 > U_1$.

26 A body cools from a temperature $3T$ to $2T$ in 10 minutes. The room temperature is T. Assume that Newton's law of cooling is applicable. The temperature of the body at the end of next 10 minutes will be **[NEET 2016]**

(a) $\frac{7}{4}T$ (b) $\frac{3}{2}T$ (c) $\frac{4}{3}T$ (d) T

Ans. *(b)*

According to Newton's law of cooling,

$$\Delta T = \Delta T_0 \, e^{-\lambda t}$$

$$\Rightarrow \quad 3T - 2T = (3T - T)\, e^{-\lambda \times 10} \quad \ldots(i)$$

Again for next 10 minutes

$$T' - T = (2T) \times e^{-\lambda(20)} \quad \ldots(ii)$$

From Eqs. (i) and (ii), we get

$$T' - T = (2T)\,(e^{-\lambda \times 10})^2 = (2T)\left(\frac{1}{2}\right)^2$$

$$= \frac{T}{2}$$

$$\therefore \quad T' = T + \frac{T}{2} = \frac{3T}{2}$$

27 The two ends of a metal rod are maintained at temperatures 100°C and 110°C. The rate of heat flow in the rod is found to be 4.0 J/s. If the ends are maintained at temperatures 200°C and 210°C, the rate of heat flow will be **[CBSE AIPMT 2015]**

(a) 44.0 J/s (b) 16.8 J/s
(c) 8.0 J/s (d) 4.0 J/s

Ans. *(d)*

Here, $\Delta T_1 = 110 - 100 = 10^\circ$ C

$$\frac{dQ_1}{dt} = 4 \text{ J/s} \Rightarrow \Delta T_2 = 210 - 200 = 10^\circ \text{ C}$$

$$\frac{dQ_2}{dt} = ?$$

As the rate of heat flow is directly proportional to the temperature difference and the temperature difference in both the cases is same i.e. 10ºC. So, the same rate of heat will flow in the second case.

$$\text{Hence,} \quad \frac{dQ_2}{dt} = 4 \text{ J/s}$$

28 Certain quantity of water cools from 70°C to 60°C in the first 5 min and to 54°C in the next 5 min. The temperature of the surroundings is **[CBSE AIPMT 2014]**

(a) 45°C (b) 20°C
(c) 42°C (d) 10°C

Ans. *(a)*

Concept Apply Newton's law of cooling.

Let the temperature of the surrounding be t°C.

For first case,

$$\frac{(70-60)}{5 \text{ min}} = K\,(65°\text{C} - t°\text{C})$$

(65° is average of 70°C and 60°C)

$$\frac{10}{5\text{min}} = K\,(65°\text{C} - t°\text{C}) \quad \ldots(i)$$

For second case,

$$\frac{(60-54)}{5\text{min}} = K\,(57 - t) \quad \ldots(ii)$$

(57°C is average of 60°C and 54°C)

From Eqs. (i) and (ii),

$$\frac{10}{6} = \frac{(65-t)}{(57-t)}$$

$$\text{So,} \quad t = 45°\text{ C}$$

29 A piece of iron is heated in a flame. If first becomes dull red then becomes reddish yellow and finally turns to white hot. The correct explanation for the above observation is possible by using **[NEET 2013]**

(a) Stefan's law
(b) Wien's displacement law
(c) Kirchhoff's law
(d) Newton's law of cooling

Ans. *(b)*

Equation of Wien's displacement law is given by $\lambda_m T$ = constant

30 If the radius of a star is R and it acts as a black body, what would be the temperature of the star, in which the rate of energy production is Q? **[CBSE AIPMT 2012]**

(σ stands for Stefan's constant.)

(a) $Q/4\pi R^2\sigma$ (b) $(Q/4\pi R^2\sigma)^{-1/2}$
(c) $(4\pi R^2 Q/\sigma)^{1/4}$ (d) $(Q/4\pi R^2\sigma)^{1/4}$

Ans. *(d)*

From Stefan' law,

$$E = \sigma T^4$$

So, the rate of energy production

$$Q = E \times A$$

$$Q = \sigma T^4 \times 4\pi R^2$$

Temperature of star

$$T = \left(\frac{Q}{4\pi R^2 \sigma}\right)^{1/4}$$

31 A cylindrical metallic rod in thermal contact with two reservoirs of heat at its two ends conducts an amount of heat Q in time t. The metallic rod is melted and the material is formed into a rod of half the radius of the original rod. What is the amount of heat conducted by the new rod when placed in thermal contact with the two reservoirs in time t? **[CBSE AIPMT 2010]**

(a) $Q/4$ (b) $Q/16$ (c) $2Q$ (d) $Q/2$

Ans. *(b)*

In steady state the amount of heat flowing from one face to the other face in time t is given by $Q = \frac{KA(\theta_1 - \theta_2)\,t}{l}$,

where K is coefficient of thermal conductivity of material of rod

$$\Rightarrow \quad \frac{Q}{t} \propto \frac{A}{l} \propto \frac{r^2}{l} \quad \text{...(i)}$$

As the metallic rod is melted and the material is formed into a rod of half the radius

$$V_1 = V_2$$

$$\pi r_1^2 l_1 = \pi r_2^2 l_2 \qquad \left[\because r_2 = \frac{r_1}{2}\right]$$

$$\Rightarrow \quad l_1 = \frac{l_2}{4} \quad \text{...(ii)}$$

Now, from Eqs. (i) and (ii)

$$\frac{Q_1}{Q_2} = \frac{r_1^2}{l_1} \times \frac{l_2}{r_2^2} = \frac{r_1^2}{l_1} \times \frac{4l_1}{(r_1/2)^2}$$

$$\Rightarrow \quad Q_1 = 16\,Q_2 \quad \Rightarrow \quad Q_2 = \frac{Q_1}{16}$$

32 A black body at 227°C radiates heat at the rate of 7 cal $cm^{-2} s^{-1}$. At a temperature of 727°C, the rate of heat radiated in the same units will be **[CBSE AIPMT 2009]**

(a) 60 (b) 50 (c) 112 (d) 80

Ans. *(c)*

According to Stefan's law

$E = \sigma T^4$

σ = Stefan's constant

T = temperature

$$\frac{E_1}{E_2} = \left[\frac{T_1}{T_2}\right]^4 \Rightarrow E_2 = 7\left[\frac{273+727}{273+227}\right]^4$$

$$= \left[\frac{1000}{500}\right]^4 \times 7$$

$$= 112 \text{ cal-cm}^2\text{s}^{-1}$$

33 The two ends of a rod of length L and a uniform cross-sectional area A are kept at two temperatures T_1 and T_2 ($T_1 > T_2$). The rate of heat transfer, $\frac{dQ}{dt}$, through the rod in a steady state is given by **[CBSE AIPMT 2009]**

(a) $\frac{dQ}{dt} = \frac{KL(T_1 - T_2)}{A}$ (b) $\frac{dQ}{dt} = \frac{K(T_1 - T_2)}{LA}$

(c) $\frac{dQ}{dt} = KLA(T_1 - T_2)$ (d) $\frac{dQ}{dt} = \frac{KA(T_1 - T_2)}{L}$

Ans. *(d)*

For a rod of length L and area of cross-section A whose faces are maintained at temperatures T_1 and T_2 respectively. Then in steady state the rate of heat flowing from one face to the other face in time t is given by

$$\frac{dQ}{dt} = \frac{KA(T_1 - T_2)}{L}$$

34 A black body is at 727°C. It emits energy at a rate which is proportional to **[CBSE AIPMT 2007]**

(a) $(727)^2$ (b) $(1000)^4$

(c) $(1000)^2$ (d) $(727)^4$

Ans. *(b)*

According to Stefan's law,

$$E \propto T^4 \quad \text{or} \quad E = \sigma T^4$$

where, σ is constant of proportionality and called Stefan's constant. Its value is 5.67×10^{-8} Wm^{-2} K^{-4}

Here, $E \propto (727 + 273)^4 \Rightarrow E \propto (1000)^4$

35 Assuming the sun to have a spherical outer surface of radius r, radiating like a black body at temperature t °C, the power received by a unit surface, (normal to the incident rays) at a distance R from the centre of the sun is where, σ is the Stefan's constant. **[CBSE AIPMT 2007]**

(a) $\frac{4\pi r^2 t^4}{R^2}$ (b) $\frac{r^2\sigma(t+273)^4}{4\pi R^2}$

(c) $\frac{16\pi^2 r^2 \sigma t^4}{R^2}$ (d) $\frac{r^2\sigma(t+273)^4}{R^2}$

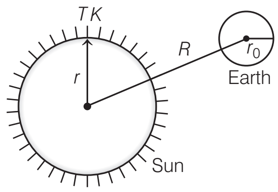
Ans. *(d)*

From Stefan's law, the rate at which energy is radiated by sun at its surface is

$$P = \sigma \times 4\pi r^2 T^4$$

[Sun is a perfectly black body as it emits radiations of all wavelengths and so for it $e = 1$]

The intensity of this power at the earth's surface (under the assumption $R >> r_0$) is



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

$$= \frac{\sigma r^2 T^4}{R^2} = \frac{\sigma r^2\,(t+273)^4}{R^2}$$

36 A black body at 1227°C emits radiations with maximum intensity at a wavelength of 5000 Å. If the temperature of the body is increased by 1000°C, the maximum intensity will be observed at **[CBSE AIPMT 2006]**

(a) 4000 Å (b) 5000 Å

(c) 6000 Å (d) 3000 Å

Ans. *(d)*

According to Wien's law

$$\lambda_m T = \text{constant (say } b)$$

where, λ_m is wavelength corresponding to maximum intensity of radiation and T is temperatures of the body in kelvin. So for two different cases i.e. at two different temperature of body

$$\therefore \quad \frac{\lambda'_{m'}}{\lambda_m} = \frac{T}{T'}$$

Given, $T = 1227 + 273 = 1500$ K,

$T' = 1227 + 1000 + 273$

$= 2500$ K

$\lambda_m = 5000$ Å

Hence, $\lambda'_m = \frac{1500}{2500} \times 5000 = 3000$ Å

37 Which of the following circular rods, (given radius r and length l) each made of the same material and whose ends are maintained at the same temperature will conduct most heat ? **[CBSE AIPMT 2005]**

(a) $r = 2r_0; l = 2l_0$ (b) $r = 2r_0; l = l_0$

(c) $r = r_0; l = l_0$ (d) $r = r_0; l = 2l_0$

Ans. *(b)*

As from law of heat transfer through conduction

$$H = \frac{\Delta Q}{\Delta t} = KA\left(\frac{T_1 - T_2}{l}\right)$$

$$\Rightarrow \quad H \propto \frac{r^2}{l} \quad \ldots(i)$$

(a) When $r = 2r_0; l = 2l_0$

$$H \propto \frac{(2r_0)^2}{2l_0} \Rightarrow H \propto \frac{2r_0^2}{l_0}$$

(b) When $r = 2r_0; l = l_0$

$$H \propto \frac{(2r_0)^2}{l_0} \Rightarrow H \propto \frac{4r_0^2}{l_0}$$

(c) When $r = r_0; l = l_0 \Rightarrow H \propto \frac{r_0^2}{l_0}$

(d) When $r = r_0; l = 2l_0 \Rightarrow H \propto \frac{r_0^2}{2l_0}$

It is obvious that heat conduction will be more in case (b).

38 If λ_m denotes the wavelength at which the radiative emission from a black body at a temperature T K is maximum, then **[CBSE AIPMT 2004]**

(a) $\lambda_m \propto T^4$
(b) λ_m is independent of T
(c) $\lambda_m \propto T$
(d) $\lambda_m \propto T^{-1}$

Ans. *(d)*

According to Wien's displacement law, the wavelength (λ_m) of maximum intensity of emission of black body radiation is inversely proportional to absolute temperature (T) of the black body.

i.e. $\quad \lambda_m T = \text{constant}$

or $\quad \lambda_m = \frac{\text{constant}}{T}$

or $\quad \lambda_m \propto \frac{1}{T}$ or $\lambda_m \propto T^{-1}$

39 We consider the radiation emitted by the human body. Which of the following statements is true ? **[CBSE AIPMT 2003]**

(a) The radiation is emitted during the summers and absorbed during the winters
(b) The radiation emitted lies in the ultraviolet region and hence is not visible
(c) The radiation emitted is in the infrared region
(d) The radiation is emitted only during the day

Ans. *(c)*

The heat radiation emitted by the human body is the infrared radiation. Their wavelength is of the order of 7.9×10^{-7} m to 10^{-3} m which is of course the range of infrared region.

40 Consider a compound slab consisting of two different materials having equal thicknesses and thermal conductivities K and $2K$, respectively. The equivalent thermal conductivity of the slab is **[CBSE AIPMT 2003]**

(a) $3K$ (b) $\frac{4}{3}K$ (c) $\frac{2}{3}K$ (d) $\sqrt{2}K$

Ans. *(b)*

The quantity of heat flowing across a slab in time t,

$$Q = \frac{KA\Delta\theta}{l}$$

K = thermal conductivity
ΔQ = change in temperature
A = area of slab
l = thickness

For same heat flow through each slab and (composite slab), we have

$$\frac{K_1 A(\Delta\theta_1)}{l} = \frac{K_2 A(\Delta\theta_2)}{l} = \frac{K' A(\Delta\theta_1 + \Delta\theta_2)}{2l}$$

or $K_1\Delta\theta_1 = K_2\Delta\theta_2 = \frac{K'}{2}(\Delta\theta_1 + \Delta\theta_2) = C$ (say)

So, $\quad \Delta\theta_1 = \frac{C}{K_1}, \ \Delta\theta_2 = \frac{C}{K_2}$

and $\quad (\Delta\theta_1 + \Delta\theta_2) = \frac{2C}{K'}$

or $\quad \frac{C}{K_1} + \frac{C}{K_2} = \frac{2C}{K'}$

or $\quad C\left(\frac{K_1 + K_2}{K_1 K_2}\right) = \frac{2C}{K'}$

$\therefore \quad K' = \frac{2K_1 K_2}{K_1 + K_2}$

Given, $\quad K_1 = K, K_2 = 2K$

So, $\quad K' = \frac{2K \times 2K}{K + 2K} = \frac{4}{3}K$

41 For a black body at temperature 727°C, its radiating power is 60 W and temperature of surrounding is 227°C. If the temperature of the black body is changed to 1227°C, then its radiating power will be **[CBSE AIPMT 2002]**

(a) 120 W (b) 240 W
(c) 304 W (d) 320 W

Ans. *(d)*

Boltzmann corrected Stefan's law and stated that the amount of radiations emitted by the body, not only depends upon the temperature of the body but also on the temperature of the surrounding. The radiated power by the body is given by

$$P = \sigma(T^4 - T_0^4) \quad \ldots(i)$$

where T_0 is the absolute temperature of the surrounding and T is the temperature of body.

So for two different cases ratio of radiation power is given by

$$\therefore \quad \frac{P_2}{P_1} = \left(\frac{T_2^4 - T_0^4}{T_1^4 - T_0^4}\right) \quad \ldots(ii)$$

Here, $P_1 = 60$ W, $T_1 = 727°\text{C} = 1000$ K

$T_0 = 227°\text{C} = 500$ K,

$T_2 = 1227°\text{C} = 1500$ K

Substituting in Eq. (ii), we get

$$P_2 = \frac{(1500)^4 - (500)^4}{(1000)^4 - (500)^4} \times 60$$

$$= \frac{(500)^4}{(500)^4} \times \left[\frac{3^4 - 1}{2^4 - 1}\right] \times 60$$

$$= \frac{80}{15} \times 60 = 320 \text{ W}$$

42 Consider two rods of same length and different specific heats (s_1, s_2), thermal conductivities (K_1, K_2) and areas of cross-section (A_1, A_2) and both having temperatures (T_1, T_2) at their ends. If their rate of loss of heat due to conduction are equal, then **[CBSE AIPMT 2002]**

(a) $K_1 A_1 = K_2 A_2$ (b) $\frac{K_1 A_1}{s_1} = \frac{K_2 A_2}{s_2}$

(c) $K_2 A_1 = K_1 A_2$ (d) $\frac{K_2 A_1}{s_2} = \frac{K_1 A_2}{s_1}$

Ans. *(a)*

Rate of loss of heat by conduction is,

$$H = \frac{\Delta Q}{\Delta t} = K A\left(\frac{T_1 - T_2}{l}\right)$$

All the symbols have their usual meaning.

For first rod, $\quad H_1 = K_1 A_1\left(\frac{T_1 - T_2}{l_1}\right)$

For second rod, $\quad H_2 = K_2 A_2\left(\frac{T_1 - T_2}{l_2}\right)$

but $\quad l_1 = l_2$ i.e. of same length

and $\quad H_1 = H_2$ i.e. same rate of loss of heat through conduction. So, we have

$$K_1 A_1 (T_1 - T_2) = K_2 A_2 (T_1 - T_2)$$

or $\quad K_1 A_1 = K_2 A_2$

43 Wien's displacement law expresses relation between

[CBSE AIPMT 2002]

(a) wavelength corresponding to maximum energy and absolute temperature
(b) radiated energy and wavelength
(c) emissive power and temperature
(d) colour of light and temperature

Ans. *(a)*

According to Wien's displacement law, the quantity of energy radiated out by a body is not uniformly distributed over all the wavelengths emitted by it. It is maximum for a particular wavelength (λ), which is different at different temperatures. As the temperature is increased, the value of the wavelength which carries maximum energy is decreased.

The statement of this law is as follows

"The wavelength corresponding to maximum energy is inversely proportional to the absolute temperature of the body."

i.e. $\lambda_m \propto \frac{1}{T}$

or $\lambda_m T = \text{constant}$

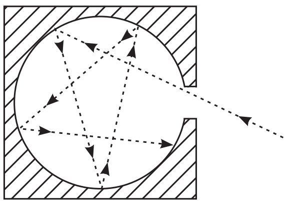
44 Which of the following is close to an ideal black body ?

[CBSE AIPMT 2002]

(a) Black lamp
(b) Cavity maintained at constant temperature
(c) Platinum black
(d) A lamp of charcoal heated to high temperature

Ans. *(b)*

Materials like black velvet or lamp black come close to ideal black bodies, but the best practical realization of an ideal black body is a small hole leading into a cavity maintained at constant temperature as this absorbs 98% of the radiation incident on them. Cavity approxi- mating an ideal black body is shown in the figure. Radiation entering the cavity has little chance of leaving before it is completely absorbed.



45 Rate of heat flow through a cylindrical rod is H_1. Temperatures of ends of rod are T_1 and T_2. If all the dimensions of rod become double and temperature difference remains same and rate of heat flow becomes H_2. Then,

[CBSE AIPMT 2001]

(a) $H_2 = 2H_1$ (b) $H_2 = \frac{H_1}{2}$

(c) $H_2 = \frac{H_1}{4}$ (d) $H_2 = 4H_1$

Ans. *(a)*

Rate of heat flow w.r.t. time

$$\frac{H_2}{H_1} = \frac{l_2}{l_1} = \frac{2l_1}{l_1}$$

K = Thermal conductivity

A = Area of body

l = Thickness or $H \propto \frac{A}{l}$

Since, dimensions of area $(A) = [L^2]$

Dimensions of length $(l) = [L]$

$\therefore \quad H \propto l$

or $\frac{H_2}{H_1} = \frac{l_2}{l_1} = \frac{2l_1}{l_1} \quad (\because l_2 = 2l_1)$

or $H_2 = 2H_1$

46 The wavelength corresponding to maximum intensity of radiation emitted by a source at temperature 2000 K is λ, then what is the wavelength corresponding to maximum intensity of radiation at temperature 3000 K?

[CBSE AIPMT 2001]

(a) $\frac{2}{3}\lambda$ (b) $\frac{16}{81}\lambda$ (c) $\frac{81}{16}\lambda$ (d) $\frac{4}{3}\lambda$

Ans. *(a)*

Wien's displacement law is given by

$\lambda_m T$ = constant

λ_m = maximum wavelength radiation

T = temperature of the body

So for two different cases, i.e. at two different temperatures

or $\lambda_1 T_1 = \lambda_2 T_2$

$$\lambda_2 = \lambda_1 \left(\frac{T_1}{T_2}\right)$$

Given, $T_1 = 2000\text{ K}, T_2 = 3000\text{ K}, \lambda_1 = \lambda$

$\therefore \quad \lambda_2 = \lambda \times \frac{2000}{3000} = \frac{2}{3}\lambda$

47 Which one of the following processes depends on gravity ?

[CBSE AIPMT 2000]

(a) Conduction (b) Convection
(c) Radiation (d) None of these

Ans. *(b)*

(a) Conduction is the process of transmission of heat in a body from the hotter part to the colder part without any bodily movement of constituent atoms or molecules of the body.
(b) In convection, the heated lighter particles move upward and colder heavier particles move downward to their place. This depends on weight and hence, on gravity.
(c) Radiation is the process of transmission of heat from one body to another body through electromagnetic waves even through vacuum, irrespective of their temperatures.

Hence, choice (b) is correct.

48 The radiant energy from the sun, incident normally at the surface of earth is 20 kcal/m^2 min. What would have been the radiant energy, incident normally on the earth, if the sun had a temperature, twice of the present one ?

[CBSE AIPMT 1998]

(a) 160 kcal/m^2 min (b) 40 kcal/m^2 min
(c) 320 kcal/m^2 min (d) 80 kcal/m^2 min

Ans. *(c)*

Concept Apply Stefan's law

According to Stefan's law, the rate at which an object radiates energy is proportional to the fourth power of its absolute temperature, i.e.

$$E = \sigma T^4 \quad \text{or} \quad E \propto T^4$$

$(\sigma = \text{Stefan's constant})$

so for two different cases, $\frac{E_1}{E_2} = \left(\frac{T_1}{T_2}\right)^4$

Given, $T_1 = T, T_2 = 2T, E_1 = 20\text{ kcal/m}^2\text{ min}$

$\therefore \quad \frac{20}{E_2} = \left(\frac{T}{2T}\right)^4$ or $\frac{20}{E_2} = \frac{1}{16}$

$\therefore \quad E_2 = 20 \times 16 = 320\text{ kcal/m}^2\text{ min}$

49 A black body is at temperature of 500 K. It emits energy at rate which is proportional to **[CBSE AIPMT 1997]**

(a) $(500)^4$ (b) $(500)^3$ (c) $(500)^2$ (d) 500

Ans. *(a)*

According to Stefan's law, energy emitted

$$E \propto T^4$$

$$E = \sigma T^4$$

$(\sigma = \text{Stefan's constant})$

$\therefore \quad E \propto (500)^4$

50 A beaker full of hot water is kept in a room. If it cools from 80°C to 75°C in t_1 minutes, from 75°C to 70°C in t_2 minutes and from 70°C to 65°C to in t_3 minutes, then **[CBSE AIPMT 1995]**

(a) $t_1 = t_2 = t_3$ (b) $t_1 < t_2 = t_3$
(c) $t_1 < t_2 < t_3$ (d) $t_1 > t_2 > t_3$

Ans. *(c)*

By Newton's law of cooling, rate of fall of temperature ∝ average temperature excess. In each case average temperature excess decreases, so rate of fall of temperature decreases. Hence, $t_1 < t_2 < t_3$. Because more and more time is required to cool, if the average temperature goes Q in decreasing.

51 A body cools from 50°C to 49.9°C in 5 s. How long will it take to cool from 40°C to 39.9°C ? (Assume the temperature of surroundings to be 30.0°C and Newton's law of cooling to be valid) **[CBSE AIPMT 1994]**

(a) 2.5 s (b) 10 s
(c) 20 s (d) 5 s

Ans. *(b)*

According to Newton's law of cooling, the rate of loss of heat of a body is directly proportional to the difference in temperatures of the body and the surroundings, provided the difference in temperature is small, not more than 30°C.

∴ Average rate of fall of temperature ∝ average temperature excess

i.e., $\frac{dT}{dt} \propto (T_t - T_s)$

$\Rightarrow \quad \frac{dT}{dt} = K(T_t - T_s)$

According to question for 1st and 2nd case,

$$\frac{50.1-49.9}{5} = k\left[\frac{50.1+49.9}{2} - 30\right] \quad \text{...(i)}$$

$$\frac{40.1-39.9}{t'} = k\left[\frac{40.1+39.9}{2} - 30\right] \quad \text{...(ii)}$$

Dividing Eq. (i) by Eq. (ii), we get

$$\frac{2}{5} \times \frac{t'}{2} = \frac{20}{10} \Rightarrow t' = 10\text{ s}$$

52 If the temperature of the sun is doubled, the rate of energy received on earth will be increased by a factor of **[CBSE AIPMT 1993]**

(a) 2 (b) 4
(c) 8 (d) 16

Ans. *(d)*

According to Stefan-Boltzmann law, amount of heat energy (E) radiated per second by unit area of a body is directly proportional to the fourth power of absolute temperature (T) of the body

i.e. $E \propto T^4$ or $E = \sigma T^4$

If T is doubled, E becomes $(2)^4$ times (i.e. 16 times).