Heat – Transfer of Heat : Objective and Subjective Questions (Typical)

No of Questions: 71 **Time Allotted: 7 Hours**

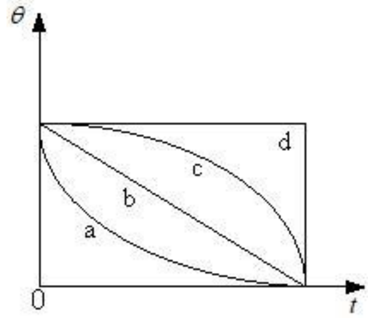
All questions are compulsory

[Note: Figures are conceptual only and not to the scale]

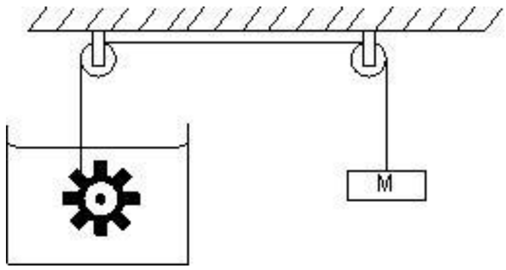
Guidelines:

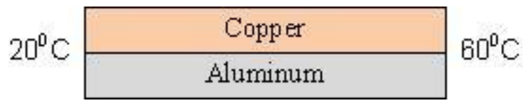
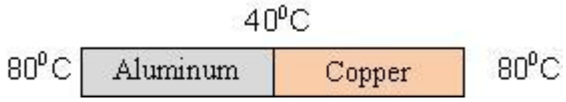
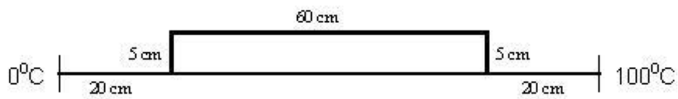
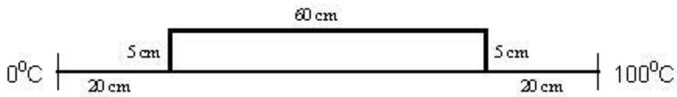
1. **Take questions in Two parts in different time slots of Three hours each, and Part Three of One Hour, with proper refreshing break of minimum two hours**
2. **Part One – has Q-01 to Q-30; Part Two – has Q-31 to Q-60; Part Three – has Q-61 to Q-71.**

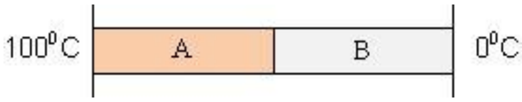
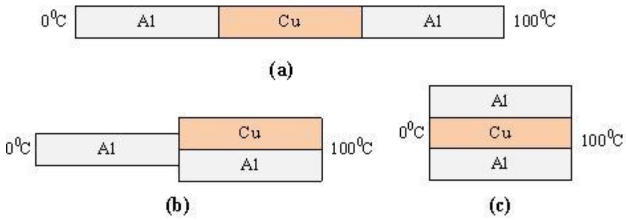
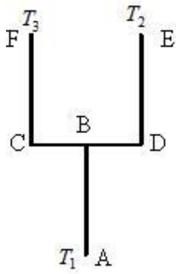
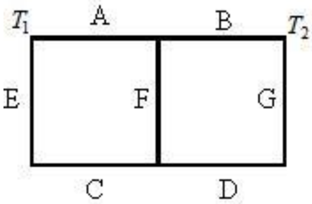
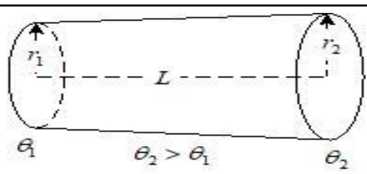
Q-01	The thermal conductivity of a rod depends on (a) Length (b) Mass (c) Area of cross-section (d) Material of the rod
Q-02	In a room containing air, heat can go from one place to another by (a) Conduction only (b) Convection only (c) Radiation only (d) All the three modes
Q-03	A solid at temperature T_1 is kept in an evacuated chamber at temperature $T_2 > T_1$. The rate of increase of temperature of the body is proportional to (a) $T_2 - T_1$ (b) $T_2^2 - T_1^2$ (c) $T_2^3 - T_1^3$ (d) $T_2^4 - T_1^4$
Q-04	Thermal radiation of a body is proportional to T^n where T is its absolute temperature. The value of n is exactly 4 for (a) Black body (b) All bodies (c) Bodies painted black (d) Polished bodies
Q-05	Two bodies A and B having equal surface area are maintained at temperatures 10^0C and 20^0C respectively. The thermal radiation emitted in a given time by A and B are in the ratio (a) 1:1.15 (b) 1:2 (c) 1:4 (d) 1:16
Q-06	One end of a metal rod is kept in a furnace. In steady state the temperature of the rod (a) Increases (b) Decreases (c) Remains constant (d) Is uniform
Q-07	Newton's Law of cooling is a special case of (a) Wien's Displacement Law (b) Kirchhoff's Law (c) Stefan's Law (d) Planck's Law

Q-08	A hot liquid is kept in big room. Its temperature is plotted as a function of time. Which of the following curve may represent the plot? 
Q-09	A hot liquid is kept in a big room. The logarithm of the numerical value of the temperature difference between the liquid and the room is plotted against time. The plot will be very nearly (a) A straight line (b) A circular arc (c) A parabola (d) An ellipse
Q-10	A body cools down from 65^0C to 60^0C in 5 minutes. It will cool down from 60^0C to 55^0C in (a) 5 minutes (b) Less than 5 minutes (c) More than 5 minutes (d) Less than or more than 5 minutes depending on whether its mass is more than or less than 1 kg.
Q-11	One end of a metal rod is dipped in boiling water and the other is dipped in melting ice- (a) All parts of the rod are in thermal equilibrium with each other (b) We can assign a temperature to the rod (c) We can assign a temperature to the rod after steady state is reached (d) The state of the rod does not change after steady state is reached
Q-12	A blackbody does not (a) Emit radiation (b) Absorb radiation (c) Reflect radiation (d) Refract radiation
Q-13	In summer, a mild wind is often found on the shore of a calm river. This is caused due to (a) Difference in thermal conductivity of the water and soil (b) Convection currents (c) Conduction between air and the soil (d) Radiation from the soil
Q-14	A piece of charcoal and a piece of shinning steel of the same surface area kept for a long time in an open lawn in the bright sun (a) The steel will absorb more heat than the charcoal (b) The temperature of the steel will be higher than that of the charcoal (c) If both are picked up by bare hands, the steel will be felt hotter than the charcoal (d) If the two are picked up from the lawn and kept in a cold chamber, the charcoal will lose heat at a faster than the steel
Q-15	A heated body emits radiation which has maximum intensity near the frequency ν_0. The emissivity of the material is 0.5. If the absolute temperature of the body is doubled (a) The maximum intensity of radiation will be near the frequency $2\nu_0$ (b) The maximum intensity of radiation will be near the frequency $\frac{\nu_0}{2}$ (c) The total energy emitted will increase by a factor of 16 (d) The total energy emitted will increase by a factor of 8
Q-16	A solid sphere and a hollow sphere of the same material and of equal radii are heated to the same temperature

	(a) Both will emit equal amount of radiation per unit of time in the beginning (b) Both will absorb equal amount of radiation from the surrounding in the beginning (c) The initial rate of cooling $\frac{dT}{dt}$ will be the same for the two spheres (d) The two spheres will have equal temperature at any instant
Q-17	A uniform slab of dimension $10\times10\times1\,\text{cm}^3$ is kept between two heat reservoirs at temperature 10^0C to 90^0C. The larger surface areas touch the reservoirs. The thermal conductivity of the material is 0.80 $\text{W.m}^{-1}.^0\text{C}^{-1}$. Find the amount of heat flowing the slab per minute.
Q-18	A liquid-nitrogen container is made of 1 cm thick Styrofoam sheet having thermal conductivity 0.025 $\text{J.s}^{-1}.\text{m}^{-1}.^0\text{C}^{-1}$. Liquid nitrogen at 80 K is kept in it. A total area of 0,80 m^2 is in contact with the liquid nitrogen. The atmospheric temperature is 300 K. Calculate the rate of heat flow from the temperature to the liquid nitrogen.
Q-19	The normal body temperature of a person is 97^0F. Calculate the rate at which heat is flowing out of his body through the clothes assuming the following values. Room temperature = 47^0F, surface of the body under clothes = 1.6 m^2, conductivity of the cloth = 0.04 $\text{J.s}^{-1}.\text{m}^{-1}.^0\text{C}^{-1}$, thickness of the cloth = 0.5 cm.
Q-20	Water is boiled in a container having a bottom of surface area 25 cm^2, thickness 1.0 mm and thermal conductivity = $50\text{W.m}^{-1}.^0\text{C}^{-1}$. 100 g of water is converted into steam per minute in the steady state after boiling starts. Assuming that no heat is lost to the atmosphere, calculate the temperature of the lower surface of the bottom. Latent heat of evaporation of water $=2.26\times10^6$ J.kg^{-1}.
Q-21	One end of a steel rod $\left(k=46\,\text{J.s}^{-1}.\text{m}^{-1}.^0\,\text{C}^{-1}\right)$ of length 1.0 m is kept in ice at 0^0C and other end is kept in boiling water at 100^0C. The area of cross-section of the rod is 0.04 cm^2. Assuming no heat loss to the atmosphere, find the mass of ice melting per second. Latent heat of fusion of ice $=3.36\times10^5$ J.kg^{-1}.
Q-22	An icebox almost completely filled with ice at 0^0C is dipped into a large volume of water at 20^0C. The box has walls of surface area 2400 cm^2, thickness 2.0 mm and thermal conductivity = 0.06 $\text{W.m}^{-1}.^0\text{C}^{-1}$. Calculate the rate at which the ice melts in the box. Latent heat of fusion of ice is $=3.4\times10^5$ J.kg^{-1}.
Q-23	A pitcher (मटका) with 1 mm thick porous walls contains 10 kg of water. Water comes to its outer surface and evaporates at the rate of 0.1 g.s^{-1}. The surface area of the pitcher(one side) = 200 cm^2. The room temperature = 42^0C, latent heat of evaporation $=2.27\times10^6$ J.kg^{-1} and thermal conductivity of the porous walls $=0.80\,\text{J.s}^{-1}.\text{m}^{-1}.^0\,\text{C}^{-1}$. Calculate the temperature of water in the pitcher when it attains a constant value.
Q-24	A steel frame $\left(k=45\,\text{J.s}^{-1}.\text{m}^{-1}.^0\,\text{C}^{-1}\right)$ of total length 60 cm and cross-sectional area 0.20 cm^2, forms three sides of a square. The free ends are maintained at 20^0C and 40^0C. Find the rate of heat flow through the cross-section area of the frame.
Q-25	Water at 50^0C is filled in a closed cylindrical vessel of height 10 cm and cross-sectional area 10 cm^2. The walls of the vessel are adiabatic but the flat parts are made of 1 mm thick aluminum $\left(k=200\,\text{J.s}^{-1}.\text{m}^{-1}.^0\,\text{C}^{-1}\right)$. Assume that the outside temperature is 20^0C. The density of water is 1000 kg.m^{-3} and the specific heat capacity of water $=4200\,\text{J.kg}^{-1}.^0\text{C}^{-1}$. Estimate the time taken for the temperature to fall by 1.0^0C. Make any simplifying assumption you need, but specify them.
Q-26	The right end of a copper rod (length 20 cm, area of cross-section 0.20 cm^2) is maintained at 20^0C and the left end at 80^0C. Neglecting any loss of heat through radiation, find (a) the temperature at a point 9 cm from the left end, and (b) the heat current through the rod. The thermal conductivity of copper =385 $\text{W.m}^{-1}.^0\text{C}^{-1}$.

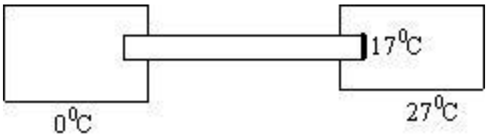
Q-27	The ends of a meter stick are maintained at 100^0C and 0^0C. One end of another rod is maintained at 25^0C. Where should its other end be touched on the meter stick so that there is no heat current in the rod in steady state?
Q-28	A cubical box of volume 216 cm^3 is made up of 0.1 cm thick wood. The inside is heated electrically by a heater of 100 W. It is found that the temperature difference between inside and outside surface is 5^0C in steady state, Assume that the entire electrical energy spent appears as heat, find the thermal conductivity of the material of the box.
Q-29	Figure shows water in a container having 2.0 mm thick walls made of a material of thermal conductivity $0.50\ W.m^{-1}.^0C^{-1}$. The container is kept in a melting ice bath at 0^0C. The total surface area in contact with water is 0.05 m^2. A wheel is clamped inside the water and is coupled to a block of mass *M* as shown in the figure. As block goes down, the wheel rotates. It is found that after some time a steady state us reached in which the block goes down with a constant speed of 10 $cm.s^{-1}$ and the temperature of the water remain constant at 1.0^0C. Find the mass of the block. Assume that heat flows out of the water only through the walls in contact. Take *g*= 10 $m.s^{-2}$. 
Q-30	On a winter day when atmospheric temperature drops to -10^0C, ice forms on the surface of a lake, (a) Calculate the rate of increase of thickness of the ice when 10 cm of ice is already formed, (b) Calculate the total time taken in forming 10 cm of ice. Assume that the temperature of the entire water reaches 0^0C before the ice starts forming. Density of water =1000 $kg.m^{-3}$, latent heat of fusion of ice $= 3.36\times10^5$ $J.kg^{-1}$ and thermal conductivity of ice =1.7 $W.m^{-1}.^0C^{-1}$. Neglect the expansion of water on freezing.
Q-31	On a winter day when atmospheric temperature drops to -10^0C, ice forms on the surface of a lake. Assume that the temperature of water at the bottom of the lake remains constant at 4^0C as the ice forms on the surface (the heat required to maintain the temperature of the bottom layer may come from the bed of the lake). The depth of the lake is 1.0 m. Show that the thickness of the ice formed attains a steady state maximum value. Find this value. The thermal conductivity of water is = 0.50 $W.m^{-1}.^0C^{-1}$. Assume that the temperature of the entire water reaches 0^0C before the ice starts forming. Density of water =1000 $kg.m^{-3}$, latent heat of fusion of ice $= 3.36\times10^5$ $J.kg^{-1}$ and thermal conductivity of ice =1.7 $W.m^{-1}.^0C^{-1}$. Neglect the expansion of water on freezing.
Q-32	Three rods of lengths 20 cm each and area of cross-section 1 cm^2 are joined to form a triangle ABC. The conductivities of the rods are $K_{AB} = 50$ $J.s^{-1}.m^{-1}.^0C^{-1}$, $K_{BC} = 200$ $J.s^{-1}.m^{-1}.^0C^{-1}$ and $K_{CA} = 400$ $J.s^{-1}.m^{-1}.^0C^{-1}$. The junctions A, B and C are maintained at 40^0C, 80^0C and 80^0C respectively. Find the rate of heat flowing through the rods AB, AC and BC.
Q-33	A semicircular rod is joined at its ends to a straight rod of the same material and the same cross-sectional area. The straight rod forms a diameter of the rod. The junctions are maintained at different temperatures. Find the ratio of the heat transferred through a cross-section of the semicircular rod to the heat transferred through cross-section of the straight rod in a given time.
Q-34	A metal rod of cross-sectional area 1.0 cm^2 is being heated at one end. At one time, the temperature gradient is 5.0 $^0C.cm^{-1}$ at cross-section A and is 2.5.0 $^0C.cm^{-1}$ at cross-section B. Calculate the rate at which the temperature is increasing in the part AB of the rod. The heat capacity of the part AB is 0.40 $J.^0C^{-1}$, thermal conductivity of the material of the rod is 200 $W.m^{-1}.^0C^{-1}$. Neglect any loss of heat to the atmosphere.
Q-35	Steam at 120^0C is continuously passed through a 50 cm long rubber tube of inner and outer radii are 1.0 cm and 1.2 cm, respectively. The room temperature is 30^0C. Calculate the rate of heat flow through the walls of

	the tube. Thermal conductivity of rubber is 0.15 $J.s^{-1}.m^{-1}.^{0}C^{-1}$.
Q-36	A hole of radius r_1 is made centrally in a uniform circular disc of thickness d and radius r_2. The inner surface of the disc is maintained at a temperature θ_1 and outer surface is maintained at temperature θ_2 such that $\theta_1 > \theta_2$. Thermal conductivity of the material of the disc is k. Calculate the heat flowing per unit time through the disc.
Q-37	A hollow tube has a length l, inner radius R_1 and outer radius R_2 and the material of the tube has thermal conductivity k. Find the heat flowing through the walls of the tube if – (a) The flat ends are maintained at temperature T_1 and T_2 such that $T_2 > T_1$ (b) The inside of the tube is maintained at temperature T_1 and outside is maintained at temperature T_2
Q-38	A composite slab is prepared by pasting two plates of thickness L_1 and L_2, and thermal conductivity K_1 and K_2. The slabs have equal cross-sectional area. Find equivalent conductivity of the composite slab.
Q-39	 Figure shows a copper rod joined to a steel rod. The rods have equal length and equal cross-sectional area. The free end of the copper rod is kept $0^{0}C$ and that of the steel rod is kept at $100^{0}C$. Find the temperature at the junction of the rods. Conductivity of copper is 390 $W.m^{-1}.^{0}C^{-1}$ and that of steel is 46 $W.m^{-1}.^{0}C^{-1}$.
Q-40	 An aluminum rod and copper rods of equal length 1.0 m and cross-sectional area 1 cm^2 are welded together as shown in the figure. One end is kept at temperature $20^{0}C$ and the other at $60^{0}C$. Calculate the amount of heat taken out per second from the hot end. Thermal conductivity of aluminum is 200 $W.m^{-1}.^{0}C^{-1}$ and of copper is 390 $W.m^{-1}.^{0}C^{-1}$.
Q-41	Figure shows an aluminum rod joined to a copper rod. Each of the rods has a length of 20 cm and area of cross-section 0.20 cm^2. The junction is maintained at a constant temperature $40^{0}C$ and the two ends maintained at $80^{0}C$. Calculate the amount of heat taken put from the cold junction in one minute after the steady state is reached. The conductivities are $K_{Al} = 200$ $W.m^{-1}.^{0}C^{-1}$ and $K_{Cu} = 400$ $W.m^{-1}.^{0}C^{-1}$. 
Q-42	 Consider the situation shown in the figure. The frame is made of the same material and uniform cross-section everywhere. Calculate the amount of heat flowing per second through a cross-section of the bent part if total heat taken out per second from the end at $0^{0}C$ is130 J.
Q-43	 Consider the situation shown in the figure.. Suppose the bent part of the frame has thermal conductivity 780 $J.s^{-1}.m^{-1}.^{0}C^{-1}$ where as it is 390 $J.s^{-1}.m^{-1}.^{0}C^{-1}$ for the straight part. Calculate the ratio of the rate of heat flow through the bent part to the rate of heat flow through the straight part.
Q-44	A room has a window fitted with a single $1.0\ m \times 2.0\ m$ glass of thickness 2mm. (a) Calculate the rate of heat flow through the closed window when the temperature inside room is$32^{0}C$ and that outside is $40^{0}C$. (b) The glass is now replaced by two glass panes, each having a thickness of 1mm and separated by a distance of 1mm. Calculate the rate of heat flow under the same conditions of temperature. Thermal conductivity of window glass is 1.0 $J.s^{-1}.m^{-1}.^{0}C^{-1}$ and that of air is 0.025 $J.s^{-1}.m^{-1}.^{0}C^{-1}$.

Q-45	The two rods as shown in the figure have identical geometrical dimensions. They are in contact with two heat baths at temperature 100^0C and 0^0C. The temperature of the junction is 70^0C. Find the temperature of the junction if rods are interchanged. 
Q-46	The three rods as shown in the figure have identical geometrical dimensions. Heat flow from the hot end at a rate of 40W in the arrangement (a). Find the heat flow when the rods are joined as in the arrangement (b) and (c). Thermal conductivity of aluminum and copper are $K_{Al} = 200$ W.m^{-1}.^{0}C^{-1} and $K_{Cu} = 400$ W.m^{-1}.^{0}C^{-1}. 
Q-47	Four identical rods AB, CD, CF and DE are joined as shown in figure. Length, cross-sectional area and thermal conductivity each rod is l, A and K respectively. The ends A, E and F are maintained at temperatures T_1, T_2 and T_3, respectively. Assuming no loss of heat to the atmosphere, find the temperature at B. 
Q-48	Seven rods A, B, C, D, E, F and G are joined as shown in the figure. All rods have equal cross-sectional area A and length l. The thermal conductivities of the rods are $K_A = K_C = K_0$, $K_B = K_D = 2K_0$, $K_E = 3K_0$, $K_F = 4K_0$ and $K_G = 5K_0$. The rod E is kept at constant temperature T_1 and the rod G is kept at a constant temperature T_2 $(T_2 > T_1)$.  **a)** Show that the rod F has a uniform temperature $T = \frac{T_1 + 2T_2}{3}$ **b)** Find the rate of heat flowing from the source which maintains the temperature T_2
Q-49	Find the rate of heat flow through a cross-section of the rod shown in the figure $(\theta_2 > \theta_1)$. Thermal conductivity of the material of the rod is k. 
Q-50	A rod of negligible heat capacity has length 20 cm, area of cross-section 1.0 cm2 and thermal conductivity 200 W.m^{-1}.^{0}C^{-1}. The temperature of one end is maintained at 0^0C and that of the other end is slowly and linearly varied from 0^0C to 60^0C in 10 minutes. Assuming no loss heat through the sides, find the total heat transmitted through the rod in these 10 minutes.
Q-51	A hollow metallic sphere of radius 20 surrounds a concentric metallic sphere of 5 cm. The space between the two spheres is filled with a non-metallic material. The inner and outer spheres are maintained at 50^0C and 10^0C respectively. And it is found that 100 J of heat passes from the inner sphere to the outer sphere per second. Find thermal conductivity of the material between the two spheres.
Q-52	Figure shows two adiabatic vessels, each containing a mass m of water at different temperatures. The if a metal rod of length L, area of cross-section A and thermal conductivity K are connected to the water as shown in the figure. Find the time taken for the difference 

	temperatures in the vessel to become half of the original value. The specific heat capacity of water is s. Neglect the heat capacity of the rod and the container and any loss of heat to the atmosphere,
Q-53	Two bodies of masses m_1 and m_2 and specific heat capacities s_1 and s_2 are connected to a rod of length L, area of cross-section A and thermal conductivity K and negligible heat capacity. The whole system is thermally insulated, At a time $t=0$, the temperature of the first body is T_1 and temperature of the second body is T_2 $\left(T_2>T_1\right)$. Find the temperature difference between the two bodies at time t.
Q-54	An amount n (in moles) of a monatomic gas at an initial temperature T_0 is enclosed in a cylindrical vessel fitted with a light piston. The surrounding air has a temperature $T_\theta\left(>T_0\right)$ and the atmospheric pressure is p_θ. Heat may be conducted between the surrounding and the gas through the bottom of the cylinder. The bottom has a surface area A, thickness x and thermal conductivity K. Assuming all changes to be slow, find the distance moved by the piston in time t.
Q-55	Assume that the total surface area of a human body is 1.6 m^2. And that it radiates like an ideal radiator. Calculate the amount of energy radiated per second by the body if body temperature is 37^0C. Stefan constant σ is 6.0×10^{-6} $W.m^{-1}.K^{-1}$.
Q-56	Calculate the amount of heat radiated per second by a body of surface area 12 cm^2 kept in thermal equilibrium in a room at temperature 20^0C. The emissivity of the surface is 0.80 and $\sigma=6.0\times10^{-8}$ $W.m^{-1}.^0C^{-1}$.
A-56	0.42 J
I-56	As per Stefan's Law of heat radiation $\frac{dQ}{dt}=Ae\sigma T^4$. Accordingly using the given data $\frac{dQ}{dt}=\left(12\times10^{-4}\right)\times0.80\times\left(6.0\times10^{-8}\right)\times\left(273+20\right)^4=0.42$ $J.s^{-1}$. **Hence answer is 0.42 J** **N.B.:** In Stefan's Law temperature is taken in Kelvin and hence necessary conversion is done.
Q-57	Q-41, HCV-II, Ch-28, Ex, pp. 102
Q-57	A solid aluminum sphere and a solid copper sphere of twice the radius are heated to the same temperature and are allowed to cool under identical surrounding temperature. Assume that the emissivity of both the spheres is the same. Find the ratio of (a) The rate of heat loss from the aluminum sphere to the rate of heat loss from the copper sphere and (b) The rate of fall of temperature of aluminum sphere to the rate of fall of temperature of copper sphere, The specific heat capacity of aluminum is 900 $J.kg^{-1}.^0C^{-1}$ and that of copper is 390 $J.kg^{-1}.^0C^{-1}$. The density of copper is 3.4 times the density of aluminum.
Q-58	A 100 W bulb has tungsten filament of total length 1.0 m and radius 4×10^{-5} m. The emissivity of the filament is 0.8 and $\sigma=6.0\times10^{-8}$ $W.m^{-1}.^0K^{-1}$. Calculate the temperature of the filament when the bulb is operating at correct wattage.
Q-59	A spherical ball of surface area 20 cm^2 absorbs any radiation that falls on it. It is suspended in closed box maintained at 57^0C. (a) Find the amount of radiation falling on the ball per second. (b) Find the net rate of heat flow to or from the ball at an instant when its temperature is 200^0C. Stefan constant $\sigma=6.0\times10^{-8}$ $W.m^{-1}.^0K^{-1}$.

Q-60	A spherical tungsten piece of radius 1.0 cm is suspended in an evacuated chamber maintained at 300 K. The piece is maintained at 1000 K by heating it electrically. Find the rate at which the electrical energy must be supplied. The emissivity of tungsten is 0.30 and the Stefan constant is $\sigma = 6.0\times10^{-8}$ W.m^{-1}.^{0}K^{-1}.
Q-61	A cubical block of mass 1.0 kg and edge 5.0 cm is heated to 227^{0}C. It is kept in an evacuated chamber maintained at 27^{0}C. Assuming that the block emits radiation like a black body, find the rate at which the temperature of the block will decrease. Specific heat capacity of the material of the block is 400 J.kg^{-1}.K^{-1}.
Q-62	A copper sphere is suspended in an evacuated chamber maintained at 300 K. The sphere is maintained at a constant temperature of 500 K by heating it electrically. A total of 210 W of electric power is needed to do it. When surface of the copper sphere is completely blackened, 700 W is needed to maintain the same temperature of the sphere. Calculate emissivity of copper.
Q-63	A spherical ball A of surface area 20 cm^{2} is kept at the centre of a hollow spherical shell B of area 80 cm^{2}. The surface of A and the inner surface of B emit as black bodies. Both A and B are at 300 K. (a) How much is the radiation energy emitted per second by the ball A? (b) How much is the radiation energy emitted per second by the inner surface of B? (c) How much of the energy emitted by the inner surface of B falls back on this surface itself?
Q-64	A cylindrical rod of length 50 cm and cross-sectional area 1 cm^{2} is fitted between a large ice chamber at 0^{0}C and an evacuated chamber maintained at 27^{0}C as shown in the figure. Only a small portions of the rod are inside the chambers and rest are thermally insulated from the surrounding. The cross-section going into the evacuated chamber is blackened so that it completely absorbs any radiation falling on it. The temperature of the blackened end is 17^{0}C when steady state is reached. Stefan constant is $\sigma = 6.0\times10^{-6}$ W.m^{-1}.^{0}K^{-1}. Find the thermal conductivity of the material of the rod.



Q-65	One end of a rod of length 20 cm is inserted in a furnace at 800 K. The sides are covered with an insulating material and the end emits radiation like a black body. The temperature of the surrounding air is 300 k. Assuming radiation to be the only important mode of energy transfer between the surrounding and the open end of the rod, find the thermal conductivity of the rod. Stefan constant is $\sigma = 6.0\times10^{-6}$ W.m^{-1}.^{0}K^{-1}.
Q-66	A calorimeter of negligible heat capacity contains 100 cc of water at 40^{0}C. The water cools to 35^{0}C in 5 minutes. The water is now replaced by K-oil of equal volume at 40^{0}C. Find the time taken for the temperature to become 35^{0}C under similar conditions. Specific heat capacities of water and K-oil are 4200 J.kg^{-1}.K^{-1} and 2100 J.kg^{-1}.K^{-1}. Density of K-oil is 800 kg.m^{-3}.
Q-67	A body cools down from 50^{0}C to 45^{0}C in 5 minutes and to 40^{0}C in another 8 minutes. Find the temperature of the surrounding.
Q-68	A calorimeter contains 50 g of water at 50^{0}C. The temperature falls to 45^{0}C in 10 minutes. When the calorimeter contains 100g of water at 50^{0}C, it takes 18 minutes for the temperature to become 45^{0}C. Find the water equivalent of calorimeter.
Q-69	A metal ball of mass 1 kg is heated by means of a 20 W heater in a room at 20^{0}C. The temperature of the ball becomes steady at 50^{0}C. (a) Find the rate of loss of heat to the surrounding when the ball is at 50^{0}C. (b) Assuming Newton's Law of Cooling, calculate the rate of loss of heat to the surrounding when the ball is at 30^{0}C. (c) Assume that the temperature of the ball rises uniformly from 20^{0}C to 30^{0}C in 5 minutes. Find the total loss of heat to the surrounding during the period. (d) Calculate the specific heat capacity of the metal.

Q-70	A metal block of heat capacity 80 $J.^0C^{-1}$ placed in a room at 20^0C is heated electrically. The heater is switched off when the temperature reaches 30^0C. The temperature of the block rises at the rate of $2^0C.s^{-1}$ just after the heater is switched on and falls at the rate of $0.2^0C.s^{-1}$ just after the heater is switched off. Assume Newton's law of cooling to hold. (a) Find the power of the heater. (b) Find the power radiated by the block just after the heater is switched off. (c) Find the power radiated by the block when the temperature of the block is 25^0C. (d) Assuming that the power radiated at 25^0C represents the average value in the heating process, find the time for which the heater is kept on.
Q-71	A hot body placed in a surrounding of temperature θ_0 obeys Newton's law of cooling $\frac{d\theta}{dt} = -k(\theta - \theta_0)$. Its temperature at $t = 0$ is θ_1. The specific heat capacity of the body is s and its mass is m. Find – (a) The maximum heat that the body can lose and, (b) The time starting from $t = 0$ in which it will lose 90% of this maximum heat.

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