DPP No: 22

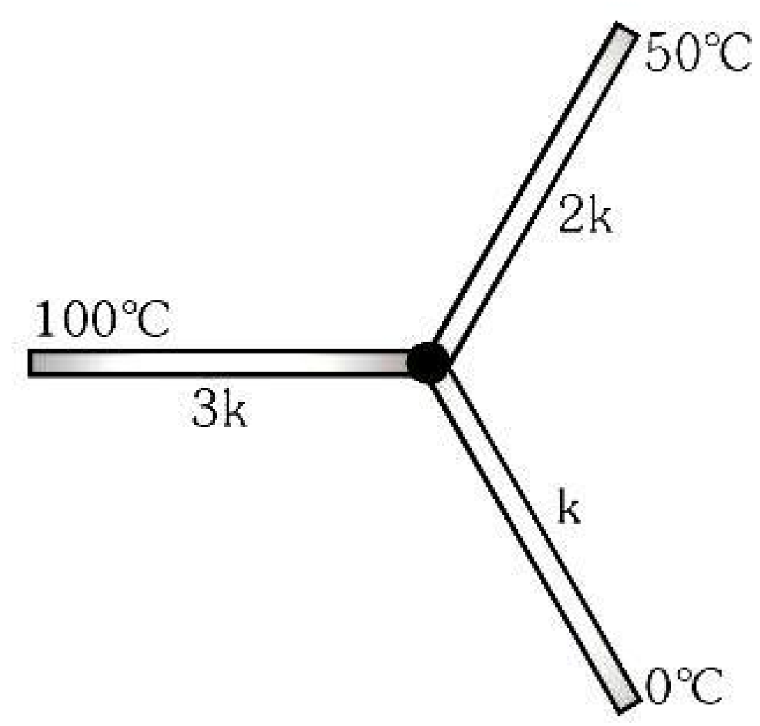
Maximum Time
50 Min

PHYSICS

TARGET
JEE-MAINS

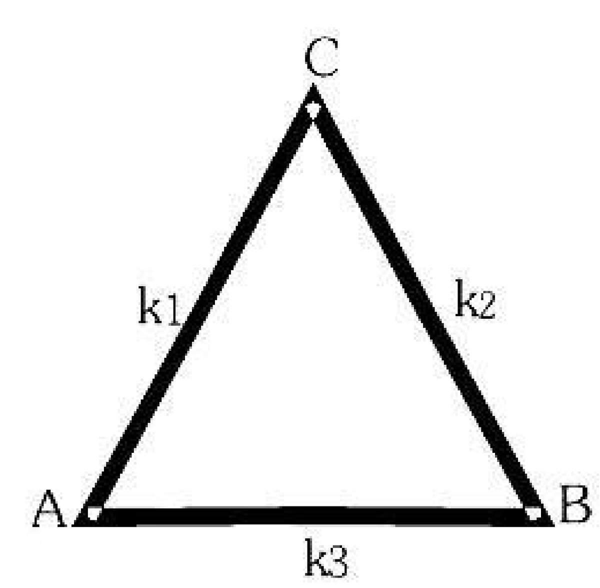
SYLLABUS : HEAT TRANSFER + ALTERNATING CURRENT

1. Three rods of the same dimensions have thermal conductivities 3k, 2k and k. They are arranged as shown, with their ends at 100°C, 50°C and 0°C. The temperature of their junction is:–



(A) 75°C (B) $\frac{200}{3}$°C (C) 40°C (D) $\frac{100}{3}$°C

2. Three rods of same dimensions are arranged as shown in the figure. They have thermal conductivities k_1, k_2 & k_3. The points A and B are maintained at different temperatures. For the heat to flow at the same rate along ACB and AB :–

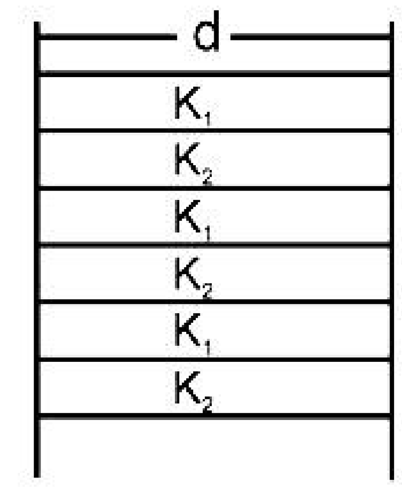


(A) $k_3 = 2(k_1 + k_2)$ (B) $k_3 = \frac{k_1k_2}{k_1 + k_2}$ (C) $k_3 = k_1 + k_2$ (D) $k_3 = \frac{1}{2}(k_1 + k_2)$

3. A wall has two layers A and B, each made of different material. Both the layers have the same thickness. The thermal conductivity for A is twice that of B. Under steady state, the temperature difference across the whole wall is 36°C. Then the temperature difference across the layer A is

(A) 6°C (B) 12°C (C) 18°C (D) 24°C

4. A wall consists of alternating blocks with length 'd' and coefficient of thermal conductivity k_1 and k_2. The cross sectional area of the blocks are the same. The equivalent coefficient of thermal conductivity of the wall between left and right is :-



(A) $K_1 + K_2$ (B) $\frac{(K_1+K_2)}{2}$ (C) $\frac{K_1 K_2}{K_1+K_2}$ (D) $\frac{2K_1 K_2}{K_1+K_2}$

5. A lake surface is exposed to an atmosphere where the temperature is < 0°C. If the thickness of the ice layer formed on the surface grows from 2 cm to 4 cm in 1 hour, The atmospheric temperature, T_a will be-

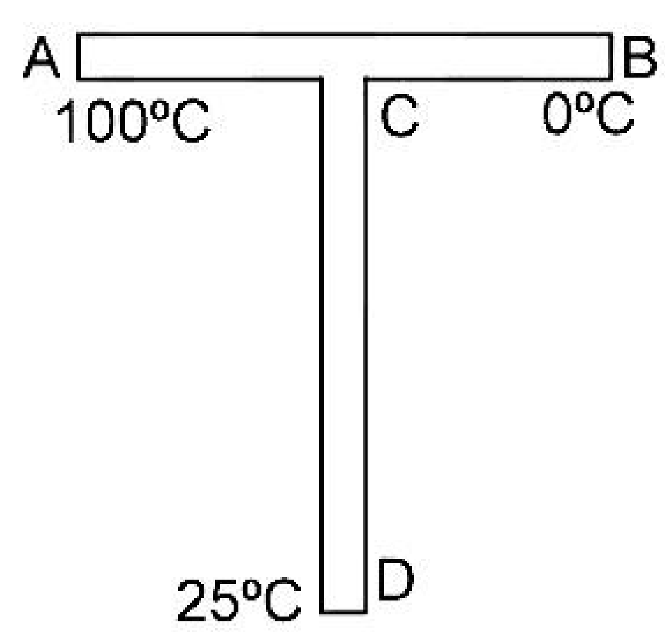
(Thermal conductivity of ice K = 4 x 10^{-3} cal/cm/s/°C; density of ice = 0.9 gm/cc. Latent heat of fusion of ice = 80 cal/gm. Neglect the change of density during the state change. Assume that the water below the ice has 0° temperature every where)

(A) – 20 °C (B) 0 °C (C) – 30 °C (D) – 15 °C

6. A uniform slab of dimension 10cm × 10cm × 1cm is kept between two heat reservoirs at temperatures 10ºC and 90ºC. The larger surface areas touch the reservoirs. The thermal conductivity of the material is 0.80 W/m–ºC. Find the amount of heat flowing through the slab per second.

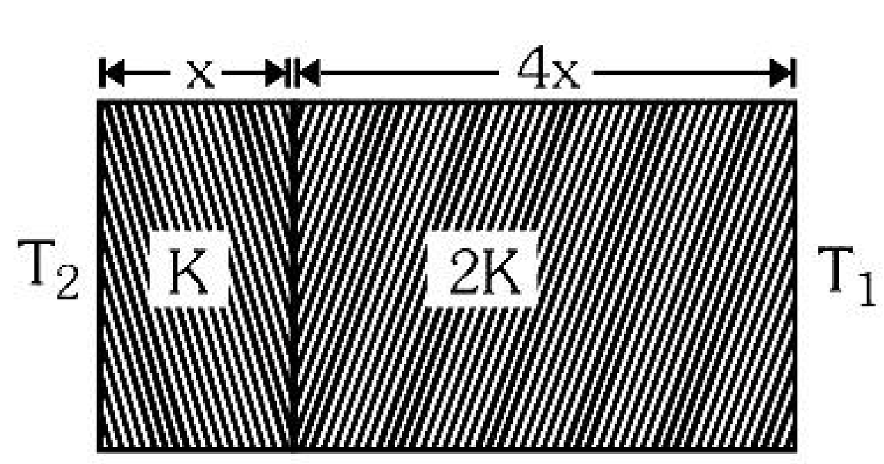
(A) 15 J (B) 32 J (C) 48 J (D) 64 J

7. A rod CD of thermal resistance 5.0 K/W is joined at the middle of an identical rod AB as shown in figure. The ends A, B and D are maintained at 100ºC, 0ºC and 25ºC respectively. Find the heat current in CD.



(A) 2.0 W (B) 4.0 W (C) 6.0 W (D) 8.0 W

8. 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 equals to:–



(A) 1 (B) 1/2 (C) 2/3 (D) 1/3

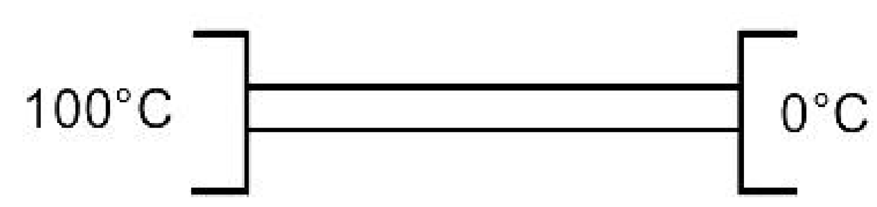
9. Heat flows radially outward through a spherical shell of outside radius R_2 and inner radius R_1. The temperature of inner surface of shell is θ_1 and that of outer is θ_2. The radial distance from centre of shell where the temperature is just half way between θ_1 and θ_2 is :

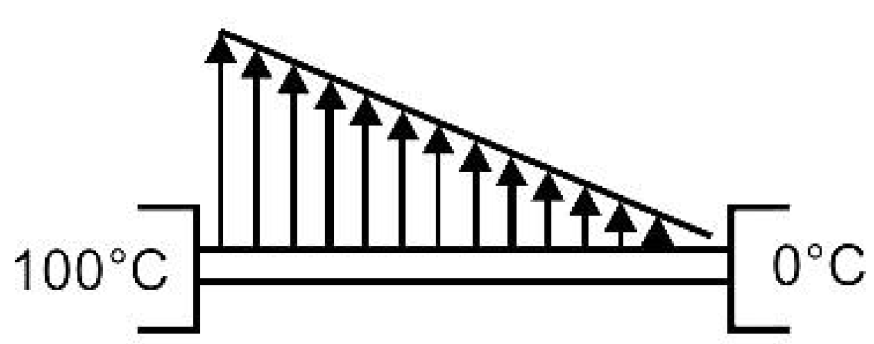
(A) $\frac{R_1+R_2}{2}$ (B) $\frac{R_1R_2}{R_1+R_2}$ (C) $\frac{2R_1R_2}{R_1+R_2}$ (D) $R_1 + \frac{R_2}{2}$

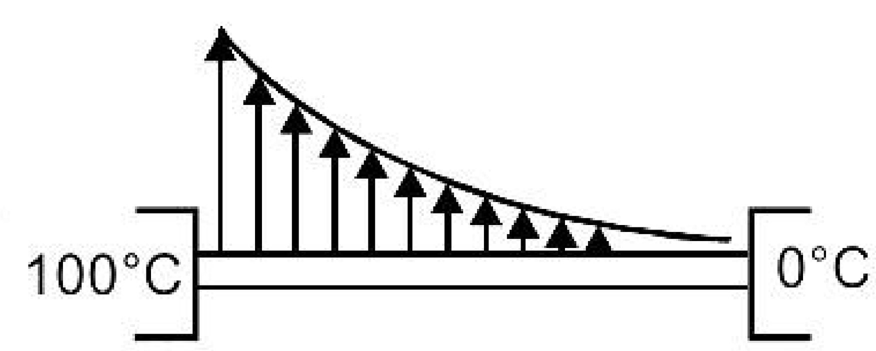
10. A hollow metallic sphere of radius 20 cm surrounds a concentric metallic sphere of radius 5 cm. The space between the two spheres is filled with a nonmetallic material. The inner and outer spheres are maintained at 50°C and 10°C respectively and it is found that 160 π Joule of heat passes radially from the inner sphere to the outer sphere per second. Find the thermal conductivity of the material between the spheres.

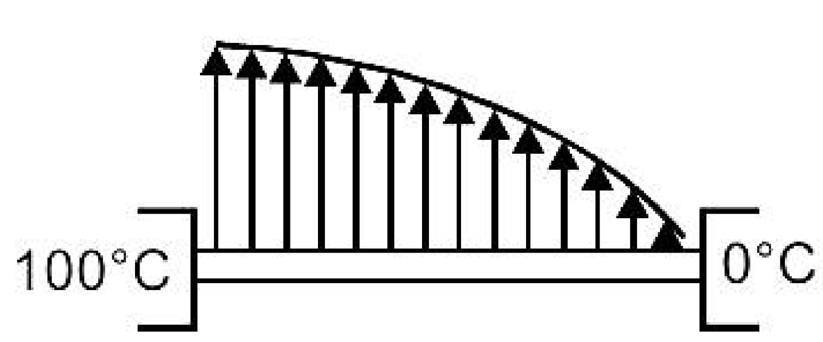
(A) 5 W/m–°C (B) 10 W/m–°C (C) 15 W/m–°C (D) 20 W/m–°C

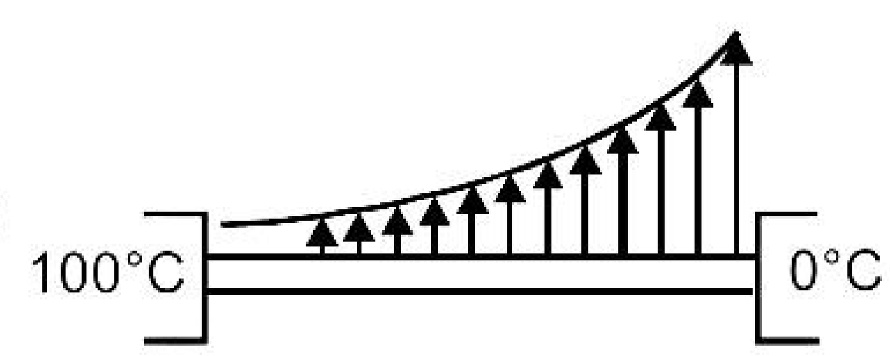
11. A conducting cylindrical rod of uniform cross-sectional area is kept between two large chambers which are at temperatures 100°C and 0°C respectively. The conductivity of the rod increases with x, where x is distance from 100°C end. The temperature profile of the rod in steady-state will be as :



(A)


(B)


(C)


(D)


12. A metal rod of cross-sectional area 1.0 cm^2 is being heated at one end. At one time, the temperature gradient is 5.0°C/cm at cross-section A and is 2.6 °C/cm at cross-section B. Calculate the rate at which the temperature is increasing in the part AB of the rod. The heat capacity of the part AB = 0.40 J/°C, thermal conductivity of the material of the rod = 200 W/m–°C. Neglect any loss of heat to the atmosphere.

(A) 10 °C/s (B) 12 °C/s (C) 5 °C/s (D) 25 °C/s

13. Assume transmitivity $t \to 0$ for all the cases :

(A) bad absorber is bad emitter (B) bad absorber is good reflector

(C) bad reflector is good emitter (D) bad emitter is good absorber

14. A metallic sphere having radius 0.08 m and mass m = 10kg is heated to a temperature of 227°C and suspended inside a box whose walls are at a temperature of 27°C. The maximum rate at which its temperature will fall is :-

(Take e = 1, Stefan's constant $\sigma = 5.8 \times 10^{-8}$ Wm^{-2} K^{-4} and specific heat of the metal s = 90 cal/kg/deg J = 4.2 Joules/Calorie)

(A) .055 °C/sec (B) .066 °C/sec (C) .044 °C/sec (D) 0.03 °C/sec

15. When q_1 joules of radiation is incident on a body it reflects and transmits total of q_2 joules. Find the emissivity of the body.

(A) $\frac{q_1 + q_2}{q_1}$ (B) $\frac{q_1 - q_2}{2q_1}$ (C) $\frac{q_1 - q_2}{q_1}$ (D) None of these

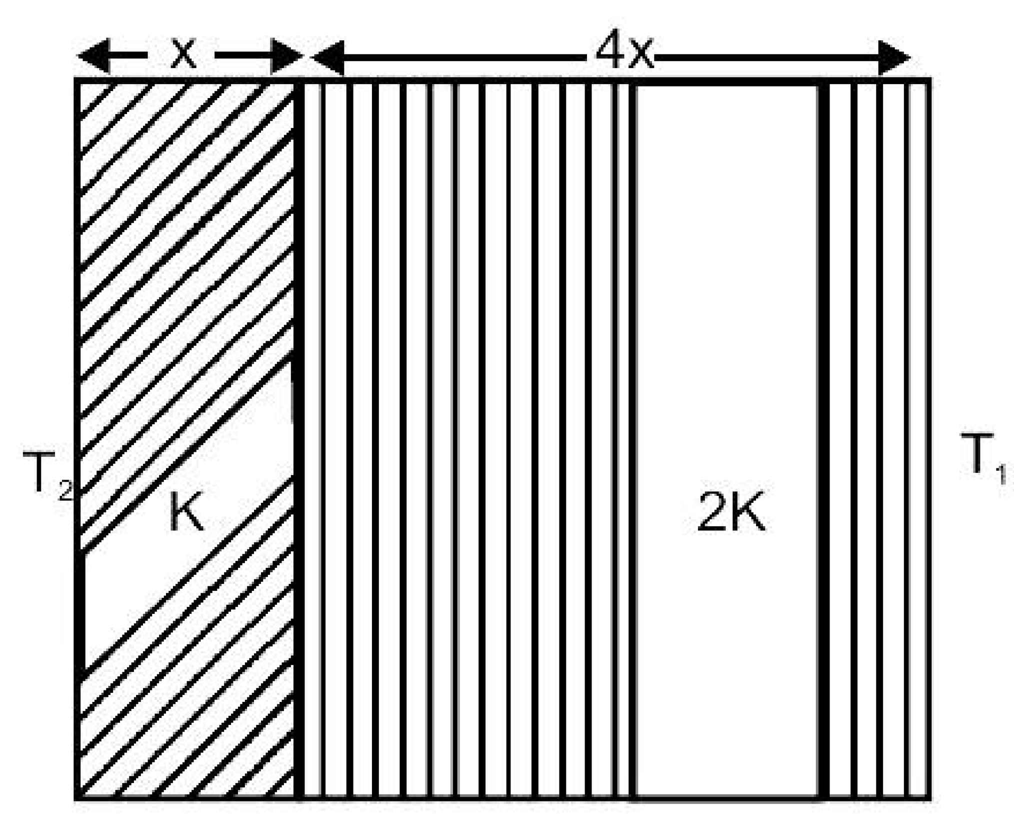
16. Estimate the temperature at which a body may appear blue or red. The values of λ_{mean} for these are 5000 and 7500 Å respectively. [Given Wein's constant b = 0.3 cm K]

(A) 6×10^3 K; 4×10^3K (B) 4×10^3 K; 5×10^3K (C) 3×10^3 K; 4×10^3K (D) None of these

17. The earth receives at its surface radiation from the sun at the rate of 1400 Wm^{-2}. The distance of the centre of the sun from the surface of the earth is 1.5×10^{11} m and the radius of the sun is 7×10^8 m. Treating the sun as a black body calculate temperature of sun.

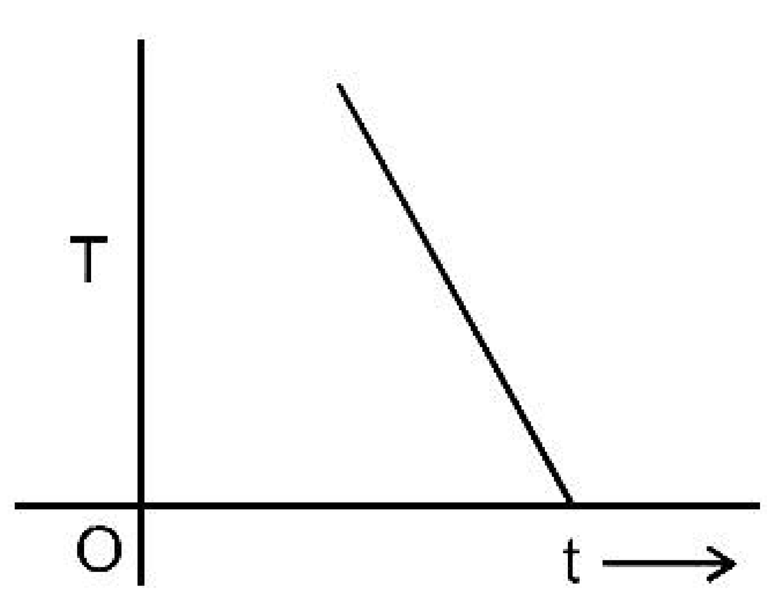
(A) 3803 (B) 4813 (C) 5815 (D) 5803

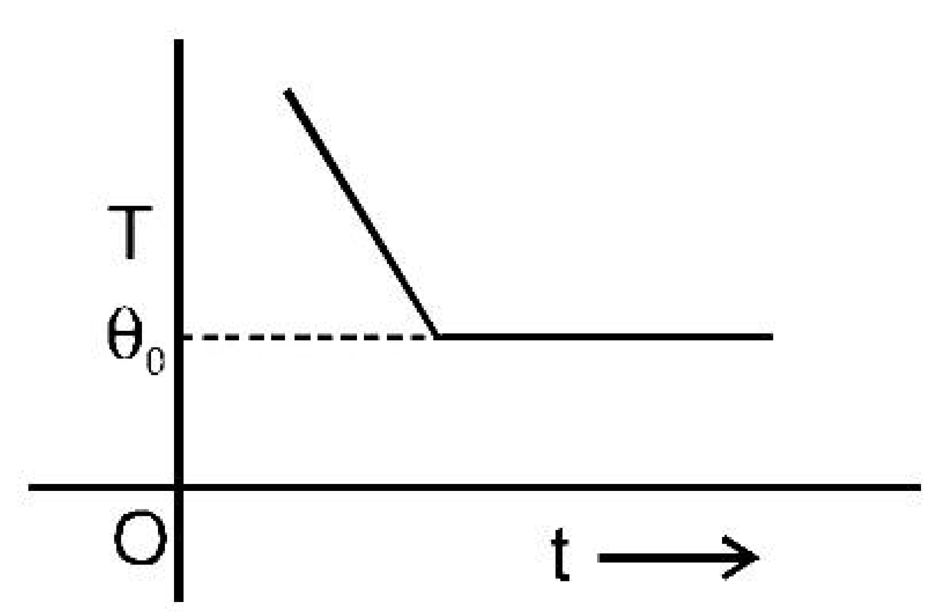
18. The temperature of the two outer surfaces of a composite slab, consisting of two materials K and 2K and thickness x and 4x, respectively, and T_2 and T_1($T_2 > T_1$). The rate of heat transfer through the slab, in a steady state is $\left(\frac{A(T_2 - T_1)K}{x}\right)f$ with f equal to–

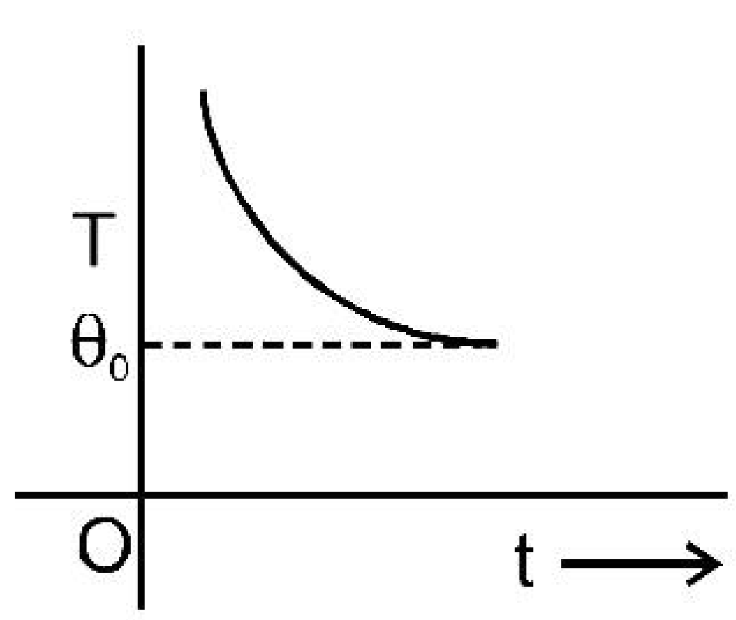


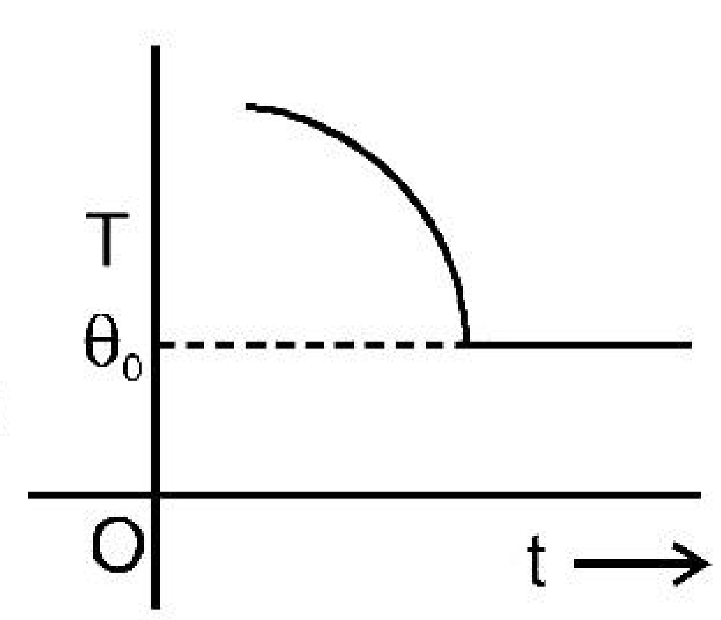
(A) 1 (B) 1/2 (C) 2/3 (D) 1/3

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

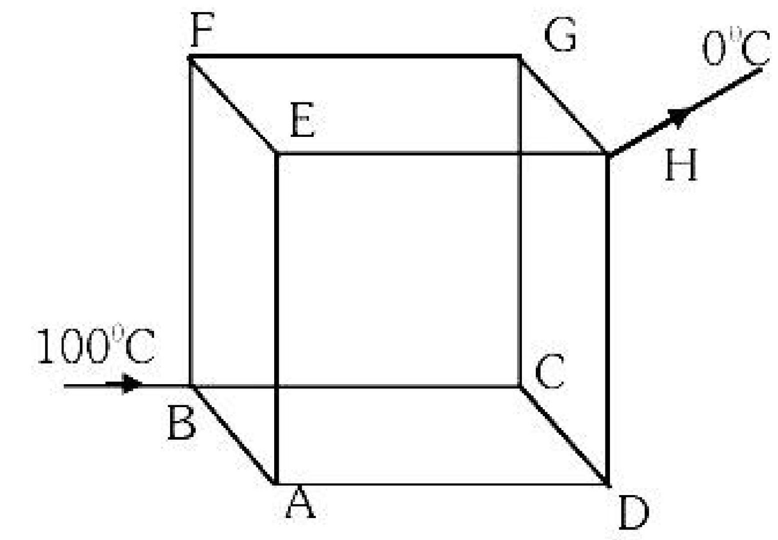
(A)


(B)


(C)


(D)


20. Twelve conducting rods form the sides of a uniform cube of side ℓ. If in steady state, B and H ends of the cube are at 100°C and 0°C respectively. Find the temperature of the junction 'A' :–

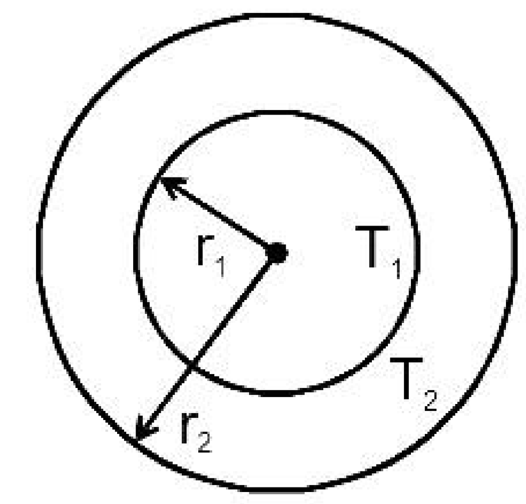


(A) 80°C
(B) 60°C
(C) 40°C
(D) 70°C

21. If the termpreature 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) 4
(B) 16
(C) 32
(D) 64

22. The figure shows a system of two concentric spheres of radii r_1 and r_2 and kept at temperature T_1 and T_2, respectively. The radial rate of flow of heat in a substance between the two concentric spheres is proportional to :

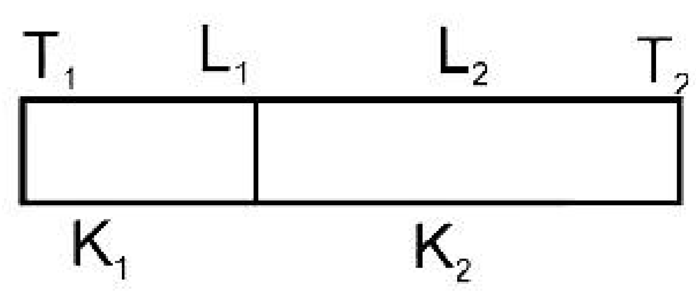


(A) $\frac{(r_2 - r_1)}{(r_1 r_2)}$
(B) $\ln\frac{(r_2)}{(r_1)}$
(C) $\frac{r_1 r_2}{(r_2 - r_1)}$
(D) $(r_2 - r_1)$

23. Assuming the sun to be a spherical body of radius R at a temperature of T K, evaluate the total radiant power, incident on Earth, at a distance r from the Sun. (earth radius = r_0)

(A) $\frac{R^2 \sigma T^4}{r^2}$
(B) $\frac{4\pi r_0^2 R^2 \sigma T^4}{r^2}$
(C) $\frac{\pi r_0^2 R^2 \sigma T^4}{r^2}$
(D) $\frac{r_0^2 R^2 \sigma T^4}{4\pi r^2}$

24. 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 lengths L_1 and L_2 and thermal conductivities k_1 and k_2 respectively. The temperature at the interface of the sections is



(A) $\frac{(K_2 L_2 T_1 + K_1 L_1 T_2)}{(K_1 L_1 + K_2 L_2)}$
(B) $\frac{(K_2 L_1 T_1 + K_1 L_2 T_2)}{(K_2 L_1 + K_1 L_2)}$
(C) $\frac{(K_1 L_2 T_1 + K_2 L_1 T_2)}{(K_1 L_2 + K_2 L_1)}$
(D) $\frac{(K_1 L_1 T_1 + K_2 L_2 T_2)}{(K_1 L_1 + K_2 L_2)}$

25. A spherical solid black body of radius 'r' radiates power 'H' and its rate of cooling is 'C'. If density is constant then which of the following is/are true.

(A) $H \propto r$ and $c \propto r^2$
(B) $H \propto r^2$ and $c \propto \frac{1}{r}$
(C) $H \propto r$ and $c \propto \frac{1}{r^2}$
(D) $H \propto r^2$ and $c \propto r^2$

ANSWER KEY

1.	(B)	2.	(B)	3.	(B)	4.	(B)	5.	(C)
6.	(D)	7.	(B)	8.	(D)	9.	(C)	10.	(C)
11.	(B)	12.	(B)	13.	(ABC)	14.	(B)	15.	(C)
16.	(A)	17.	(D)	18.	(D)	19.	(C)	20.	(B)
21.	(D)	22.	(C)	23.	(C)	24.	(C)	25.	(B)