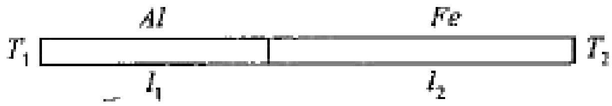
PHYSICS

BOOKS - GK PUBLICATIONS PHYSICS (HINGLISH)

HEAT TRANSFER

Illustrative Example 4 1

1. Consider two rods of equal cross - sectionai area A, one of Aluminium and other of iron joined end to end as shown in figure -4.8. Length of the two rods and their thermal coductivities are $l_1, k_1$and l_2, k_2 respectively . If the ends of the rods are maintained at temperature T_1 and $T_2, (T_1 > T_2)$ find the temperature of the junction in steady state .



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Illustrative Example 4 2

1. A bar of copper of length 75 cm and a bar of steel of length 125 cm are joined together end to end . Both are of circular cross - section with diameter 2 cm . The free ends of the copper and steel bars are maintained at $100^\circ C$ and $0^\circ C$ respectively . The surface of the bars are thermally insulted . What is the temperature of the copper - steel junction ? What is the heat transmitted per unit time across the junction ? Thermal conductivty of copper $9.2 \times 10^{-2} kcalm^{-1 \circ} C^{-1} s^{-1}$ and that of steel is $1.1 \times 10^{-2} kcalm^{-1} s^{-1} (\circ) C^{-1}$.

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Illustrative Example 4 3

1. A cylinderical brass boiler of radius 15 cm and thickness 1.0 cm is filled with water and placed on an elerctric heater. If the If the water boils at the rate of $200g/s$, estimate the temperature of the heater filament. Thermal conductivity of $brass = 109J/s/m^{\circ}C$ and heat of vapourization of water $= 2.256 \times 10^3 J/g$.

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Illustrative Example 4 4

1. A slab of stone of area of $0.36m^2$ and thickness $0.1m$ is exposed on the lower surface to steam at $100^{\circ}C$. A block of ice at $0^{\circ}C$

rests on the upper surface of the slab. In one hour $4.8kg$ of ice is melted. The thermal conductivity of slab is

(Given latent heat of fusion of ice $= 3.63 \times 10^5 Jkg^{-1}$)

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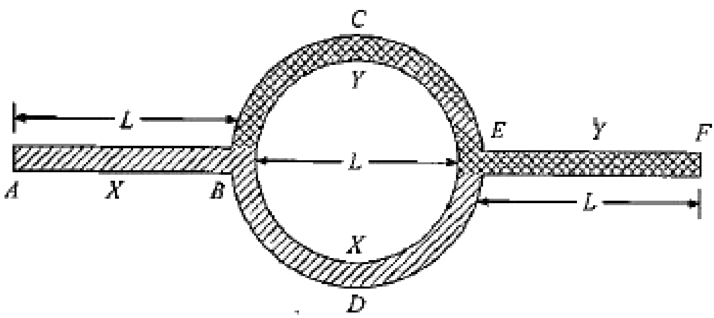
Illustrative Example 4 5

1. Few rods of material X and Y are connected as shown in figure - 4.10. The cross sectional area of all the rods are same. If the end A is maintained at $80^\circ C$ and the end F is maintained at `10^(@)C~ . Calculate the temperatures of junctions B and E in steady state . Given that thermal conductivty of material X is double that of Y.



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Illustrative Example 4 6

1. The space between two thin concentric metallic spherical shells of radii a and b is filled with a thermal conducting medium of conductivity k. The inner shell is maintained at temperature T_1 and outer is maintained at a lower temperatureT_2 . Calculate the rate of flow of heat in radially outward direction through the medium.

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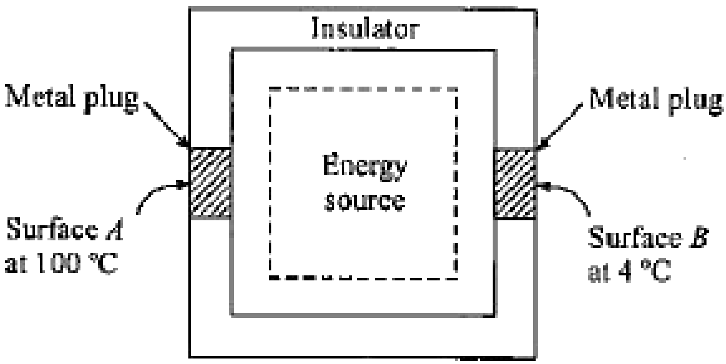
Illustrative Example 4 7

1. A closed cubical box made of a perfectly insulating material has walls of thickness 8 cm and the only way for the heat to enter or leave the box is through two solid cylinderical metal plugs , each of cross - sectional area $12 cm^2$ and length 8 cm fixed in the opposite walls of the box . The outer surface A of one plug is kept at a temperature of $100^\circ C$ while the outer surface of the other plug is maintained at a temperature of $4^\circ C$~. $The thermal co \in ductivity of the material of the plug is$0.5 cal // cmsec""^(@)C. $A source of e \ne rgy \ge \ne rat \in g$36 cal s^(-1)` is enclosed inside the box . Find the equilibrium temperature of the inner surface of the box assuming that it is the same at all points on the inner surface



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Illustrative Example 4 8

1. Figure-4.13 shows a water tank at a constant temperature. T_0 and a small bodyof mass m, and specific heat S at a temperature T_1 . Given that $T_1 < T_0$. A metal rod of length L, cross-sectional area A whose thermal conductivity is K is placed between the tank and the body to connect than. Find the temperature of body as a function of time. Given that the heat capacity of rod is negligible.

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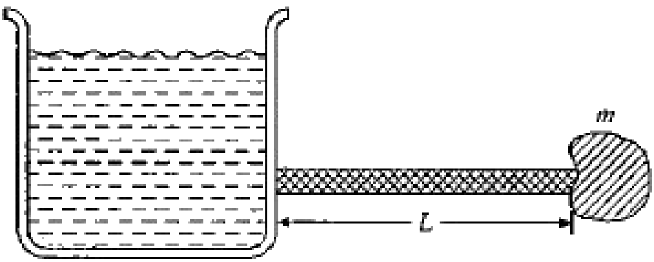

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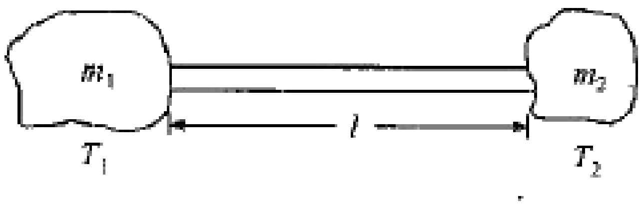
Illustrative Example 4 9

1. When two bodies ofmasses m_1 and m_2 with specific heats s_1 and s_2 at absolute temperatures T_{10} and $T_{20}(T_{10} > T_{20})$ are connected by a rod of length l and cross sectional area A with thermal conductivity k. Find the temperature difference of the bodies after time t. Neglect any heat loss due to radiation at any surface..



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Illustrative Example 4 10

1. Acubical container of side a and wall thickness x (a: « a) is suspendedin air and filled n molesof diatomic gas (adiabatic exponent=y) inaroom where room temperature isT^. Ifat/ = 0 gastemperature is Fj (F, > Fq), find the gas temperature as a function of time t. Assume the heat is conducted through all the walls ofcontainer.

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Illustrative Example 4 11

1. A layer of ice of $0^{\circ} C$ of thickness x_1 is floating on a pond. If the atmospheric temperature is $-7^{\circ} C$. Show that the time taken for thickness of the layer of ice to increase from x_1 to x_2 is given by

$$t = \frac{pL}{2kT}\left(x_2^2 - x_1^2\right)$$

where p is the density of ice, k its thermal conductivity and L is the latent heat of fusion of ice.

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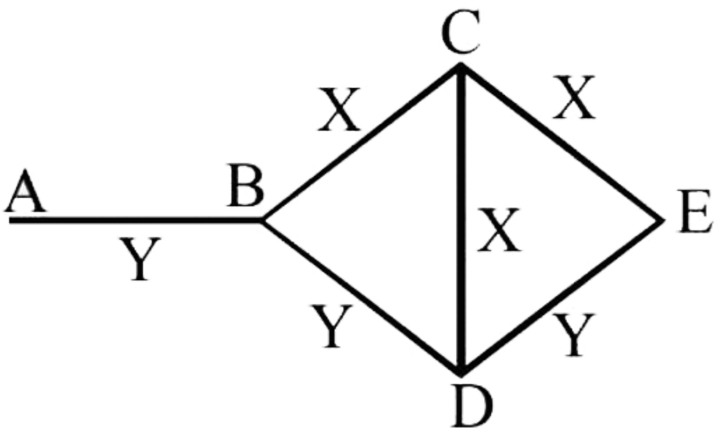
Illustrative Example 4 12

1. Three rods of material X and three rods of material Y are connected as shown in the figure. All the rods are of identical length and cross-sectional area. If the end A is maintained at $60^\circ C$ and the junction E at $10^\circ C$. Calculate the temperature of the junction B, C and D. The thermal conductivity of X is $0.92 cal/\sec - cm^\circ C$ and that of Y is $0.46 cal/\sec - cm -^\circ C$.



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Illustrative Example 4 13

1. An electric heater ofpower 1kW emits thermal radiations the surface area of heating element of heater is $200cm^2$. If this heating element is treated like a black bodyfind the temperature at its surface. Assume its temperature is very much higher then its surroundings.

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Illustrative Example 4 14

1. A cube of mass 1 kg and volume $125cm^2$ is placed in an evacuated chamber at $27^\circ C$. Initially temperature of block is $227^\circ C$. Assume block behaves like a block body, find the rate of cooling of block if specific heat of the material of block is $400J / kg - K$.

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Illustrative Example 4 15

1. One end A of a metallic rod of length 10 cm is inserted in a furnace whose temperature is $827^\circ C$. The curved surface of the rod is insulated. The room temperature is $27^\circ C$. When the steady state is attained, the temperature of the other end B ofthe rod is $702^\circ C$. Find the thermal conductivity ofthe metal. Stefan's constant $= 5.67 \times 10^{-8} Wm^{-2}K^{-4}$.

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Illustrative Example 4 16

1. A solid metallic sphere of diameter 20 cm and mass 10 kg is heated to a temperature of $327^{\circ} C$ and suspended in a box in which a constant temperature of $27^{\circ} C$ is maintained. Find the rate at which the temperature of the Sphere will fall with time. Stefan's constant $= 5.67 \times 10^{-8} W / m^2 / K^4$ and specific heat of metal $= 420 J / kg /^{\circ} C$.

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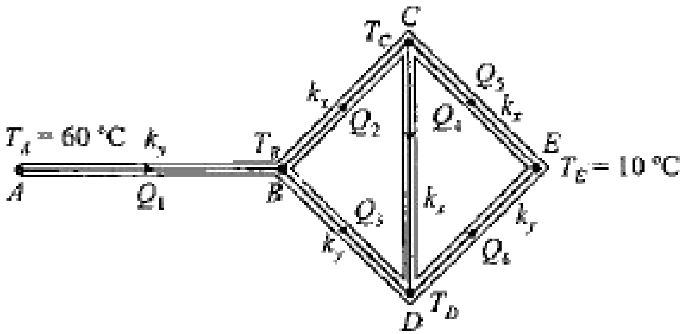
Illustrative Example 4 17

1. A cylindrical rod of 50 cm length and having $1 cm^2$ cross sectional area isused as a conducting material between an ice bath at$0^{\circ} C$ and a vacuum chamber at $27^{\circ} C$ as shown in figure. The end of rod which is inside the vacuum chamber behaves like a black body and is at temperature $17^{\circ} C$ in steady state. Find the thermal

conductivity of the material of rod and rate at which ice is melting in the ice bath. Given that latent heat of fusion of ice is $3.35 \times 10^5 J/kg$..



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Illustrative Example 4 18

1. The earth receives solar energy at the rate of 2 cal Cm^{-2} per minute. Assuming theradiation tobeblack body in character, estimate the surface temperature of the sun. Given that

$\sigma = 5.67 \times 10^{-8} W m^{-2} K^{-4}$ and angular diameter of the sun =32 minute of arc.

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Illustrative Example 4 19

1. A spherical ball of radius 1cm coated with a metal having emissivity 0.3 is maintained at 1000 K temperature and suspended in a vacuum chamber whose walls are maintained at 300 K temperature. Find rate at which electrical energy is to be supplied to the ball to keep its temperature constant.

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Illustrative Example 4 20

1. There are two concentric spherical shells A and B of surface area $20cm^2$ and $80cm^2$. Surfaces ofboth the shells behave like black bodies. It is given thatthethermal conductivity ofmaterial of B is very low and that of A is very high. Initially the temperature of 4 is 400 K and that of B is 300 k. Find the rate of change of temperature of A and B. Given that the heat capacities of A and B are $50J/^{\circ}C$ and $80J/^{\circ}C$ respectively.

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Illustrative Example 4 21

1. The temperature of a body in a surrounding of temperature $16^{\circ}C$ falls from $40^{\circ}C$ to $36^{\circ}C$ in 5 mins. Assume Newtons law of cooling to be valid and find the time taken by the body to reach temperature $32^{\circ}C$.

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Illustrative Example 4 22

1. In a container some water is filled at temperature$50^\circ C$.It cools to$45^\circ C$ in 5 minutes and to $40^\circ C$ in next 8 minutes. If we assume Newton's law of cooling to be valid in this case, find the surrounding temperature.

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Illustrative Example 4 23

1. A solid body X of heat capacity C is kept in an atmosphere whose temperature is $T_A = 300K$. At time $t = 0$ the temperature of X is $T_0 = 400K$. It cools according to Newton's law of cooling. At time t_1, its temperature is found to be 350K. At this time (t_1), the body

X is connected to a large box Y at atmospheric temperature is T_4, through a conducting rod of length L, cross-sectional area A and thermal conductivity K. The heat capacity Y is so large that any variation in its temperature may be neglected. The cross-sectional area A of hte connecting rod is small compared to the surface area of X. Find the temperature of X at time $t = 3t_1$.

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Illustrative Example 4 24

1. A black walled metal container of negligible heat capacity is filled with water. The container has sides of length 10cm. It is placed in an evacuated chamber at $27^\circ C$. How long will it take for the temperature of water to change from $30^\circ C \rightarrow 29^\circ C$.

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Illustrative Example 4 25

1. A calorimeter of water equivalent 100gm cools in air in 18 minutes from $60^\circ C$ to$40^\circ C$.When a block of metal of mass 60 gm is heated to $60^\circ C$ and placed inside the calorimeter. Assume heat loss only by radiation and Newton's Law of cooling to be valid. Find the specific heat of metal if now the system cools from $60^\circ C$ to $40^\circ C$ in 20 minutes.

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Illustrative Example 4 26

1. A metal ball of 1kg mass is heated by a 20W heater in a room at $20^\circ C$. After some time temperature of ball becomes steady at $50'^\circ C$. Find the rate of loss of heat by the ball to surrounding when its temperature becomes $50^\circ C$. Also find the rate at which it looses heat to the surrounding when its temperature was $30^\circ C$.

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Illustrative Example 4 27

1. A black body at 1500K emits maximum energy of wavlength 20000Å. If sun emits maximum energy of wavelength 5500Å, what would be the temperature of sun.

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Illustrative Example 4 28

1. If the filament of a 100 W bulb has an area $0.25cm^2$ and behaves as a perfect block body. Find the wavelength corresponding to the maximum in its energy distribution. Given that Stefan's constant is

$\sigma = 5.67 \times 10^{-8} J / m^2 s K^4$.

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Illustrative Example 4 29

1. A body emits maximum energy at 4253 Å and the same body at some other temperature emits maximum energy at 2342 Å. Find the ratio of the maximum energy radiated by the body in a short wavelength range.

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Practice Exercise 4 1

1. A wall has two layers A and B, each made of different material. Both the layers have the same thickness. The thermal conductivity of the material of A is twice that of B . Under thermal equilibrium, the temperature difference across the wall is $36^\circ C.$ The temperature difference across the layer A is

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2. A 100 W heater is placed in a cubical container of edge length $6 \times 10^{-2} m.$ The wall thick ness of the container is 1 mm. If inside and outside temperature in steady state are $30^\circ C.$ and $25^\circ C,$ find the thermal conductivity of the material of the box.

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3. One end of a copper rod of length 1.0 m and area of cross-section 10^{-3} is immersed in boiling water and the other end in ice. If the coefficient of thermal conductivity of copper is $92 cal/m-s-.^{\circ}C$ and the latent heat of ice is $8 \times 10^{4} cal/kg$, then the amount of ice which will melt in one minute is

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4. Water is filled in a closed cylindrical vessel of 10 cm height and base radius $\sqrt{10/\pi}$ cm. The open ends ofthe cylinder are closed by two metal discs made ofa material whose thickness is $10^{-3}m$ and having thermal conductivity $200W/m^{\circ}C$. If water temperature inside the cylinder is $50^{\circ}C$ and surrounding temperature is $20^{\circ}C$, findthe time taken for the temperature to fall by $1^{\circ}C$, Given that the specific heat ofwater is $4200J/kg^{\circ}C$.

and heat loss from water only takes place by the discs as the walls are made up of a thermally insulating material.

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5. A uniform steel rod of length 50 cm is insulated on its sides. There is a layer of water of thick ness 0.2 mm at each end of the rod. If the ends of the rod are exposed to ice at $0^\circ C$, and steam at $100^\circ C$, calculate the temperature gradient in the rod. Thermal conductivities of steel and water are $0.11 cal cm^{-1} s^{-1} {}^\circ C^{-1}$ and $1.5 \times 10^{-3} cal cm^{-1} s^{-1} {}^\circ C^{-1}$

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6. Two plates ofthe same area and the same thickness having thermal conductivities k_1 and k_2 are placed one on top of the other. Show that the thermal conductivity of the composite plate for conduction of heat is given by

$$k = \frac{2k_1k_2}{(k_1 + k_2)}$$

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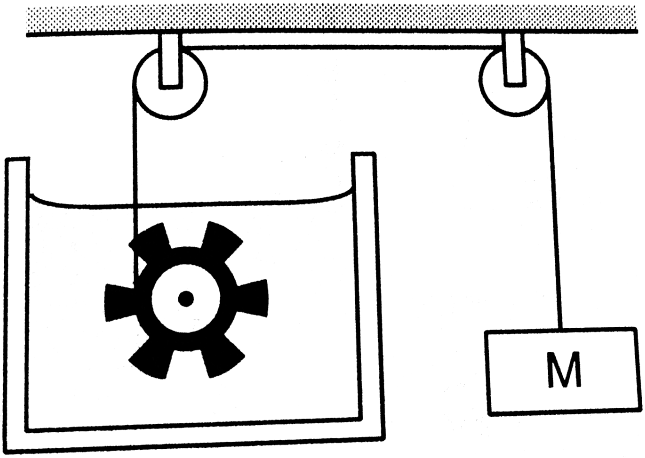
7. Figure shows water in a container having $2.0mm$ thick walls made of a material of thermal conductivity $0.50Wm^{-1}.^{\circ}C^{-1}$. The container is kept in a melting-ice bath at $0^{\circ}C$. The total surface area in contact with water is $0.05m^2$. A wheel is clamped inside the water and is coupled to a block of mass M as shown in the figure. As the block goes down, the wheel rotates. It is found that after some time a steady state is reached in which the block goes down with a constant speed of $10cm^{-1}$ and the temperature of the water remains constant at $1.0^{\circ}C$. Find the mass M of the block. Assume that the heat flow out of the water only through the walls in contact. Take $g = 10 ms^{-2}$.



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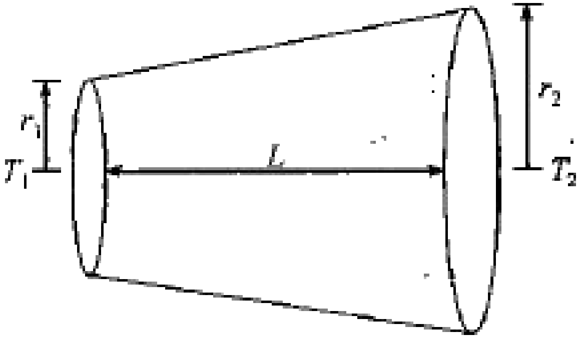
8. Find the heat current through the frustum of a cone shown in figure-4.20. Temperature of its two ends are maintained at T_1 and T_2(T_(2)>T_(1))` respectively and the thermal conductivity of the material is k.



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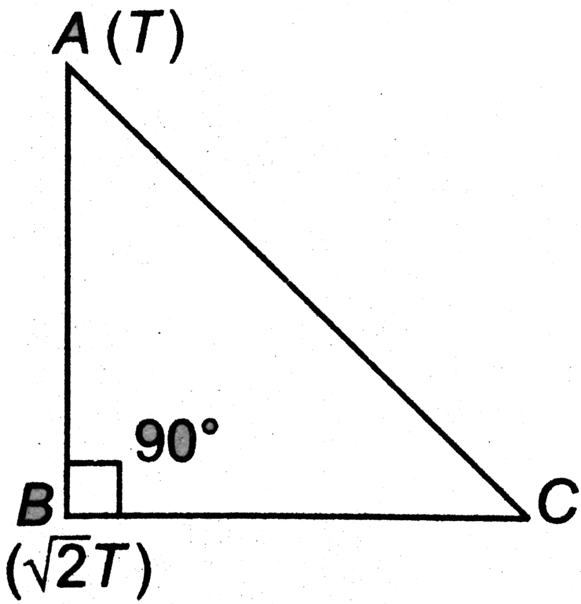
9. Three rods of identical cross-sectional area and made from the same metal form the sides of an isosceles triangle ABC right angled at B as shown in the figure. The points A and B are maintained at temperature T and $(\sqrt{2})T$ respectively in the steady state. Assuming that only heat conduction takes place, temperature of point C will be



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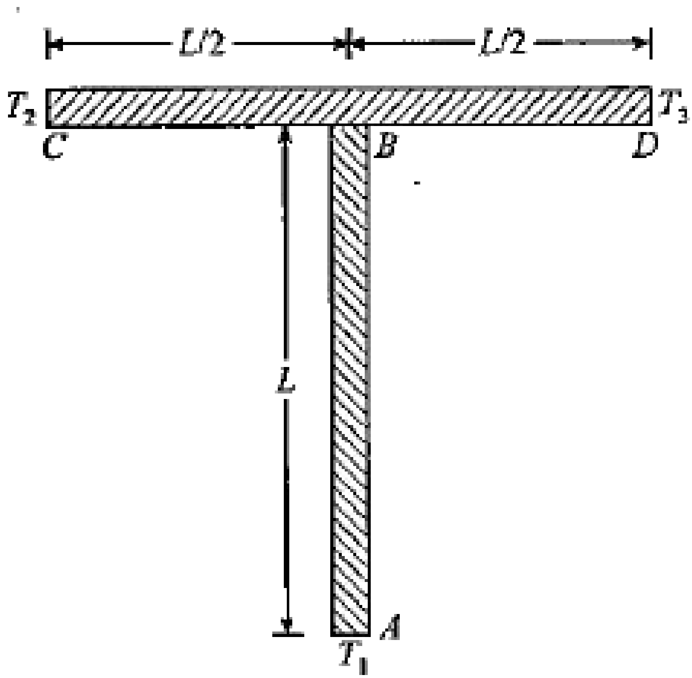
10. Two identical rods AB and CD, each of length L are connected as shown in figure-4.22. Their cross-sectional area is A and their thermal conductivity is k. Ends A, C and D are maintained at temperatures T_1, T_2 and T_3 respectively. Neglecting heat loss to the surroundings, find the temperature at B.



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11. A room at $20^{\circ} C$ is heated by a heater of resistence 20 ohm connected to 200 VV mains. The temperature is uniform throughout the room and the heati s transmitted through a glass window of area $1 m^2$ and thickness 0.2 cm. Calculate the

temperature outside. Thermal conductivity of glass is $0.2cal/mC^{\circ}$ s and mechanical equivalent of heat is $4.2J/cal.$

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Practice Exercise 4 2

1. A 500W lamp loses all of its energy by emission of radiation from the surface. If the area of the surface of the filament is $2.0cm^2$ and its emissivity is 0.5, estimate the temperature of its filameiit. Given that Stefan constant, $\sigma = 5.7 \times 10^{-8} W/m^2K^4.$ Neglect radiation receivedby lamp from surrounding.

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2. A white-hot metal wire at 3000 K has a radius of 0.075 cm. Calculate the rate per unit length at which it emits radiation if its emissivity is 0.35. Ignore the radiation it receives from the surroundings. Take Stefan'sconstant $\sigma = 5.7 \times 10^{-8} W/m^2 K$.

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3. The temperature of the tungsten filament of a 60 W electric bulb is T= 2000 K. Find the surface area ofthe filament. The emmissivity of the surface is e= 0.30. Neglect radiation received from surrounding. Take $\sigma = 5.7 \times 10^{-8} w/M^2 k$.

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4. A spherical black body with a radius of 12 cm radiates 450 W power at 500 K. If the radius were halved and the temperature doubled, the power radiated in watt would be

(a)225 (b)450

(c) 900 (d)1800

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5. A block having some emissivity is maintained at 500 K temperature in a surrounding of300 K temperature. It isobserved that, to maintain the temperature of the block, 210 W external power is required to be supplied to it. If instead ofthis block a black body ofsame geometry and size is used, 700 W external power is needed for the same. Find the emissivity of the material ofthe block.

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6. A solid sphere of copper of radius R and a hollow sphere of the same materail of inner radius r and outer radius A are heated to the same temperature and allowed to cool in the same environment. Which of tehm starts cooling faster?

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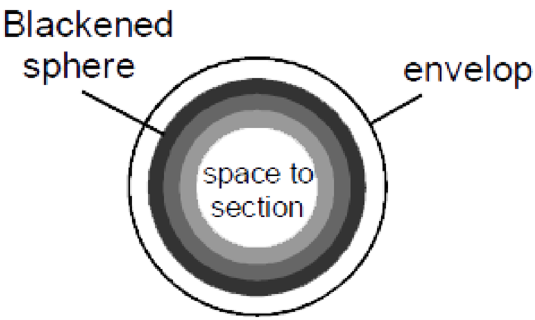
7. The shell of a space station is a blackened sphere in which a temperature T = 500K is maintained due to operation of appliances of the station. Find the temperature of the shell if the station is enveloped by a thin spherical black screen of nearly the same radius as the radius of the shell.



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8. A copper ball of diameter d was placed in an evacuated vessel whose walls are kept at the absolute zero temperature. The initial

temperature of the ball is t_0. Assuming the surface of the ball to be absolutely black, find how soon its temperature decreases η times. Take specific heat of copper c, density of copper ρ and emissivity e.

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Practice Exercise 4 3

1. The temperature of a body falls from $40^{\circ} C$ to $36^{\circ} C$ in 5 minutes when placed in a surrounding of constant temperature $16^{\circ} C$. Find the time taken for the temperature of the body to become $32^{\circ} C$.

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2. A body initially at $80^{\circ} C$ cools to $64^{\circ} C$ in 5 minutes and to $52^{\circ} C$ in 10 minutes. What will be its temperature in 15 minutes and what is the temperature of its surroundings?

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3. The excess temperature of a hot body above its surroundings is halved in t = 10 minutes. In what time will it be $\frac{1}{10}$ of its initial value. Assume Newton's law of cooling.

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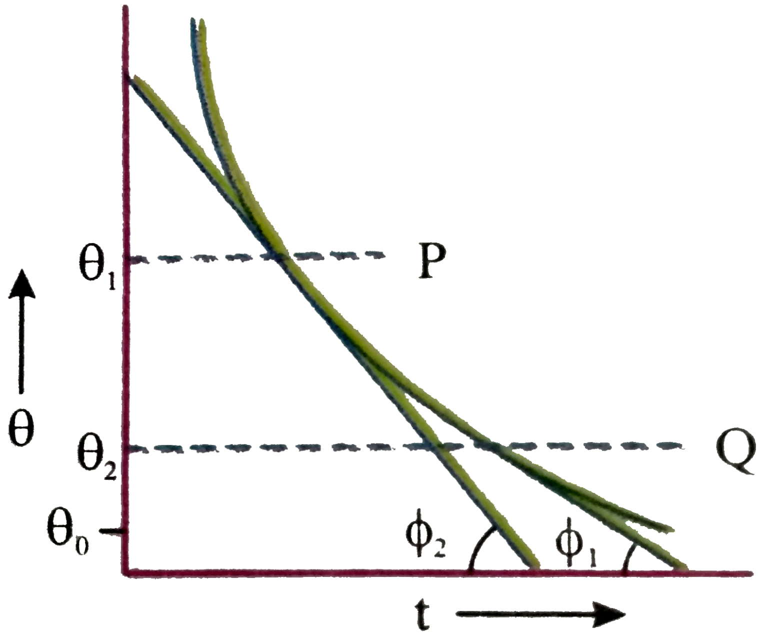
4. A body cools in a surrounding which is at a constant temperature of θ_0 Assume that it obeys Newton's law of cooling Its temperature θ is plotted against time t Tangents are drawn to the curve at the points $P(\theta = \theta_1)$ and $Q(\theta = \theta_2)$ These tangents meet the time axis at angle of ϕ_2 andϕ_1 as shown



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5. A calorimeter of negligible heat capacity contains 100 gm water at $40^\circ C$. The water cools to $35^\circ C$. in 5 minutes. If the water isnow replaced bya liquid ofsame volume as that of water at same initial temperature, it cools to $35^\circ C$ in 2 mintues. Given specific heats of water and that liquid are $4200 J / Kg^{\circ} C$. and $2100 J / Kg^{\circ} C$ respectively. Findthe density of the liquid.

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Practice Exercise 4 4

1. The maximum in the energy distribution spectrum of the sun is at wavelength 4753A and its temperature is 6050 K. What will be the temperature of the star whose energy distribution shows a maximum at wavelength 9506A.

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2. The power radiated by a black body is P, and it radiates maximum energy around the wavelength λ_0. If the temperature of the black body is now changed so that it radiates maximum energy around a wavelength $3\lambda_0/4$, the power radiated by it will increase by a factor of

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3. A furnace is at a temperature of $2000K$. At what wavelength does it emit most intensively?

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4. A black body is at a temperature of 2880 K. The energy of radiation emitted by this object with wavelength between 4990 A and 5000A is E_1 , and that between 9990 A and 10000 A is E_2 . Find the ratio of E_2 and E_1.

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5. The radiant emittance of a black bodyt is $R = 250 kW/m^2$. At what wavelength will the emmisivity of this black body be maximum? $(b = 2.9 \times 10^{-3} m. K$ and $\sigma = 5.67 \times 10^{-8} Wm^{-2}K^{-4})$

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Discussion Question

1. Explain why the surface of a lake freezes first.

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2. Is temperature a conserved quantity in transfer of heat between two bodies at different temperatures.

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3. When two identical object on touching feels hot and cold respectively, can we comment on the heat capacities ofthe objects.

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4. A vessel is used to boil water. To boil water faster the thermal conductivity and specific heat of the material of vessel should be high or low.

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5. Why are clear nights colder than cloudy nights ?

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6. White clothing is more comfortable in summer but colourful clothing in winter. Explain.

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7. Why a thermos flask has its interior surface mirror like polished.

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8. If we put our hands above a fire or at the side of the fire to get warmth in a winter night. It feels hotter above a fire than by its side. Explain.

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9. The body ofa refrigerator is painted white, but the pipes and metal grid at its back are painted black. Why ?

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10. Why are calorimeter made of metal, why not of glass?

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11. It is observed that if two blankets of same thickness x are used together,will keep more warm as compared to a single blanket of thickness 2x. Why ?

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12. A solid sphere of copper of radius R and a hollow sphere of the same materail of inner radius r and outer radius A are heated to the same temperature and allowed to cool in the same environment. Which of tehm starts cooling faster?

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13. What is "Green House Effect"?

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14. A sphere, a cube and a circular disc, made of same material and of same mass are heated to same temperature and placed in same surrounding. Which one will have fastest rate of cooling and which one will have slowest ?

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15. A black platinum wire, when heated, first appears dull red, then yellow, then blue and finally white. Explain.

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16. Why it is advantageous to paint the outer walls and roof of a house white in hot weather ?

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17. "Good thermal conductors are also good electrical conductors." Explain this statement.

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18. Why do some materials, such as glass and metals, usually fell cold and other materials, such as cloth, usually feel warm?

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19. Explain why it is advisable to add water to an overheated automobile engine only slowly and only with the engine running.

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20. A piece of wood lying in the sun absorbs more heat than a piece of shiny metal. Even after that the wood feels less hot than the metal when we touch it. Why ?

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21. A person pours a cup of hot cofee,intending to drink it five minutes later. To keep it as hot as possible, should he put cream in it now or wait until just before he drinks it ?

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22. Aluminium foil used for food cooking and storage sometimes has one shiny surface and one dull surface. When food is wrapped for baking, should the shiny side be in or out ?

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23. Why must a room air conditioner be placed in a window ? Why can't it just be set on the floor and plugged in ?

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24. When you step out of a shower bath, you feel cold, bust as soon as you are dry, you feel warmer, even though the room temperature remains same. Explain.

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25. Ice is slippery to walk on and is especially slippery if you wear ice skates. Why ?

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26. Even when a lake freezes in winters, how do the animals survive deep inside the lake.

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Conceptual Mcqs Single Option Correct

1. A bottle of water at $0^\circ C$ is opened on the surface of moon. Which of the following correctly expresses the behaviour of water in it ?

A. It will freeze

B. It will decompose into H_2 and O_2

C. It will boil

D. None of the above

Answer: C

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2. The radiation power from a source at temperature T and2m away is $2W/m^2$. If the temperature of the source increases by

100% the radiation power at a distance 4m from the source will increase by:

A. 1

B. 2

C. 6

D. None of the above

Answer: D

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3. Which one of the following statements is not true about thermal radiations ?.

A. All bodies emit thermal radiations at all temperature

B. Thermal radiations are electromagnetic waves

C. Thermal radiations are not reflected from a mirror

D. Thermal radiations travel in free space with a velocity of $3 \times 10^8 ms^{-1}$

Answer: C

Watch Video Solution

4. A metallic sphere of diameter D has a cavity of diameter d at its centre. If the sphere is heated, the diameter of the cavity will:

A. Decrease

B. Increase

C. Remain unchanged

D. Decrease if $d < D/2$ and increase if $d > D/2$

Answer: B

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5. The wavelength of radiation emitted by a body depends upon

A. The nature of its surface

B. The area of its surface

C. The temperature of its surface

D. All the above factors

Answer: C

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6. The amount of energy radiated by a body depends upon

A. The nature of its surface

B. The area of its surface

C. The temperature of its surface

D. All the above factors

Answer: D

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7. The top of a lake gets frozen at a place where the surrounding air is at a temperature of $-20^\circ C$. Then :

A. The temperature of the layer of water in contact with the lower surface of the ice block will be at $0^\circ C$ and that at the bottom of the lake will be $4^\circ C$

B. The temperature of water below the lower surface of ice will be $4^\circ C$ right up to the bottom of the lake

C. The temperature of the water below the lower surface of ice will be $0^\circ C$ right up to the bottom of the lake

D. The temperature of the layer of water immediately in contact with the lower surface of ice will be $-20^\circ C$ and that of water at the bottom will be $0^\circ C$

Answer: A

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8. A solid sphere and a hollow sphere of the same material and size are heated to the same temperature and allowed to cool in the same surroundings. If the temperature difference between the surroundings and each sphere is T, then :

A. The hollow sphere will cool at a faster rate for all values of T

B. The solid sphere will cool at a faster rate for all values of T

C. Both spheres will cool at the same rate for all values of T

D. Both spheres will cool at the same rate only for small values of T

Answer: A

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9. Ice starts forming on the surface of lake and takes 8 hours to form a layer of 1 cm thick. How much time will it take to increase the thickness of layer to 2 cm ?

A. 8 hours

B. Less than 8 hours

C. Between 8 to 16 hours

D. More than 16 hours

Answer: D

Watch Video Solution

10. Why metals are good conductors of heat ?

A. Their surfaces are good reflectors of heat

B. Their atoms move very violently

C. They contain large number of free electrons

D. Because of some reason other than those mentioned above

Answer: C

Watch Video Solution

11. Why the walls and roof of the green house are made of glass ?

A. The glass absorbs most of the radiations coming from the sun

B. The glass transmits the radiations coming from the sun but not those given out by the bodies inside

C. The glass equally transmits the radiations from the sun as well as those from inside

D. For some reason other than those mentioned above

Answer: C

Watch Video Solution

12. A drop of water is sprinkled on a red hot iron plate.The drop forms a small sphere but does not vaporise immediately. This happens because :

A. Red hot iron is a poor conductor of heat

B. A layer ofwater vapour between the drop and plate prevents conduction of heat

C. Boiling point of water is raised

D. Of some other reason

Answer: B

Watch Video Solution

13. Two ends of a conducting rod of varying cross-section are maintained at $200^\circ C$ and $0^\circ C$ respectively. There are two sections marked in the rod AB and CD of same thickness. In steady state :

A. Temperature difference across AB and CD are equal

B. Temperature difference across AB is greater than that of across CD

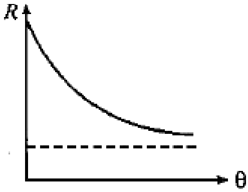
C. Temperature difference across AB is less than that of across CD

D. Temperature difference may be equal or different depending on the thermal conductivity of the rod

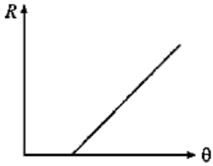
Answer: C

View Text Solution

14. Themperature of a body θ is slightly more than the temperature of the surrounding θ_0 its rate of cooling (R) versus temperature of body (θ) is plotted its shape would be .

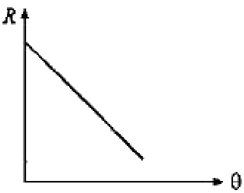


A.



B.

C.



D.

Answer: B

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15. One end of conducting rod is maintained at temperature $50^\circ C$ and at the other end ice is melting at $0^\circ C$. The rate of melting of ice is doubled if:

A. The temperature is made $200^\circ C$ and the area of cross-section of the rod is doubled

B. The temperature is made $100^\circ C$ and length of the rod is made of four times

C. Area of cross section of rod is halved and length is doubled

D. The temperature is made $100^\circ C$ and area of cross-section of rod and length both are doubled

Answer: D

Watch Video Solution

16. The diagram below shows rods of the same size of two different materials P and Q placed end to end in thermal contact and heavily lagged at their sides. The outer ends of P and Q are kept at $0^\circ C$ and $100^\circ C$,respectively.The thermal conductivity of P is four times that of Q. What is the steady-state temperature of the interface?

A. $20^\circ C$

B. $75^\circ C$

C. $25^\circ C$

D. $80^\circ C$

Answer: A

View Text Solution

17. The length of the two rods made up of the same metal and having the same area of cross-section are 0.6 m and 0.8 m respectively. The temperature between the ends of first rod is 90° C and 60° C and that for the other rod is 150 and 110° C. For which rod the rate of conduction will be greater

A. First

B. Second

C. Same for both

D. None of these

Answer: C

Watch Video Solution

18. Why two thin blankets put together are warmer than one blanket of double the thickness ?

A. Conductivity depends upon thickness

B. Two blankets enclose a layer of air between them

C. One blanket closes the pores in the other

D. Because of some reason other than those mentioned above

Answer: B

Watch Video Solution

19. λ_m is the wavelength of the radiations corresponding to maximum intensity of a very very hot body at temperature T. Which of the following correctly represents the relations between λ_m and T:

A. λ_m decreases with increase in T

B. λ_m increases with increase in T

C. λ_m is independent of T

D. None of the above

Answer: A

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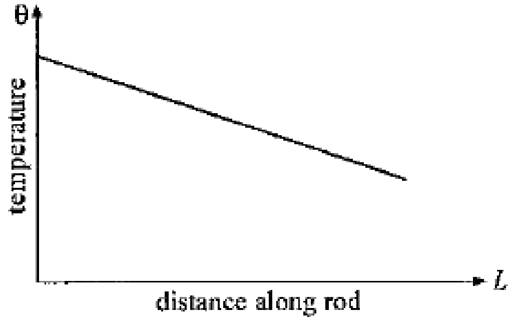
20. In designing a method for measuring the thermal conductivity of polystyrene, care must be taken to choose a specimen of appropriate dimensions as well as to decide whether or not the specimen requires lagging. Which ofthe following would be the correct choice ?

	Cross-sectional area of Specimen	*Thickness of Specimen*	*Lagging Required*
(A)	Small	Thin	No
(B)	Small	Thick	Yes
(C)	Large	Thin	No
(D)	Large	Thick	Yes

Watch Video Solution

21. The graph shows how temperature varies with distance along a well-insulated metal rod which is conducting thermal energy at a steady rate. The slope of this graph is the temperature gradient. There is an analogy between electrical conduction and thermal energy conduction. If an equivalent electrical-graph were to be drawn, which electrical quantity,when plotted against distance along the rod, would have the slope shown. ?



	Electrical quantity	*Slope*
(A)	Charge	Current
(B)	Potential	Potential gradient
(C)	Potential difference	Resistance
(D)	Current	Current gradient

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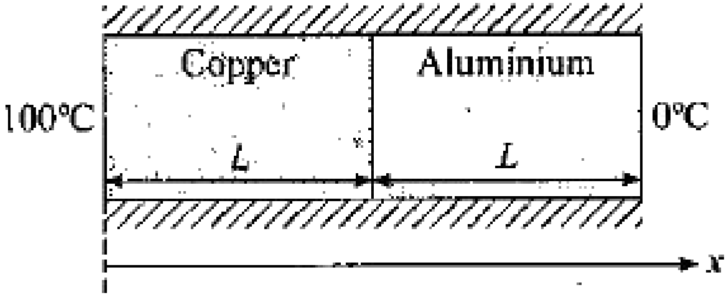
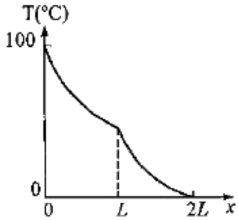
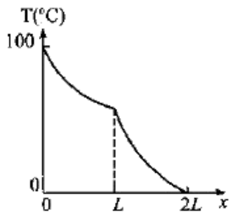
22. A composite rod of uniform cross-section has copper and aluminium sections of the same length in good thermal contact. The ends of the rod, which is well-lagged, are maintained at $100^\circ C$ and at$0^\circ C$ as shown in the diagram (Figure-4.33). The thermal conductivityof copper is twice that of aluminium.

Which one of the following graphs represents the variation of temperature T with x along the rod in the steady state ?

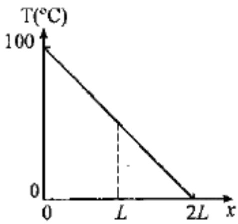




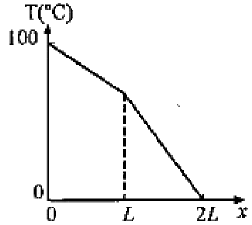
A.



B.



C.

D. 

Answer: D

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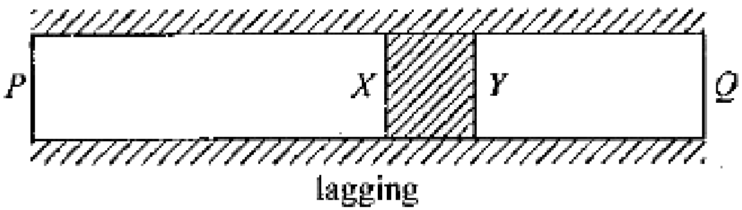
23. PQ is a fully-lagged metal bar, containing a section XY of a material of lower thermal conductivity. The thermal conductivities of the two materials are independent of temperature. Ends P and Q are maintained at different temperature.

In the steady , the temperature difference across XY would be independent of :



A. The temperature difference between P and Q

B. The metal of which the bar is made

C. The thickness of the section XY

D. The distance of the section XY from the end P

Answer: D

Watch Video Solution

24. Two adiabatic vessels, each containing the same mass m of water but at different temperatures, are connected by a rod of length L, cross-section A, and thermal conductivity K. the ends of the rod are inserted into the vessels, while the rest of the rod is insulated so that .there is negligible loss of heat into the atmosphere. The specific heat capacity of water is s, while that of the rod is negligible. The temperature difference between the two vessels reduces to l/e of its original value after a time, δt. The thermal conductivity (K) of the rod may be expressed by:

A. $\frac{msL}{A\delta t}$

B. $\frac{emsL}{A\delta t}$

C. $\frac{msL}{2eA\delta t}$

D. $\frac{msL}{2A\delta t}$

Answer: D

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Numerical Mcqs Single Options Correct

1. Two spheres of radii R_1 and R_2 are made of the same material and are at the same temperature. The ratio of their thermal capacities is:

A. R_1^4 / R_2^4

B. R_1^3 / R_2^3

C. R_1^2 / R_2^2

D. R_1 / R_2

Answer: B

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2. Two different metal rods of equal lengths and equal areas of cross-section have their ends kept at the same temperature θ_1 and θ_2. if K_1 and K_2 are their thermal conductivities, ρ_1 and ρ_2 their densities and S_1 and S_2 their specific heats, then the rate of flow of heat in the two rods will be the same if:

A. $\dfrac{k_1}{k_2} = \dfrac{\rho_1 s_1}{\rho_1 s_2}$

B. $\dfrac{k_1}{k_2} = \dfrac{\rho_1 s_2}{\rho_2 s_1}$

C. $\frac{k_1}{k_2} = \frac{\theta_1}{\theta_2}$

D. $k_1 = k_2$

Answer: D

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3. A slab of stone of area $0.34m^2$ and thickness 10 cm is exposed on the lower face to steam at $100^\circ C$.A block of ice at $0^\circ C$ rests on the upper face of the slab. In one hour, 3.6 kg of ice is melted. Assume that the heat loss from the sides is negligible. The latent heat of fusion of ice is $3.4 \times 10^4 Jkg^{-1}$. What is the thermal conductivity of the stone in units of $Js^{-1}m^{-1}{}^\circ C^{-1}$?

A. 0.1

B. 0.15

C. 0.2

D. 0.25

Answer: A

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4. The top of a lake is frozen as the atmospheric temperature is $-10^{\circ}C$. The temperature at the bottom of the lake is most likely to be,

A. $4^{\circ}C$

B. $0^{\circ}C$

C. $-4^{\circ}C$

D. $-10^{\circ}C$

Answer: A

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5. The tungsten filament of an electric lamp has a surface areaA and a power rating P. If the emissivity of the filament is ε and σ is Stefan's constant,the steady temperature of the filament will be:

A. $T = \left(\frac{p}{A\varepsilon\sigma}\right)^2$

B. $T = \frac{p}{A\varepsilon\sigma}$

C. $T = \left(\frac{p}{(A\varepsilon\sigma)^{1/4}}\right.$

D. $T = \left(\frac{p}{A\varepsilon\sigma}\right)^{1/4}$

Answer: D

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6. What are the dimensions of Stefan's constant ?

A. $ML^{-2}T^{-2}K^{-4}$

B. $ML^{-1}T^{-2}K^{-4}$

C. $MLT^{-3}K^{-4}$

D. $ML^{0}T^{-3}K^{-4}$

Answer: D

Watch Video Solution

7. Two uniform brass rods A and B of lengths l and 2l and radii 2r and r respectively are heated to the same temperature. The ratio of the increase in the length of A to that of B is :

A. $1:1$

B. $1:2$

C. $1:4$

D. $2:1$

Answer: B

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8. A slab consists of two parallel layers of two different materials of same thickness having thermal conductivities K_1 and K_2. The equivalent conductivity of the combination is

A. $k_1 + k_2$

B. $\frac{k_1 + k_2}{2}$

C. $\frac{2k_1 k_2}{(k_1 + k_2)}$

D. $\frac{(k_1 + k_2)}{2k_1 k_2}$

Answer: B

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9. The amount of heat conducted out per second through a window, when inside temperature is $10^\circ C$ and outside temperature is $-10^\circ C$, is 1000 J. Same heat will be conducted in through the window, when outside temperature is $-23^\circ C$ and inside temperature is:

A. $23^\circ C$

B. $230K$

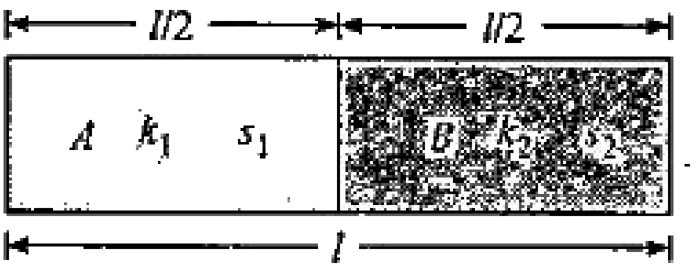
C. $270K$

D. $296K$

Answer: C

Watch Video Solution

10. A composite slab consists of two slabs A and B of different materials but of the same thickness placed one on top of the other. The thermal conductivities of A and B are k_1 and K_2 respectively. A steady temperature difference of $12^{\circ} C$ is maintained across the composite slab. If $k_1 = K_2/2$, the temperature difference across slab A will be:



A. $4^{\circ} C$

B. $8^{\circ} C$

C. $12^{\circ} C$

D. $16^{\circ} C$

Answer: B

Watch Video Solution

11. Two rods of equal length and diameter but of thermal conductivities 2 and 3 unites respectively are joined in parallel. The thermal conductivity of the combination is:

A. 1

B. 1.5

C. 2.5

D. 5

Answer: C

Watch Video Solution

12. If the coefficient of conductivity of aluminium is $0.5calcm^{-1}s^{-1}.^{\circ}C^{-1}$, then the other to conductor $10cals^{-1}cm^{-2}$ in the steady state, the temperature gradient in aluminium must be

A. $5^{\circ}C/cm$

B. $10^{\circ}C/cm$

C. $20^{\circ}C/cm$

D. $10.5^{\circ}C/cm$

Answer: C

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13. Wien's constant is 2892×10^{-6} SI unit and the value of λ_m for Moon is 14.46 micron.The surfece temperature of Moon is :

A. 100 K

B. 300 K

C. 400 K

D. 200 K

Answer: D

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14. The coefficient of thermal conductivity of copper, mercury and glass are respectively K_c, K_m and K_g that $K_c > K_m > K_g$. If the same quantity of heat is to flow per second per unit of each and corresponding temperature gradients are X_c, X_m and X_g, then

A. $X_c = X_m = X_g$

B. $X_c > X_m > X_g$

C. $X_c < X_m < X_g$

D. $X_m < X_c < X_g$

Answer: C

Watch Video Solution

15. Two cylindrical rods of lengths l_1 and l_2, radii r_1 and r_2 have thermal conductivities k_1 and k_2 respectively. The ends of the rods are maintained at the same temperature difference. If $l_1 = 2l_2$ and $r_1 = r_2 / 2$, the rates of heat flow in them will be the same if k_1 / k_2 is:

A. 1

B. 2

C. 4

D. 8

Answer: D

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16. The amount of thermal radiations emitted from one square centimetre area of a black body in one second when at a temperature of 1000 K is:

A. 5.67 J

B. 56.7 J

C. 567 J

D. 5670 J

Answer: A

Watch Video Solution

17. If temperature of a black body increases from $7^{\circ}C$ to $287^{\circ}C$, then the rate of energy radiation increases by

A. $\left(\frac{287}{7}\right)^4$

B. 16

C. 4

D. 2

Answer: B

Watch Video Solution

18. A body cools from $60^{\circ}C$ to $50^{\circ}C$ in 10 minutes . If the room temperature is $25^{\circ}C$ and assuming Newton's law of cooling to hold good, the temperature of the body at the end of the next 10 minutes will be

A. $38.5^\circ C$

B. $40^\circ C$

C. $42.85^\circ C$

D. $45^\circ C$

Answer: C

Watch Video Solution

19. Given that p joule of heat is incident on a body and out of it q joule is reflected and transmitted by it. The absorption co-efficient of the body is :

A. p/q

B. q/p

C. $(q-p)/p$

D. $(p - q)/p$

Answer: D

Watch Video Solution

20. A black body radiates 3 joule per square centimeter per second when its temperature is $127^{\circ}C$.How much heat will be radiated per square centimetre per second when its temperature is $527^{\circ}C$?

A. 6 J

B. 12 J

C. 24 J

D. 48 J

Answer: D

Watch Video Solution

21. The rate of loss of heat by radiation from a body at $400^\circ C$ is R. The radiation from it when the temperature rises to $800^\circ C$?

A. 2 R

B. 4 R

C. 16 R

D. None of the above

Answer: D

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22. Two rods of the same length and material transfer a given amount of heat in 12 seconds when they are joined end to end. But when they are joined lengthwise, they will transfer the same amount of heat, in the same conduction, in :

A. 24 s

B. 10 s

C. 15 s

D. 48 s

Answer: D

Watch Video Solution

23. A body cools from $50.0^\circ C$ to$49.9^\circ C$ in 5s. How long will it take to cool from $40.0^\circ C$ to $39.9^\circ C$? Assume the temperature of the surroundings to be $30.0^\circ C$ and Newton's law of cooling to be valid:

A. 2.5 s

B. 10 s

C. 20 s

D. 5 s

Answer: B

Watch Video Solution

24. Radiation from a black body at the thermodynamic temperature T_1 is measured by a small detector at distance d_1 from it. When the temperature is increased to T_2 and the distance to d_2 , the power received by the detector is unchanged. What is the ratio d_2 / d_1?

A. $\frac{T_2}{T_1}$

B. $\left(\frac{T_2}{T_1}\right)^2$

C. $\left(\frac{T_1}{T_2}\right)^2$

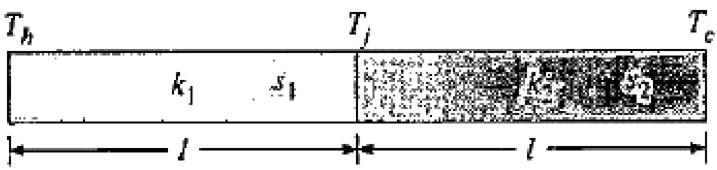
D. $\left(\frac{T_2}{T_1}\right)^4$

Answer: B

Watch Video Solution

25. Two bars of equal length and the same cross-sectional area but of different thermal conductivities,k_1 and k_2, are joined end to end as shown in figure-4.36. One end of the composite bar is maintained at temperature T_h whereas the opposite end is held at T_c.

If there are no heat losses from the sides of the bars, the temperature T_j of the junction is given by :



A. $\dfrac{k_2}{k_1}\dfrac{(T_h + T_c)}{2}$

B. $\dfrac{k_2}{k_1 + k_2}(T_h + T_c)$

C. $\dfrac{k_1 + k_2}{k_2}\dfrac{(T_h + T_c)}{2}$

D. $\dfrac{1}{k_1 + k_2}(k_1 T_h + k_2 T_c)$

Answer: D

Watch Video Solution

26. A composite slab consists of two parts of equal thickness. The thermal conductivity of one is twice that of the other. What will be the ratio of temperature difference across the two layers in the state of equilibrium ?

A. 1

B. 2

C. 3

D. 4

Answer: B

Watch Video Solution

27. The room temperature is 20''C. Water in a container cools from $55^{\circ} C$ to $45^{\circ} C$ in 8 minutes. How much time will it take in cooling from $45^{\circ} C$ to $35^{\circ} c$?

A. 4 minutes

B. 12minutes

C. 16minutes

D. 24 minutes

Answer: B

Watch Video Solution

28. When the temperature difference between inside and outside of a room is $20^\circ C$,the rate of heat flow through a window is $273 J s^{-1}$. If the temperature difference becomes 20K, the rate of flow of heat through the same window will be:

A. $253 J s^{-1}$

B. $273 J s^{-1}$

C. $293 J s^{-1}$

D. Given by one of the above mentioned values

Answer: B

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29. A wall has two layers A and B, each made of different materials. Both layers are of same thickness. But, the thermal conductivity of material A is twice that of B. If, in the steady state, the temperature difference across the wall is $24^\circ C$, then the temperature difference across the layer B is :

A. $8^\circ C$

B. $12^\circ C$

C. $16^\circ C$

D. $20^\circ C$

Answer: C

Watch Video Solution

30. You are given two spheres of same material and radii 10 cm and 20 cm. They are heated to the same temperature. They are placed in the same environment. The ratio of their rates of cooling will be:

A. $1:2$

B. $2:1$

C. $1:4$

D. $4:1$

Answer: B

View Text Solution

31. An object is cooled from $75^\circ C$ to $65^\circ C$ in 2 min in a room at $30^\circ C$. The time taken to cool the same object from $55^\circ C$ to $45^\circ C$ in the same room is

A. 5 minutes

B. 3 minutes

C. 4 minutes

D. 2 minutes

Answer: C

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32. The temperature of a room heated by heater is $20^\circ C$ when outside temperature is $-20^\circ C$ and it is $10^\circ C$ when the outside temperature is $-40^\circ C$. The temperature of the heater is

A. $80^\circ C$

B. $100^\circ C$

C. $40^\circ C$

D. $60^\circ C$

Answer: D

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33. The thermal conductivity of two materials are in the ratio 1 : 2. What will be the ratio of thermal resistances of rods of these materials having length in the ratio 1 :2 and area of cross-section in the ratio 1:2 :

A. $2:1$

B. $1:4$

C. $1:8$

D. $1:16$

Answer: A

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34. Two rods made of same material having same length and diameter are joined in series. The thermal power dissipated through then is 2W.If they are joined in parallel, the thermal power dissipated under the same conditions on the two ends of the rods, will be :

A. 16 W

B. 8 W

C. 4 W

D. 2 W

Answer: B

Watch Video Solution

35. The maximum radiations from two bodies correspond to 560 nm and 420 nm respectively. The ratio of their temperature is:

A. $4:3$

B. $3:4$

C. $2:1$

D. $3:2$

Answer: B

Watch Video Solution

36. A ball is coated with lamp black. Its temperature is $327^\circ C$ and is placed in the atmosphere at $27^\circ C$. Let the rate of cooling be R. If the temperature of the ball be $627^\circ C$, what will be its rate of cooling ?

A. 2 R

B. 4 R

C. 8 R

D. $\frac{16}{3}R$

Answer: D

Watch Video Solution

37. Two metallic rods are connected in series. Both are of same material of same length and same area of cross-section. If the conductivity of each rod be k, then what will be the conductivity of the combination ?

A. 4 k

B. 2 k

C. k

D. $k/2$

Answer: C

Watch Video Solution

38. A compound slab is made of two parallel plates of copper and brass of the same thickness and having thermal conductivities in the ratio $4:1$. The free face of copper is at $0^\circ C$. The temperature of the internal is $20^\circ C$. What is the temperature of the free face of brass?

A. $0^\circ C$

B. $20^\circ C$

C. $40^\circ C$

D. $100^\circ C$

Answer: D

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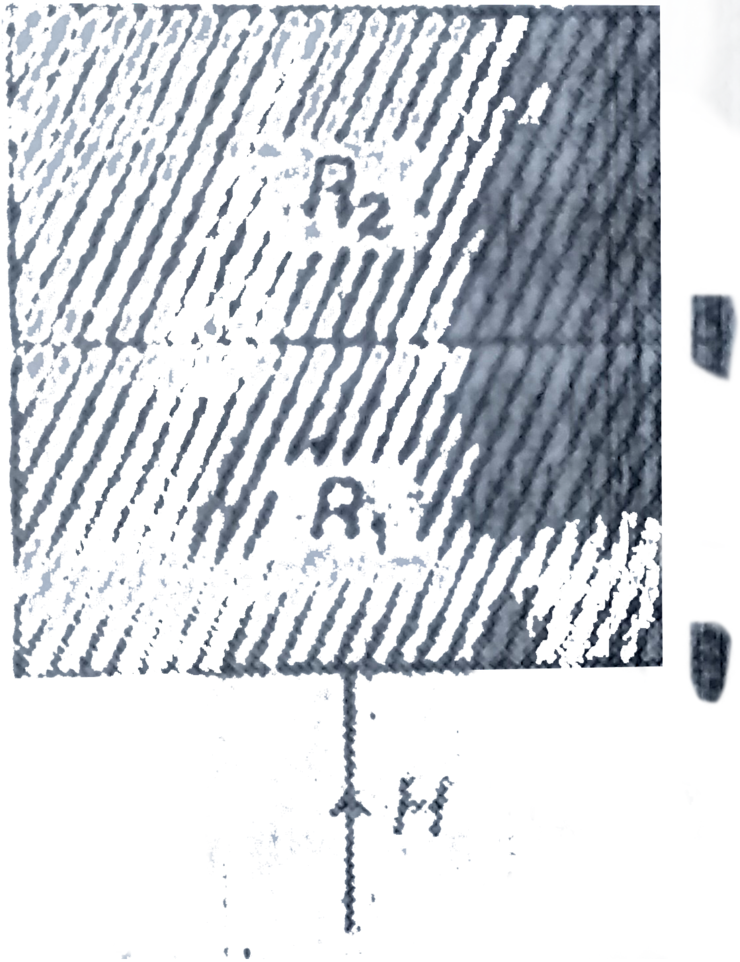
39. Consider the two insulating sheets with thermal resistance R_1 and R_2 as shown in figure. The temperature θ is



A. $\dfrac{\theta_1\theta_2R_1R_2}{(\theta_1+\theta_2)(R_1+R_2)}$

B. $\dfrac{\theta_1R_1+\theta_2R_2}{R_1+R_2}$

C. $\dfrac{(\theta_1+\theta_2)R_1R_2}{R_1^2+R_2^2}$

D. $\dfrac{\theta_1R_2+\theta_2R_1}{R_1+R_2}$

Answer: D

Watch Video Solution

40. Two cylindrical rods of same meterial have the same temperature difference between their ends. The ratio of rates of flow of heat through them is 1 : 8. The ratio of the radii of the rods are 1 : 2. What is the ratio of their lengths ?

A. $2:1$

B. $4:1$

C. $1:8$

D. $1:32$

Answer: A

Watch Video Solution

41. An object is at temperature of $400^\circ C$. At what approximate temperature would it radiate energy twice as first ? The temperature of surroundings may be assumed to be negligible:

A. $200^\circ C$

B. 200K

C. $800^\circ C$

D. 800 K

Answer: D

Watch Video Solution

42. A wall has two layers A and B, each made of different material. Both the layers have the same thickness. The thermal conductivity of the material of A is twice that of B . Under thermal equilibrium, the temperature difference across the wall is $36^\circ C$. The temperature difference across the layer A is

A. $6^\circ C$

B. $12^\circ C$

C. $18^\circ C$

D. $24^\circ C$

Answer: B

Watch Video Solution

43. The ratio of the coefficient of thermal conductivity of two different materials is $5:3$. If the thermal resistance of the rod of same thickness resistance of the rods of same thickness of these materials is same, then the ratio of the length of these rods will be

A. $\frac{3}{5}$

B. $\frac{5}{3}$

C. $\frac{2}{7}$

D. $\frac{7}{2}$

Answer: B

Watch Video Solution

44. A cylindrical rod with one end in a steam chamber and the other end in ice results in melting of 0.1 g of ice per second. If the rod is replaced by another rod with half the length and double the radius of the first and if the thermal conductivity of material of the second rod is 0.25 times that of first, the rate at which ice melts in gs^{-1} will be:

A. 0.1

B. 0.2

C. 1.6

D. 3.2

Answer: B

Watch Video Solution

45. There is ice formation on a tank of water of thickness 10 cm.How much time it will take to have a layer of 0.1 cm below it ? The outer temperature is $-5^{\circ}C$, the thermal conductivity of ice is $0.005 ca \text{lcm}^{-1\circ}C^{-1}$ and latent heat of ice is $80 cal / g$ and the density of ice is $0.91 gcm^{-3}$:

A. 46.39 minute

B. 47.63 minute

C. 48.78 minute

D. 49.31 minute

Answer: C

Watch Video Solution

46. The rectangular surface of area $8cm \times 4cm$ of a black body at temperature $127^\circ C$ emits energy E per section if length and breadth are reduced to half of the initial value and the temperature is raised to $327^\circ C$, the ratio of emission of energy becomes

A. $\frac{3}{8}E$

B. $\frac{81}{16}E$

C. $\frac{9}{16}E$

D. $\frac{81}{64}E$

Answer: D

Watch Video Solution

47. The emissivity and surface area of tungsten filament of an electric bulb are 0.35 and $0.25 \times 10^{-4} metre^2$ respectively. The operating temperature of filament is 3000 K. If $\sigma = 5.67 \times 10^{-8} wamelre^{-2} K^{-4}$, then power of bulb is approximately:

A. 40 watt

B. 143 watt

C. 3000 watt

D. 1050watt

Answer: A

Watch Video Solution

48. Ice starts forming in lake with water at $0^{\circ}C$ and when the atmospheric temperature is $-10^{\circ}C$. If the time taken for $1cm$ of ice be 7 hours. Find the time taken for the thickness of ice to change from $1cm$ to $2cm$

A. 3.5hour

B. 7 hour

C. 14 hour

D. 21 hour

Answer: D

Watch Video Solution

49. Which of the following cylindrical rods of the same metal has the highest rate of flow of heat ? The rods have equal difference of temperature between their ends :

A. l = 2m, r=1 cm

B. l=4m,r=2cm

C. l = 2 m, r = 2 cm

D. l = 2 m, r = 4 cm

Answer: D

Watch Video Solution

50. In Q.No.4-49, the lowest rate of flow of heat is for:

A. l = 2m, r=1 cm

B. l=4m,r=2cm

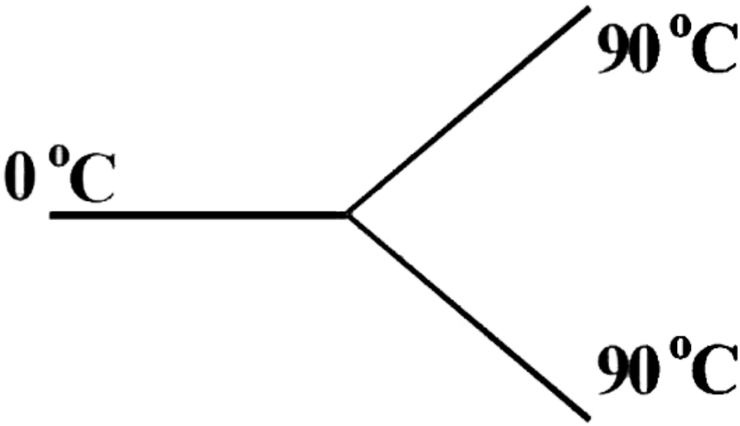
C. l = 2 m, r = 2 cm

D. l = 2 m, r = 4 cm

Answer: A

Watch Video Solution

51. Three rods made of same material and having the same cross-section have been joined as shown. In the figure.Each rod is of the same length. The left and right ends are kept at $0^\circ C$ and $90^\circ C$ respectively. The temperature of the junction of the three rods will be



A. $45^{\circ} C$

B. $60^{\circ} C$

C. $30^{\circ} C$

D. $20^{\circ} C$

Answer: B

Watch Video Solution

52. The intensity of radiation emitted by the sun has its maximum value at a wavelength of 510 nm and that emitted by the North star has the maximum value at 350 nm. If these stars behave like black bodies, then the ratio of the surface temperatures of the sun and the north star is

A. 1.46

B. 0.69

C. 1.21

D. 0.83

Answer: B

Watch Video Solution

53. Two different metal rods of the same length have their ends kept at the same temperature θ_1, and $\theta_2$with $\theta_2 > \theta_1$. If A_1 and A_2 are their cross-sectional areas and K_1 and K_2 their thermal conductivities, the rate of flow of heat in the two rods will be the same it:

A. $\frac{A_1}{A_2} = \frac{k_1}{k_2}$

B. $\frac{A_1}{A_2} = \frac{k_2}{k_1}$

C. $\frac{A_1}{A_2} = \frac{k_1\theta_1}{k_2\theta_2}$

D. $\frac{A_1}{A_2} = \frac{k_2\theta_2}{k_1\theta_1}$

Answer: B

Watch Video Solution

54. The heat is flowing through two cylinderical rods of same material. The diameters of the rods are in the ratio $1:2$ and their lengths are in the ratio $2:1$. If the temperature difference between their ends is the same, the ratio of rates of flow of heat through them will be

A. $1:1$

B. $2:1$

C. $1:4$

D. $1:8$

Answer: D

Watch Video Solution

55. The temperature gradient in a rod of $0.5m$ length is $80^\circ C / m$. It the temperature of hotter end of the rod is $30^\circ C$, then the temperature of the cooler end is

A. $40^\circ C$

B. $-10^\circ C$

C. $10^\circ C$

D. $0^\circ C$

Answer: B

Watch Video Solution

56. A body at $300^\circ C$ radiates $10 Jcm^{-2}s^{-1}$. If Sun radiates $10^5 Jcm^{-2}s^{-1}$,then its temperature is:

A. $3000^\circ C$

B. $5457^{\circ} C$

C. $300 \times 10^{4} {}^{\circ} C$

D. $5730^{\circ} C$

Answer: B

Watch Video Solution

57. Two solid spheres of radii R_1 and R_2 are made of same material and have similar surface. The spheres are raised to the same temperature and then allowed to cool under identical conditions. Assuming spheres to be perfect conductors of heat, their initial ratio of rates of loss of heat is:

A. $\frac{R_1^2}{R_2^2}$

B. $\frac{R_1}{R_2}$

C. $\frac{R_2}{R_1}$

D. $\dfrac{R_2^2}{R_1^2}$

Answer: A

Watch Video Solution

58. Q.No 4-57, the ratio of their initial rates of cooling is:

A. $\dfrac{R_1^2}{R_2^2}$

B. $\dfrac{R_1}{R_2}$

C. $\dfrac{R_2}{R_1}$

D. $\dfrac{R_2^2}{R_1^2}$

Answer: C

Watch Video Solution

59. Two identical vessels are filled with equal amounts of ice. The vessels are made from different materials. If the ice melts in the two vessels in times t_1 and t_2 respectively, then their thermal conductivities are in the ratio:

A. $\frac{t_1}{t_2}$

B. $\frac{t_2}{t_1}$

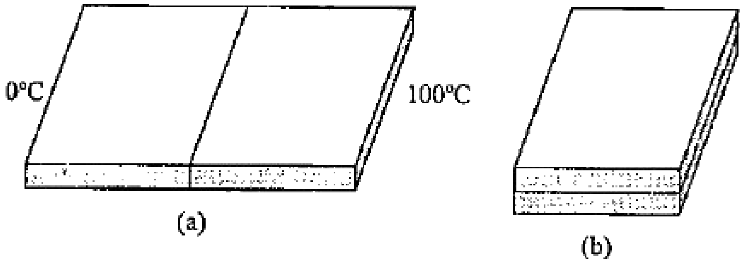
C. $t_2^2 : t_1^2$

D. $t_1^2 : t_2^2$

Answer: B

Watch Video Solution

60. Two identical rods of a metal are welded as shown in figure-4.39(a). 20 cal of heat flows through them in 4 minute. If the rods are welded as shown in figure-4.39(b), then the same amount of heat will flow in:



A. 1 minute

B. 2 minute

C. 4 minute

D. 16 minute

Answer: A

Watch Video Solution

61. A small hole is made in a hollow enclosure whose walls are maintained at a temperature of 1000 K. The amount of energy being emitted per square metre per second is :

A. 567 J

B. 5670 J

C. 56700 J

D. 567000 J

Answer: C

Watch Video Solution

62. The ends of the two rods of different materials with their lengths, diameters of cross-section and thermal conductivities all in the ratio 1 : 2 are maintained at the same temperature difference. The rate of flow of heat in the shorter rod is $1 cal s^{-1}$.

What is the rate of flow of heat in the larger rod:

A. $1 cal s^{-1}$

B. $4 cal s^{-1}$

C. $8 cal s^{-1}$

D. $16 cal s^{-1}$

Answer: B

Watch Video Solution

63. The ratio of energy of emitted radiation of a black body at $27^{\circ} C$ and $927^{\circ} C$ is

A. $1:4$

B. $1:16$

C. $1 : 64$

D. $1 : 256$

Answer: D

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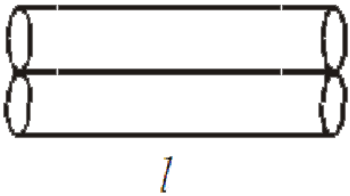
64. Two rods of same length and transfer a given amount of heat 12 second, when they are joined as shown in figure (i). But when they are joined as shwon in figure (ii), then they will transfer same heat in same conditions in



A. 24 s

B. 13 s

C. 15 s

D. 48 s

Answer: D

Watch Video Solution

65. The energy emitted per second by a black body at $27^\circ C$ is 10 J. If the temperature of the black body is increased to $327^\circ C$, the energy emitted per second will be

A. 20 J

B. 40 J

C. 80 J

D. 160 J

Answer: D

Watch Video Solution

66. The dimensional forumla for thermal resistance is

A. $\left[M^{-1}L^{-2}T^3K\right]$

B. $[ML^2T^{-2}K^{-1}]$

C. $[ML^2T^{-3}K]$

D. $[ML^2T^{-2}K^{-2}]$

Answer: A

Watch Video Solution

67. Two vessels of different materials are similar in size in every respect. The same quantity of ice filled in them gets melted in 20 minutes and 30 minutes. The ratio of their thermal conductivities will be

A. 1.5

B. 1

C. $\frac{2}{3}$

D. 4

Answer: A

Watch Video Solution

68. The temperature of a body is increased by 50%. The amount of radiation emitted by it would be nearly

A. 0.5

B. 2.25

C. 2.5

D. 4

Answer: D

Watch Video Solution

69. A cylinder of radius R made of material of thermal conductivity K_1 is surrounded by a cylindrical shell of inner radius R and outer radius 3R made of a material of thermal conductivity K_2. The two ends of the combined system are maintained at two different temperatures. What is the effective thermal conductivity of the system ?

A. $K_1 + K_2$

B. $\frac{K_1 + 8K_2}{9}$

C. $\frac{K_1 K_2}{K_1 + K_2}$

D. $\frac{8K_1 + K_2}{9}$

Answer: B

Watch Video Solution

70. The temperature of a body in increased from $27^\circ C$ to $127^\circ C$. By what factor would the radiation emitted by it increase?

A. $\frac{256}{81}$

B. $\frac{15}{9}$

C. $\frac{4}{5}$

D. $\frac{12}{27}$

Answer: A

Watch Video Solution

71. A metal ball of surface area $200cm^2$ and temperature $527^\circ C$ is surrounded by a vessel at $27^\circ C$. If the emissivity of the metal is 0.4, then the rate of loss of heat from the ball is $(\sigma = 5.67 \times 10^{-8} J/m^2 - s - k^4)$

A. 108 joule

B. 168 joule

C. 186 joule

D. 192 joule

Answer: C

Watch Video Solution

72. A spherical black body with a radius of 12 cm radiates 450 W power at 500 K. If the radius were halved and the temperature doubled, the power radiated in watt would be

(a)225 (b)450

(c) 900 (d)1800

A. 225

B. 450

C. 90

D. 1800

Answer: D

Watch Video Solution

73. Wires A and B have have identical lengths and have circular cross-sections. The radius of A is twice the radius of B i.e. $R_A = 2R_B$. For a given temperature difference between the two ends, both wires conduct heat at the same rate. The relation between the thermal conductivities is given by-

A. $K_A = 4K_B$

B. $K_A = 2K_B$

C. $K_A = K_B/2$

D. $K_A = K_B/4$

Answer: D

Watch Video Solution

74. The ratio of thermal conductivity of two rods of different material is $5:4$. The two rods of same area of cross-section and same thermal resistance will have the lengths in the ratio

A. $4:5$

B. $9:1$

C. $1:9$

D. $5:4$

Answer: D

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75. The height of a waterfall is 84 metre . Assuming that the entire kinetic energy of falling water is converted into heat, the rise in temperature of the water will be ($g = 9.8m/s^2$, $J = 4.2$ joule / cal)

A. $0.2^\circ C$

B. $1.960^\circ C$

C. $0.96^\circ C$

D. $0.0196^\circ C$

Answer: D

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76. In a steady state of thermal conduction, temperature of the ends A and B of a 20 cm long rod are $100^\circ C$ and $0^\circ C$ respectively.

What will be the temperature of the rod at a point at a distance of 6 cm from the end A of the rod

A. $-30^{\circ} C$

B. $70^{\circ} C$

C. $5^{\circ} C$

D. None of these

Answer: B

Watch Video Solution

77. A black metal foil is warmed by radiation from a small sphere at temperature T and at a distance d it is found that the power received by the foil is P If both the temperature and the distance are doubled the power received by the foil will be .

A. $16P$

B. $4P$

C. $2P$

D. P

Answer: B

Watch Video Solution

78. A heat flux of 4000 J/s is to be passed through a copper rod of length 10 cm and area of cross section $100cm^2$. The thermal conductivity of copper is $400W/m/^\circ C$ The two ends of this rod must be kept at a temperature difference of

A. $1^\circ C$

B. $10^\circ C$

C. $100^\circ C$

D. $1000^\circ C$

Answer: C

Watch Video Solution

79. The temperature of a liquid drops from 365 K to 361 K in 2 minutes . Find the time during which temperature of the liquid drops from 344 K to 342 K.Temperature of room is 293 K

A. 84 s

B. 72 s

C. 66 s

D. 60 s

Answer: A

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80. Consider two hot bodies B_1 and B_2 which have temperature $100^\circ C$ and $80^\circ C$ respectively at t = 0. The temperature of surroundings is $40^\circ \quad C$. The ratio of the respective rates of cooling R_1 and R_2 of these two bodies at $t = 0$ will be

A. $R_1 : R_2 = 3 : 2$

B. $R_1 : R_2 = 5 : 4$

C. $R_1 : R_2 = 2 : 3$

D. $R_1 : R_2 = 4 : 5$

Answer: A

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81. The temperature of a perfect black body is $727^{\circ}C$ and its area is $0.1m^{2}$. If Stefan's constant is $5.67 \times 10^{-8} wa / m^{2} - s - K^{4}$, then heat radiated by it in 1 minute is:

A. 8100 cal

B. 81000 cal

C. 810 cal

D. 81 cal

Answer: B

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82. The temperature of a piece of metal is raised from $27^{\circ}C$ to $51.2^{\circ}C$. The rate at which the metal radiates energy increases nearly,

A. 2 times

B. 4 times

C. $4.46 \times$

D. $1.36 \times$

Answer: D

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83. The dimensions of coefficient of thermal conductivity is

A. $ML^{-1}T^{-2}K^{-1}$

B. $ML^{-2}T^{-3}K^{-1}$

C. $ML^{-1}T^{-1}K^{-1}$

D. $MLT^{-3}K^{-1}$

Answer: D

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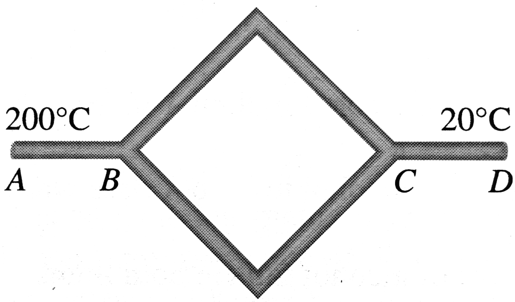

84.

Six identical cunducting rods are joined as shown in Fig. Points A and D are maintained at temperatures $200^\circ C$ and $20^\circ C$ respectively. The temperature of junction B will be

A. $120^\circ C$

B. $100^\circ C$

C. $140^\circ C$

D. $80^\circ C$

Answer: C

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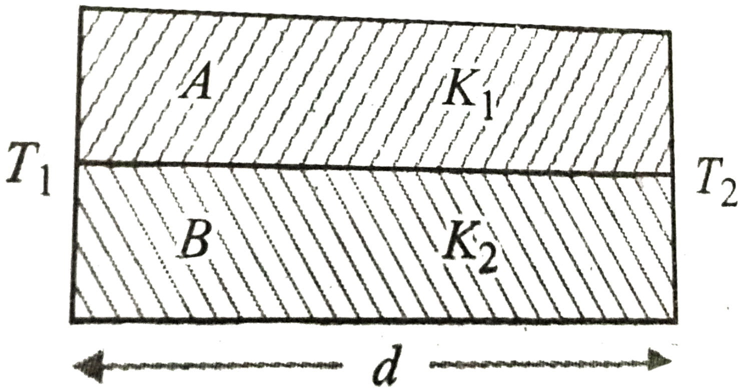
85. Two rods A and B of different materials are welded together as shown in figure. Their thermal conductivities are K_1 and K_2. The thermal conductivity of the composite rod will be



A. $2(k_1 + k_2)$

B. $\frac{3}{2}(k_1 + k_2)$

C. $(k_1 + k_2)$

D. $\frac{1}{2}(k_1 + k_2)$

Answer: D

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86. A parallel-sided slab is made of two different materials. The upper half of the slab is made of material X, of thermal conductivity λ, the lower half is made of material Y, of thermal conductivity 2λ. In the steady state, the left hand face of the composite slab is at a higher, uniform temperature than the right-hand face, and the flow of heat through the slab is parallel to its shortest sides. What fraction of the total heat flow through the slab passes through material X ?

A. $\frac{1}{4}$

B. $\frac{1}{3}$

C. $\frac{1}{2}$

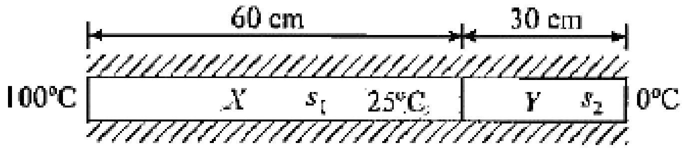
D. $\frac{2}{3}$

Answer: B

View Text Solution

87. Metal rods X and Y of identical cross-sectional area, have lengths 60 cm and 30 cm respectively. They are made of metals of thermal conductivities λ_x and λ_y. They are well-lagged and joined end-to-end as shown in the figure-4.43. One end of X is maintained at $100^\circ C$ and the opposite end of Y is maintained at $0^\circ C$. When steady conditions have been .reached, the temperature of the junction is found to be $25^\circ C$.

What is the value of $\frac{\lambda_x}{\lambda_y}$?



A. $\frac{1}{6}$

B. $\frac{2}{3}$

C. $\frac{25}{24}$

D. $\frac{3}{2}$

Answer: B

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88. When the centre of earth is at a distance of $1.5 \times 10^{11} m$ from the centre of sun, the intensity of solar radiation reaching at the earth's surface is $1.26 kW / m^2$. There is a spherical cloud of cosmic dust, containing iron particles. The melting point for iron particles in the cloud is 2000 K. Find the distance of iron particles from the centre of sun at which the iron particle starts melting. (Assume sun and cloud as a black body, $\sigma = 5.8 \times 10^{-8} W / m^2 K^4$):

A. $2.81 \times 10^5 m$

B. $2.81 \times 10^{10} m$

C. $2.81 \times 10^9 m$

D. $1.40 \times 10^{10} m$

Answer: C

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89. Read the passage carefully and answer the followingquestions.

Imagine a system, that can keep the room temperature within a narrow range between $20^\circ C$ to $25^\circ C$. the system includes a heat engine operating with variable power $P = KT$, where K is a constant coefficient, depending upon the thermal insulation of the room, the area of the walls and the thickness of the walls. T is temperature of the room in degree, when the room temperature drops lower than $20^\circ C$, the engine turns on,when the temperature increase over $25^\circ C$, theengineturnsoff, room looses energy at a ate of $K(T - T_0$ is the outdoor temperature. Thde heat capacity of the room is C.

Given

$$\left(T_0 = 10^\circ C, In\left(\frac{3}{2}\right) = 0.4, In\left(\frac{6}{5}\right) = 0.18, \frac{C}{K} = 750SI - unit\right)$$

Suppose at t = 0, the engine turns off, after how much time interval, again, the engine will turn on:

A. 10 minute

B. 5 minute

C. $1.125 \min ute$

D. $2.25 \min ute$

Answer: B

View Text Solution

90. Two balls of same material and finish have their diameters in the ratio 2:1. Both are heated to the same temperature and allowed to cool by radiation. Rate of cooling of big ball as compared to smaller one will be in the ratio:

A. $1:1$

B. $1:2$

C. $2:1$

D. $4:1$

Answer: B

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91. Three bars each of area of cross section A and length L are connected in series as shown in the figure. Thermal conductivities of their materials are K, 2K and 1.5K. If the temperatures of free end of first and the last bar are $200^{\circ}C$ and $18^{\circ}C$. The value of θ_1 and θ_2 are (in steady state):

A. $120^{\circ}C, 80^{\circ}C$

B. $116^{\circ}C, 80^{\circ}C$

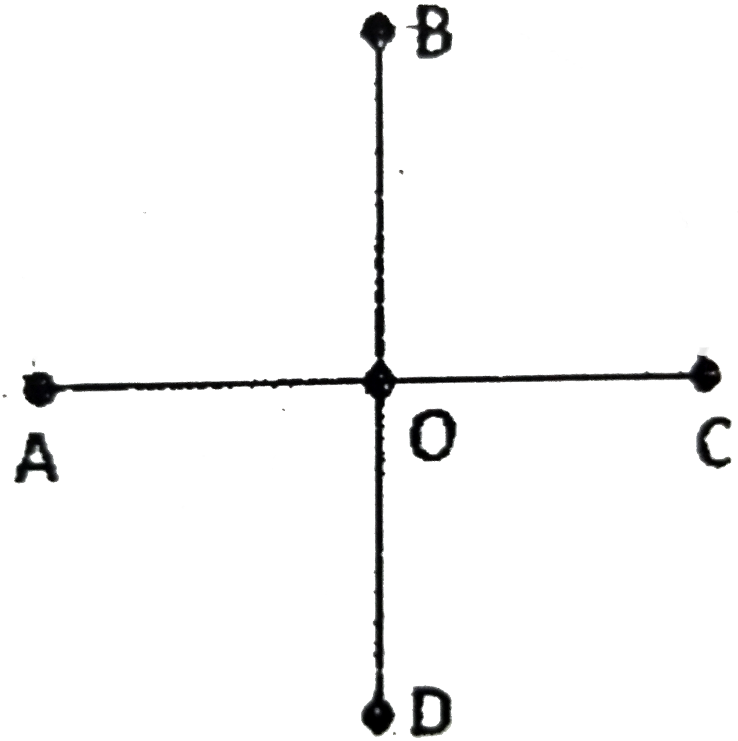
C. $116^\circ C, 74^\circ C$

D. $120^\circ C, 74^\circ C$

Answer: C

View Text Solution

92. Four identical rods which have thermally insulated lateral surface are joined at point O. Points A,B,C and D are connected to furnace maintained at constant tempertures. If the heat flows into the junction O from A at the rate of 2J/s and from B at 4J/s and flows out towards C is 8J/s. Chosse the correct relation.



A. $T_A < T_0$

B. $T_0 < T_C$

C. $T_A = T_D$

D. $T_B = T_D$

Answer: C

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93. In a room where the temperature is $30^{\circ}C$, a body cools from $61^{\circ}C$ to $59^{\circ}C$ in 4 minutes. The time (in min.) taken by the body to cool from $51^{\circ}C$ to $49^{\circ}C$ will be

A. 4 minute

B. 6 minute

C. 5 minute

D. 8 minute

Answer: B

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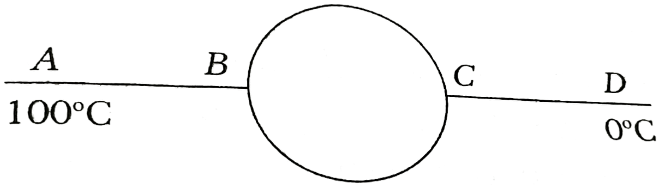
94. Two identical conducting rods AB and CD are connected to a circular conducting ring at two diametrically opposite points B and

C, the radius of the ring is equal to the length of rods AB and CD. The area of cross-section, thermal conductivity of the rod and ring are equal. points A and D are maintained at temperatures of $100^{\circ} C$ and $0^{\circ} C$. temperature at poimt C will be



A. $62^{\circ} C$

B. $37^{\circ} C$

C. $28^{\circ} C$

D. $45^{\circ} C$

Answer: C

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Advance Mcqs With One Or More Option Correct

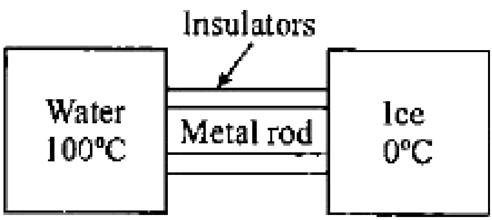
1. An insulated container is filled with ice at $0^{\circ} C$, and another container is filled with water that is continuously boiling at $100^{\circ} C$. In series of experiments, the container connected by various, thick metal rods that pass through the walls of container as shown in the figure-4.46.

In the experiment- I: A copper rod is used and all ice melts is 20 minutes.

In the experiment - II: A steel rod of identical dimensions is used and all melts in 80 minutes.

In the experiment-III: Both the are used in parallel all ice melts in t_{10} minutes.

In the cxperiment-IV: Both rods are used in parallel all ice melts in t_{20}



4

A. The value of t_{10} is 100 minutes

B. The value of t_{10} is 50 minutes

C. The value of t_{20} is 16 minutes

D. The value of t_{20} is 8 minutes

Answer: A::C

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2. Two spheres A and B have radius but the heat capacity of A is greater than that of B. The surfaces of both are painted black. They are heated to the same temperature and allowed to cool. Then initially

A. A cools faster than B

B. Both A and B cool at the same rate

C. At any temperature the ratio of their rates of cooling is a constant

D. B cools faster than A

Answer: C::D

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3. The two ends of a uniform rod of thermal conductivity k are maintained at different but constant temperatures. The temperature gradientat any point on the rod is $\frac{d\theta}{dl}$(equal to the difference in temperature per unit length). The heat flow per unit time per unit cross-section of the rod is l then which of the following statements is/are correct:

A. $\frac{dth\eta}{dl}$ is the same for all points on the rod

B. I will decrease as we move from higher to lower temperature

C. $I \propto k. \frac{dth\eta}{dl}$

D. All the above options are incorrect

Answer: A::C

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4. A planet having surface temperature T, K has a solar constant S. An angle θ is subtended by the sun at the planet:

A. $S \propto T^2$

B. $S \propto T^4$

C. $S \propto \theta^\circ$

D. $S \propto \theta^2$

Answer: B::D

Watch Video Solution

5. Two ends of area A of a uniform rod of thermal conductivity k are maintained at different but constant temperatures. At any point on the rod, the temperature gradient is $\frac{dT}{dl}$. If I be the thermal current in the rod, then:

A. $I \propto A$

B. $I \propto \frac{dT}{dl}$

C. $I \propto A^{\circ}$

D. $I \propto \frac{1}{\left(\frac{dT}{dl}\right)}$

Answer: A::B

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6. Two bodies A and B have thermal emissivities of 0.01 and 0.81 respectively. The outer surface areas of the two bodies are same. The two bodies emit total radiant power at the same rate. The wavelength λ_B corresponding to maximum spectral radiancy from B is shifted from the wavelength corresponding to maximum spectral radiancy in the radiation from A by 1.0 μm. If the temperature of A is 5802 K, calculate (a) the temperature of B, (b) wavelength λ_B.

A. The temperature of B is 1934 K

B. $\gamma_B = 1.5 \mu m$

C. The temperature of B is 11604 K

D. The temperature of B is 2901 K

Answer: A::B

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7. Curved surface of a uniform rod is isolated from surrounding. Ends of the rod are maintained at temperatures T_1 and $T_2 (T_1 > T_2)$ for a long time. At an instant, temperature T_1 starts to decrease at a constant and slow rate. If thermal capacity of material of the rod is considered, then which of thefollowing statements is/are correct ?

A.) At an instant,rate of heat flow near the hotter end is equal to that near the other end

B. Rate of heat flow through the rod starts to decrease near the hotter end and remains constant near the other end

C. Rate of heat flow is maximum at mid section of the rod

D. None of these

Answer: D

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8. A thin spherical shell and a thin cylindrical shell (closed at both ends) have same volume. Both the shells are filled with water at the same temperature and are exposed to the same atmosphere. Initial temperature of water is slightly greater than that of surrounding. Then at initial moment:

A. Rate of heat radiation from two shells will be same

B. Rate of fall of temperature in both the shells will be same

C. Rate of heat radiation and rate of fall of temperature, both, in cylindrical shell are less than those in spherical shell

D. None of these

Answer: D

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9. The gross radiation emitted by a perfectly black body is:

A. Dependent on its temperature

B. Dependent on the area of its surface

C. Dependent on the temperature of the surroundings

D. Independent of the temperature of the surroundings

Answer: A::B::D

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10. The rates of fall temperature of two identical solid spheres of different materials are equal at a certain temperature if:

A. Their specific heat capacities are equal

B. Their heat capacities are equal

C. Their specific heat capacities are proportional to their densities

D. Their specific heat capacities are inversely proportional to their densities

Answer: B::D

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11. A hollow copper sphere & a hollow copper cube of same surface area & negligible thickness , are filled with warm water of same temperature and placed in an enclosure of constant temperature a few degrees below that of the bodies. Then in the beginning:-

A. Energy lost by the sphere is less than that by the cube

B. Energy lost by the sphereis more than that by the cube

C. Energy lost by the two are equal

D. Fall of temperature for sphere is less than that for the cube

Answer: C::D

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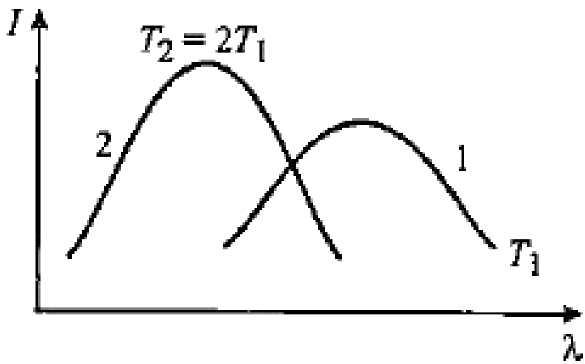
12. The plots of intensity vs wavelength for two black bodies at temperature T_1 and T_2 such that $T_2 = 2T_1$, respectively are as shown. Let the energy radiated per second by body I and body 2 be E_1 and E_2 respectively. Pick up the correct statement(s).



A. $E_1 = 16E_2$

B. E_1 may be equal to 16 times of E_2

C. The area under curve 1 and area under curve 2 will be same

D. Area under curve 2 is larger than area under curve 1

Answer: B

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13. A metal cylinder of mass 0.5 kg is heated electrically by a 12 W heater in a room at 15° C. The cylinder temperature rises uniformly to 25° C in 5 min and finally becomes constant at 45° C Assuming that the rate of heat losss is proportional to the excees temperature over the surroundings,

A. The rate of loss of heat of the cylinder to surrounding at $20^\circ C$ is 2 W

B. The rate of loss of heat of the cylinder to surrounding at

$45^\circ C$ is l2 W

C. The rate of loss of heat of the cylinder to surrounding at

$20^\circ C$ is 5 W

D. The rate of loss of heat of the cylinder to surrounding at

$45^\circ C$ is 30 W

Answer: A::B

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14. A particle of mass 1 kg slides in a horizontal circle of radius 20 m with a constant speed of $1m/s$. The only forces in the vertical direction acting on the particle are its weight and the normal reaction, however no information is available about the forces in the horizontal plane. Over a period of time whole energy dissipated due to work done by friction is conducted to ground and simultaneously radiated to surround. If the coefficient of friction is $\mu = 0.5$. Then (Take `g =10 m//s^(2):

A. The magnitude of frictional force acting on the block must be 5 N

B. The frictional force must be in tangential direction.

C. The frictional force must be towards the centre.

D. No comment can be made about the direction or magnitude of friction based on the given data.

Answer: A::B

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15. In accordance with Kirchhoffs law (Assume transmissivity $a_t arrow 0$ 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

Answer: A::B::C

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16. A hollow and a solid sphere of same material and identical outer surface under identical condition are heated to the same temperature at the same time (both have same e, a):

A.) In the beginning both will emit equal amount of radiation per unit time

B. In the beginning both will absorb equal amount of radiation per unit time

C. Both spheres will have same rate of fall of temperature $(dT)/dt)$

D. Both spheres will have equal temperatures at any moment

Answer: A::B

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17. A heated body emits radiation which has maximum intensity at frequency v_m If the temperature of the body is doubled:

A. The maximum intensity radiation will be at frequency $2V_m$

B. The maximum intensity radiation will be at frequency v_m

C. The total emitted energy will increase by a factor 16

D. The total emitted energy will increase by a factor 2

Answer: A::C

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18. Two spherical black bodies A and B,having radii r_A and $r_B = 2r_A$ emit radiation with peak intensities at wavelength 400 nm and 800 nm respectively. If their temperature are T_A and T_B respectively in Kelvin scale, their emissive powers are E_A and E_B then :

A. $\frac{T_A}{T_B} = 2$

B. $\frac{T_A}{T_B} = 4$

C. $\frac{E_A}{E_B} = 8$

D. $\frac{E_A}{E_B} = 4$

Answer: A::D

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19. Which of the following statements are true?

A. Hole in the wall of a cavity radiator behaves like a black body

B. Hole in the wall of a cavity radiator does not act like a black body

C. When a body is kept in a surrounding of low temperature it does not absorb any energy from the surroundings

D. When a body is kept in surrounding of low temperature it simultaneously radiates heat to the surroundings and absorbs heat from the surroundings.

Answer: A::D

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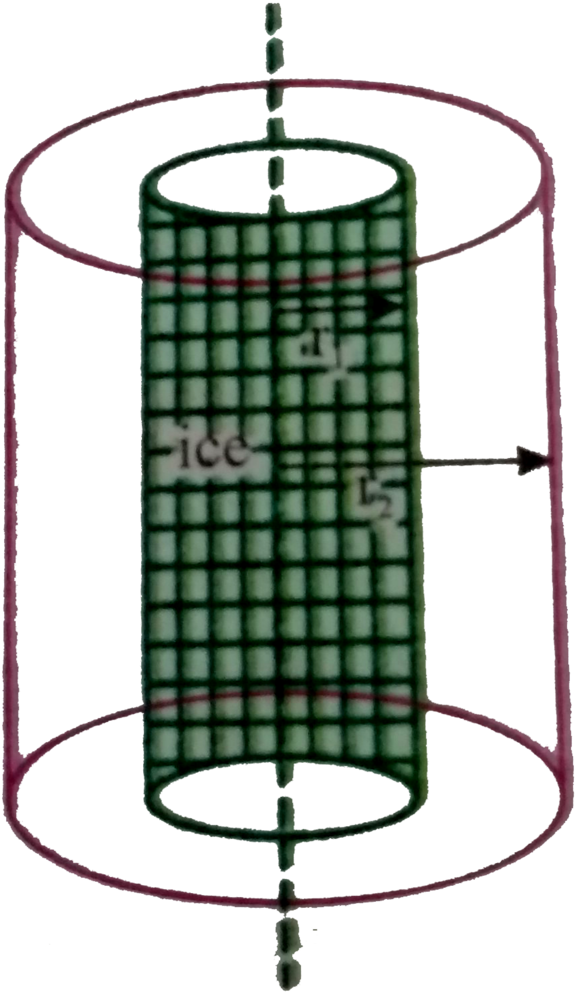
20. A $100cm$ long cylindrical flask with inner and outer diameter $2cm$ and $4cm$ respectively is completely filled with ice as shown in the The constant temperature outside the flask is $40^{\circ}C$

(Thermal conductivity of the flask is

$0.693W / m^\circ C, L_{ice} = 80cal / gm\&In2 = 0.693)$



A. Rate of heat flow from outside to the flask is $80\pi J / s$

B. The rate at which ice melts is $\frac{\pi}{4200} Kg / s$

C. The rate at which ice melts is $100\pi kg / s$

D. Rate of heat flow from outside to flask is $40\pi J/s$

Answer: A::B

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Unsolved Numerical Problems For Preparation Of Nsep Inpho Ipho

1. A compound rod is formed of a steel core of diameter $1cm$ and outer casing is of copper, whose outer diameter is $2cm$. The length of this compound rod is $2m$ and one end is maintained as $100^\circ C$ and the end is at $0^\circ C$. If the outer surface of the rod is thermally insulated, then heat current in the rod will be (Given thermal conductivity of steel $j = 12cal/m/k/s$, thermal conductivity of copper $= 92cal/m/k/s$

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2. A hollow glass sphere whose thicknes is $2mm$ and external radius is $10cm$ is filled with ice and placed in a bath containing boiling water at $100^{\circ} C$. Calculate the rate of which the ice melts. Thermal conductivity of glass $= 1.1 Js^{-1} m^{-1} K^{-1}$ and L of ice $= 336 \times 10^3 Jkg^{-1}$.

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3. A steel boiler whose thickness is 3 cm is placed on a plate of area $1m^2$. The temperature of the plate is $300^{\circ} C$ and that of the boiling water in the boiler is $100^{\circ} C$. How much water will evaporate per minute? (Conductivity of steel $= 63.0 Js^{-1} m^{-1} K^{-1}$ and sp. latent heat of vaporisation of water $= 2251.2 \times 10^3 Jkg^{-1}$.)

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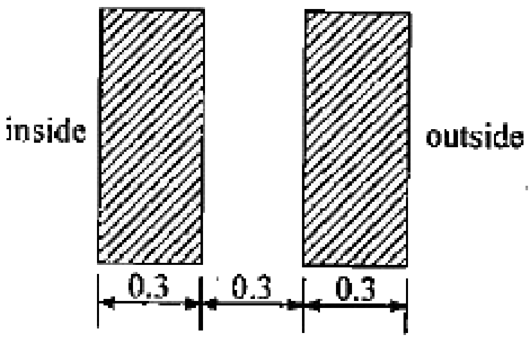
4. A certain double plane window consists of two glass sheets each $80cm \times 80cm \times 0.30cm$, separated by $0.3cm$ stagnant air space between them (see figure-4.49). The indoor surface temperature is $20^\circ C$, while the outdoor surface temperature is $0^\circ C$. Find:

(a) the temperature of the surface of the sheets in contact.with the stagnant air

(b) the power transmitted from the inside to the outside. Given that $K_{glass} = 2.0 \times 10^{-3} cals^{-1} cm^{-1 \circ} C$,

$K_{air} = 2.0 \times 10^{-4} cals^{-1} cm^{-1 \circ} C^{-1}$



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5. Water is being boiled in a flat bottomed kettle placed on a stove The area of the bottom is $300cm^2$ and the thickness is $2mm$ If the amount pf steam produced is $1gm \min^{-1}$ then the difference of the temperature between the inner and the outer surface of the bottom is (thermal conductivity of the matrial of the kettle $0.5ca\,\mathrm{lcm}^{-1}C^{-1}$ latent heat of the steam is equal to $540calg^{-1}$) .

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6. A spherical ball of surface area $2 \times 10^{-3}m^2$ is suspended in a room at temperature 330 K. If the temperature of the ball is $200^\circ C$, find the net rate of loss of heat from the ball if it behaves like a black body.

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7. Some water is placed in a container made ofa material of poor thermal conductivity. Temperature of water in it is 520 K. The total wall area of the container is $8000 cm^2$. The surrounding temperature is 300 K. Find the rate at which heat current will flow from atmosphere to water.

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8. Heat is conducted through a slab composed of paralel layers of two different materials of conductivities 134.4 SI units and 58.8 SI units and of thickness $3.6 cm$ and $4.2 cm$ respectively. The temperature of the outer faces of the compound slab are $96^{\circ} C$ and $8^{\circ} C$. Find (i) the temperature of the interface, (ii) temperature gradient in each section of the slab.

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9. Two bodies each of mass m, having specific heats s, are connected by ametal rod of negligible heat capacity of length l, area of cross section A and thermal conductivity k. Initially both bodies are at different temperatures, find the time taken for the temperature difference between the two bodies to become half of the. initial value.

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10. A 2 m long wire of resistance 4Ω and diameter 0.64 mm is coated with plastic insulation of thickness 0.66 mm. A current of 5A flows through the wire. Find the temperature difference across the insulation in the steady state. Thermal conductivity of plastic is $0.16 \times (10^{-2}) cal / scm.^{\circ} C.$

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11. One end of a steel rod of length 1 m and area of cross section $4 \times 10^{-6} m^2$ is put in boiling water and the other end is kept in an ice bath at $0^\circ C$. If thermal conductivity of steel is $46 W / m^\circ C$, find the amount of ice melting per second if heat flow only by conduction. Given that the latent heat of fusion of ice is $3.36 \times 10^5 J / kg$.

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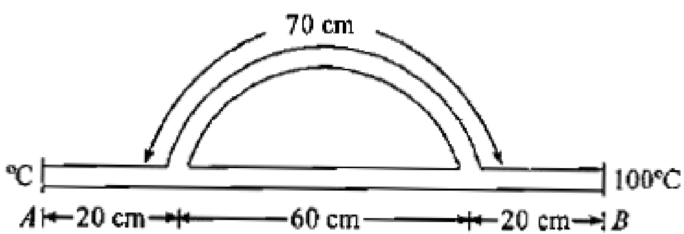
12. Figure-4.50 shows a thermal network of two metal rods of same cross section area. If the heat current from the ends A and B is 130 W, find the heat current through the curved metal rod.



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13. The heat generated by radioactivity within the earth is conducted outward through the oceans. Assuming the average temperature gradient within the solid earth beneath the ocean to be $0.07^{\circ} C^{-1}$ and the average thermal conductivity $0.2 calm^{-1} s^{-1} \hat{} (\circ) C^{-1}$, determine the rate of heat transfer per square metre. Radius of the earth = 6400 km.- further, determine the quantity of heat transferred through the earth's surface each day

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14. Two rods whose lengths are l_1 and l_2 and heat conductivity coefficient x_1 and x_2 are placed end to end. Find the heat conductivity coefficient of a uniform rod of length $l_1 + l_2$ whose conductivity is the same as that of the system of these two rods.

The lateral surfaces of the rods are assumed to be thermally insulated.

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15. A solid copper sphere (density $= 8900 kgm^{-3}$ and specific heat $C = 390 Jkg^{-1}K^{-1}$) of radius $r = 10cm$ is at an initial temperature $T_1 = 200K$. It is then suspended inside an chamber whose walls are at almost OK. Calculate the time required for the temperature of the sphere to drop to $T_2 = 100K$, $\sigma = 5.67 \times 10^{-8} Wm^{-2}K^{-4}$.

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16. A calorimeter of mass 100 g contains $100cm^3$ of water at $70^\circ C$. It cools down to $30^\circ C$ in 12 minutes. When the same volume of glycerine is used in the same calorimeter, it takes 8 minutes to cool down through the same temperature range. Find the specific heat of glycerine of specific heat of the calorimeter is $0.1 cal g^{-1} \hat{} (\circ) C^{-1}$ and specific gravity of glycerine $= 1.27$.

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17. A vertical brick duct (tube) is filled with cast iron. The lower end of the duct is maintained at a temperature T_1 which is greater than the melting point T_m of cast iron and the upper end at a temperature T_2 which is less than the temperature of the melting point of cast iron. It is given that the conductivity of liquid cast iron is equal to k times the conductivity of solid cast iron. Determine the fraction of the duct filled with molten metal.

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18. The gas between two long coaxial cylindrical surfaces is filled with a homogeneous isotropic substance. The radii of the surfaces are $r_1 = 5.00 cm$ and $r_2 = 7.00 cm$. In the steady state the temperatures of the inner and outer surfaces are $T_1 = 290 K$ and $= 320 K$ respectively. Find the temperature of a coaxial surface of radius r.

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19. The tungsten filament of an electric lamp has a length $l = 0.25 m$ and diameter $d = 0.04 mm$. The power rating is $P = 100 W$. Assuming the radiation from the filament to be $\eta = 80\%$ of that of a black body radiator at the same temperature, estimate the temperature of the filament. Stefan constant $= 5.7 \times 10^{-8} W / m^2 K^4$.

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20. There are two concentric metallic shells of negligible thickness of radii 5 cm and 20 cm. The region between the two shells is filled with a medium of thermal conductivity k. The temperature of inner and outer sphere is maintained at $5^\circ C$ and $10^\circ C$ respectively. If the heat current flowing from inner to outer sphere is 100 W, find the value of k.

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21. Two bodies A and B ahave thermal emissivities of 0.01 and 0.81 respectively. The outer surface areas of the two bodies are the same. The two bodies emit total radiant power of the same rate. The wavelength λ_B corresponding to maximum spectral radiancy in the radiation from B shifted from the wavelength corresponding to maximum spectral radiancy in the radiation from A, by $1.00 \mu m$. If the temperature of A is 5820K:

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22. A thin brass rectangular sheet of sides 15.0 and 12.0 cm is heated in a furnace to 600° C and taken out. How much electric power is needed to maintain the sheet at this temperature, given that its emissivity is 0.250?

Neglect heat loss due to convection (Stefan-Boltzmann constant, $\sigma = 5.67 \times 10^{-8} W / m^2 - K^4$).

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23. A body which has a surface area $5.0 cm^2$ and a temperature of $727^{\circ} C$ radiater 300 J energy each minute. What is its emissivity? Stefan's Boltzmann's constat is $5.76 \times 10^{-8} W m^{-2} K^{-4}$.

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24. Over what distance must there be heat flow by conduction from the blood capillaries beneath the skin to the surface if the temperature difference is $0.50^{\circ}C$? Assume $200W$ must be transferred through the whole body's surface area of $1.5m^2$ Given that thermal conductivity of blood cells is $0.2W/mK$.

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25. A room at $20^{\circ}C$ is heated by a heater of resistence 20 ohm connected to 200 VV mains. The temperature is uniform throughout the room and the heati s transmitted through a glass window of area $1m^2$ and thickness 0.2 cm. Calculate the temperature outside. Thermal conductivity of glass is $0.2cal/mC^{\circ}$ s and mechanical equivalent of heat is $4.2J/cal$.

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26. Assume that a planet radiates heat at a rate proportional to the fourth power of its surface temperature T and that the temperature of the planet is such that this loss is exactly compensated by the heat gained from the sun. Show that other things remaining the same, a planet's surface temperature will vary inversely as the square root of its distance from the sun.

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27. The atmospheric temperature above a lake is below $0^\circ C$ and constant. It is found that a 2 cm layer of ice is formed in four days. In how many days will the thickness increase to 3 cm?

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28. A hollow cube of metal has sides measuring $0.8cm$ (internal) and thickenes $0.5cm$. It is filled with ice $0^\circ C$ and immersed in boiling water at $100^\circ C$. How many kg of ice will melt in one minute? Thermal conductivity of metal $= 252 J m^{-1} s^{-1} K^{-1}$ and latent heat capacity of ic e $= 336 \times 10^3 J kg^{-1}$.

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29. The walls of a closed cubical box of edge 50cm are mdade of a material of thickness 1mm and thermal conductivity 4×10^{-4} cal $s^{-1} cm^{-1} . ^\circ C^{-1}$ the interior of the box maintained at $100^\circ C$ above the outside temperature by a heater placed inside the box and connected acros a 400 V d.c. source. Calculate the resistance of the heater.

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30. A 300 W lamp loses all its energy by emission of radiation from the surface of its filament. If the area of surface of filament is

$2.4cm^2$ and is of emissivity 0.4, estimate its temperature. Given that $\sigma = 1.36 \times 10^{-12} calcm^{-2} s^{-1} K^{-4} J = 4.2 Jcal^{-1}$. Neglect the absorption from the surroundings.

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31. A blackened solid copper sphere of radius 2 cm is placed in an evacuated enclosure whose walls are kept at $100^\circ C$. At what rate must energy be supplied to the sphere to keep its temperature constant at $127^\circ C$? Stefan constant $= 5.67 \times 10^{-8} Jm^{-2} K^{-4}$.

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32. Two identical solid bodies one of aluminium and other of copper are heated to the same temperature and are put in same surrounding. If the emissivity of the aluminium body is 4 times that of copper body, find the ratio of the thermal power radiated by the two bodies. If specific heat of aluminum is $900 / kg^{\circ} C$ and that of copper is $390 J / kg^{\circ} C$ and density of copper is 3.4 times that of aluminum, find the ratio of rate of cooling of the two spheres.

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33. A solid copper sphere (density rho and specific heat c) of radius r at an initial temperature $200 K$ is suspended inside a chamber whose walls are at almost $0 K$. The time required for the temperature of the sphere to drop to 100K is ....

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34. The thermal powered density u is generated uniformly inside a uniform sphere of radius R and thermal conductivity Find the temperature distribution in the sphere when the steady state temperature at the surface is T_0.

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35. A rof of length l with thermally insulated lateral surface consists of material whose heat conductivity coefficient varies with temperature as $x = \alpha / T$, where α is a constant. The ends of the rod are kept at temperatures T_1 and T_2. Find the function $T(x)$, where x is the distance from the end whose temperature is T_1, and the heat flow density.

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36. A hot water radiator at 310 K temperature radiates thermal radiation like a black body. Its total surface area is $1.6m^2$. Find the thermal power radiated by it.

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37. A flat bottomed metal tank of water is dragged along a horizontal floor at the rate of $20ms^{-1}$. The tank is of mass 20kg and contains 1000 kg of water and all the heat produced in the dragging is conducted to the water through the bottom plate of the tank. If the bottom plate has an effective area of conduction 1 m^2 and a thickness 5 cm and the temperature of the water in the tank remains constant at $50^{\circ} C$, calculate the temperature of the bottom surface of the tank, given the coefficient of friction between the tank and the floor is 0.343 and K for the material of the tank is $25 cal m^{-1} s^{-1} K^{-1}$.

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38. Two solid spheres, one of aluminium and the other of copper, of twice the radius are heated to the same temperature and are allowed to cool under the identical conditions. Given that specific heat of aluminium is $900 J / kg$ K and that ofcopper is $390 J / kg$ K. Specific gravity of aluminium and copper are 2.7 and 8.9 respectively.

initial rates of fall of temperature, and

the initial rates of loss of heat

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39. Estimate the rate that heat can be conducted from the interior of the body to the surface. Assume that the thickness of tissue is 4.0 cm, that the skin is at $34^{\circ} C$ and the interior at $37^{\circ} C,$ and that the surface area is $1.5 m^2.$ Compare this to the measured value of about $225 W$ that must be dissipated by a person working lightly.

This clearly shows the necessity of conveclive cooling by the blood. Given that the thermal conductivity of the blood cells is $0.2W/mK$

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40. The temperature of the filament of $100-$ watt lamp is $4000^{\circ}C$ in the steady state and the radius of the glass bulb is 4 cm and the thickness of the wall is $0.4mm.$ Assuming that there is no convection, calculate the thermal conductivity of glass. The temperature of the outside air is $27^{\circ}C.$

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41. A thin pipe having outside diameter of 3 cm is to be covered with two layers of insulation each having thickness of 2.5 cm. The thermal conductivity of one material is five times that of the other.

Assuming that the inner and outer surface temperatures of the composite wall are fixed, find the percentage reduction in heat transfer when the better insulating material is next to the thin pipe than when it is outside.

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42. A spherical metal ball of radius 1 cm is suspended in a room at 300 K temperature. Inside the sphere there is a battery operated heater which maintains the temperature of the ball at 1000 K. Find the power of the heater if emissivity of the metal ball is 0.3.

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43. A block of copper of radius $r = 5.0 cm$ is coated black on its outer surface. How much time is required for block to cool down from 1000 K to 300 K? Density of copper, $p = 9000kg / m^3$ and its specific heat, $c = 4kJ / kg. K$.

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44. One end of a rod of length 20 cm is maintained at 800 K. The temperature of the other end of the rod is 750 K in steady state and this end is blackened to radiate thermal radiations like a black body. If temperature of the surrounding is 300 K, find the thermal conductivity of the rod. Assume no energy loss takes place through the lateral surface of the rod during conduction through its length.

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45. In a pitcher 10 kg water is contained.Total surlace area of pitcher walls is $2 \times 10^{-2} m^2$ and its wall thickness is $10^{-3} m$. If surrounding temperature is $42^\circ C$, find the temperature of water in the pitcher when it attains a steady value. Given that in steady state 0.1 gm water gets evaporated per second from the outer surface of pitcher through its porous walls. The thermal conductivity of the walls of pitcher is $0.8W / m^\circ C$ and latent heat of vaporization of water is $2.27x10^6 J / kg$.

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46. A uniform copper rod 50 cm long is insulated on the sides, and has its ends exposed to ice and steam, respectively. If there is a layer of water 1 mm thick at each end, calculate the temperature gradient in the bar. The thermal conductivity of copper is $436Wm^{-1}K^{-1}$ and that of water is $0.436Wm^{-1}K^{-1}$.

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47. Find the temperature distribution in a substance palced between two parallel plates kept at temperatures T_1 and T_2. The plate separation is equal to l, the heat conductivity coefficient of the substance $x \overline{\propto} V\overline{T}$.

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48. Four spheres A, B, C and D of different metals but all same radius are kept at same temperature. The ratio all their densities and specific heats are $2:3:5:1$ and $3:6:2:4$. Which sphere will show the fastest rate all cooling (initially) (assume black body radiation for all of them)

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49. A closed cubical box made of perfectly insulating material has walls of thickness 8 cm and the only way for heat to enter or leave the box is through two solid, cylindrical, metallic plugs, each of cross-sectional area $12cm^2$ and length 8 cm in opposite walls of the box. The outer surface of one plug is kept at $100^\circ C$ while the outer surface of the other plug is maintained at $4^\circ C$. The thermal conductivity of the plug is $50cals^{-1}m^{-1}K^{-1}$. A source of energy generating $36cals^{-1}$ is enclosed inside the box. Find the equilibrium temperature of the inner surface of the box, assuming that it is the same at all points on the inner surface.

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50. The solar energy received by the Earth persquare metre per minute is $8.315 \times 10^4 Jm^{-2}\min^{-1}$. If the radius of the Sun is 7.5×10^5 km and the distance of the Earth from the Sun is

1.5×10^8 km, calculate the surface temperature of Sun. Assume the Sun as a perfect black body. Given that Stefen constanta $\sigma = 5.7 \times 10^{-8} W m^{-2} K^{-4}$.

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51. Two solid spheres are heated to the same temperature allowed to cool under identical conditions Compare (i) initial rates of fall of temperatre, and (ii) initial rates of loss of heat Assume that all the surfaces have the same emissivity and ratios of their radii specific heats and densities are respectively $1 : \alpha 1 : \beta, 1 : \gamma$.

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52. A metal block with a heater in it is placed in a room at temperature 293 K. When the heater is switched on it is observed that the temperature of the block rises at the rate of $2^\circ C / s$ and when its temperature rises to $30^\circ C$, it is switched off. Just after when heater is switched off, it is observed that the block cools at $0.2^\circ C/s$. If Newton's law of cooling is assumed to be valid, find the power of the heater. Also find the thermal power radiated by the block when it was at $30^\circ C$ and at $25^\circ C$. Given that the heat capacityof the block is $80J/^\circ C$.

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53. In a cylindrical metallic vessel some water is taken and is put on a burner. The bottom surface area of the vessel is $2.5 \times 10^{-3} m^2$ and thickness $10^{-3} m$. The thermal conductivity of the metal of vessel is $50W/m^\circ C$. When water boils, it is observed that 100 gm water is vaporized per minute. Calculate the temperature of the bottom surface of the vessel. Given that the latent heat of vaporization of water is $2.26 \times 10^6 J/kg$.

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54. A system S receives heat continuously from an electric heater of power $10W$. The temperature of S becomes constant at $50^\circ C$ when the surrounding temperature is $20^\circ C$. After the heater is switched off, S cools from $35.1^\circ C$ to $34.9^\circ C$ in $1 \min ute$. the heat capacity of S is

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55. In winters ice forms on the surface of a lake. Due to abnormal expansion of water the temperature of the water at the bottom of the lake remains constant at $4^\circ C$ and we assume that the amount of heat required to maintain this temperamre of the bottom layer of water may come from the bed of the lake. If surrounding temperature is - $10^\circ C$ Prove that ice formed from the surface of the lake attains a maximum thickness. Find the maximum depth from surface upto which ice is formed if the depth of lake is I m. Given that thermal conductivity of ice is $0.5 W / m^{\circ} C$.

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56. Two spheres of the same material have radii $1 m$ and $4 m$ and temperatures $4000 K$ and $2000 K$ respectively. The energy radiated per second by the first sphere is greater than that by the second.

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57. The temperature of the tungsten filament of a 40 watt lamp is $1655^{\circ} C$. The effective surface area of the filament is $0.85 cm^2$. Assuming that the energy radiated from the filament is 60% of that of a black body radiator at the same temperature, find the value of Stefan's constant.

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58. A cubical tank of water of volume $1m^3$ is kept at a constant temperature of $65^\circ C$ by 1 KW heater. At time $t=0$, the heater is switched off. Find the time taken by the tank to cool down to $50^\circ C$, given the temperature of the room is steady at $15^\circ C$. Density of water $=10^3 kgm^{-3}$ and specific heat of water $=1.0 cal g^{-1} \hat{} (\circ) C^{-1}$. (Do not assume average temperature during cooling). Take $1KW = 240 cal s^{-1}$.

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59. Find the temperature distribution in the space between two coaxial cylinders of radii R_1 and R_2 filled with a uniform heat conducting substance if the temperatures of the cylinders are constant and are equal to T_1 and T_2 respectively.

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60. A cube $a = 3.0$ cm on each side radiates energy at the rate of $P = 20J/s$ when its temperature is $727^\circ C$ and surrounding temperature $27^\circ C$. Determine its emissivity.

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61. Solve the foregoing problem for the case of two concentric spheres of radii R_1 and R_2 and temperatures T_1 and T_2.

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62. A long tungsten heater wire is rated at $3kWm^{-1}$ and is $5.0 \times 10^{-4}m$ in diameter. It is embedded along the axis of a ceramic cylinder of diameter $0.12m$. When operating at the rated power, the wire is at $1500^\circ C$, the outside of the cylinder is at $20^\circ C$. Find the thermal conductivity of the ceramic.

A. $\left[5.33 J s^{-1} m^{-1} K^{-1}\right]$

B. $\left[1.026 k J s^{-1} m^{-1} K^{-1}\right]$

C. $\left[5.33 k J s^{-1} m^{-1} K^{-1}\right]$

D. $\left[1.026 J s^{-1} m^{-1} K^{-1}\right]$

Answer: $\left[1.026 J s^{-1} m^{-1} K^{-1}\right]$

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63. A constant electric current flows along a uniform wire with cross-sectional radius R and heat conductivity coefficient x. A unit volume of the wire generates a thermal power ω. Find the temperature distribution across the wire provided the steady-state temperature at the wire surface is equal to T_0.

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64. An iron boiler with walls 1.25 cm thick contains water at atmospheric pressure. The heated surface is $2.5m^2$ in area and the temperature of the underside is $120^\circ C$. Thermal conductivity of iron is $20cals^{-1}m^{-1}K^{-1}$ and the latent heat of evaporation of water $536 \times 10^3 calkg^{-1}$. Find the mass of water evaporated per hour.

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65. A thin wire of length $l = 50cm$ and area of cross-section $S = 3 \times 10^{-4} m^2$ is heated to $727^\circ C$. How much electri power P is needed to maintain the wire at this temperature ? Assume that emmissivity of the wire's surface is $e = 0.25$.

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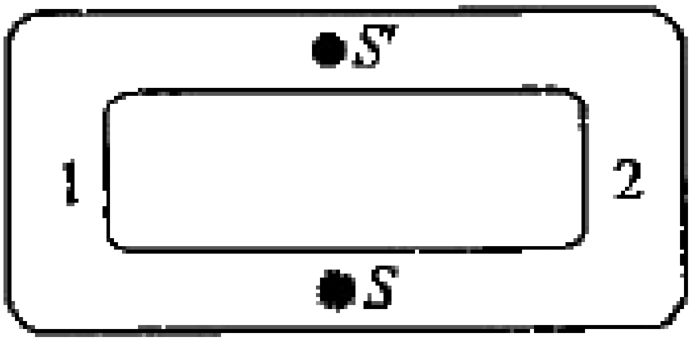
66. In the figure-4.51 shown here, S is a source of heat supplying energy at a constant rate $75 J s^{-1}$ and S' is a sink maintained at $10^{\circ} C$. The two conductors joining S to S' are each 20 cm long, $1 cm^2$ in cross-section and of thermal conductivity $385 W m^{-1} K^{-1} s^{-1}$. Calculate the temperature of the point S.



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