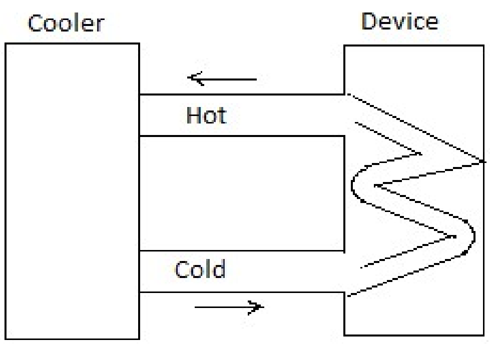
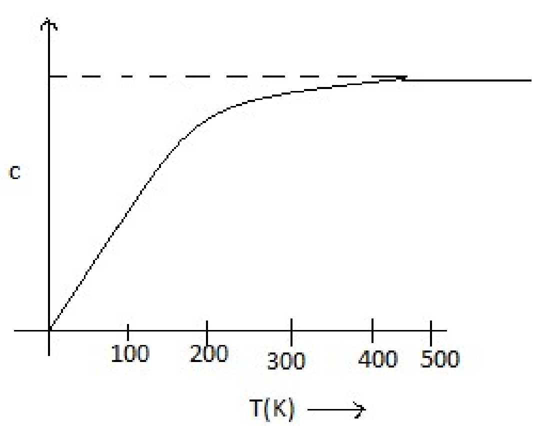
PHYSICS		
Class	**PUC 1^{st} Yr.**	
Topic	**Heat Transfer.**	**March 2014**

1. The ends Q and R of two thin wires PQ and RS are soldered together. Initially each of the wires has a length of 1 m at 10^0 C. Now the end P is maintained at 10^0 C while the end S is heated and maintained at 400^0 C. The system is thermally insulated from the surroundings. If the thermal conductivity of wire PQ is twice that of wire RS and the coefficient of linear thermal expansion of PQ is 1.2 (10^{-5}) /K, the change in length of the wire PQ is
*(A) 0.78 mm (B) 0.90 mm (C) 1.56 mm (D) 2.34 mm



2. A water cooler of capacity 120 liters can cool water at a constant rate of P watts. In a closed circulation system as shown the water from the cooler is used to cool an external device that generates constantly 3kW of heat (thermal load). The temperature of the water fed into the device cannot be more than 30^0 C and the entire stored 120 liters of water is initially at 10^0 C. The entire system is thermally insulated. The minimum value of P in watts for which the device can be operated for 3 hours is (specific heat of water is 4.2kJ/kg/K and density is 1000 kg/m^3)
(A) 1600 *(B) 2067 (C) 2533 (D) 3933



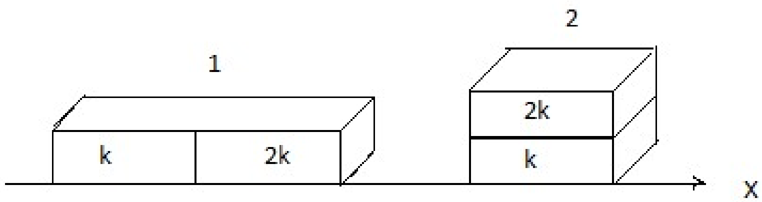
3. The figure shows the variation of specific heat capacity C of a solid as a function of temperature T. The temperature is increased continuously from 0 to 500 K at a constant rate. Ignoring any volume change, which of the following statements is/are correct to a reasonable approximation?

*(A) the rate at which heat is absorbed in the range 0 to 100 K varies linearly with temperature T

*(B) Heat absorbed in increasing the temperature from 0 to 100 K is less than the heat required for increasing the temperature from 400 to 500 K

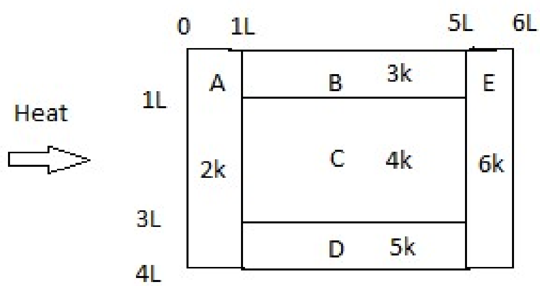
*(C) There is no change in the rate of heat absorption in the range 400 to 500 K

*(D) The rate of heat absorption increases in the range 200 to 300 K



4. Two rectangular blocks having identical dimensions can be arranged either in configuration 1 or 2. The temperature difference between the ends along the x-axis is same in both the configurations. It takes 9 sec to transfer a certain amount of heat from hot end to cold end in configuration 1. The time to transfer the same amount of heat in configuration 2 is

(A) 2 s (B) 3 s (C) 4.5 s (D) 6 s



5. A composite block is made up of slabs A, B, C, D and E of different thermal conductivities given in terms of k and sizes in terms of L as shown. All the slabs are of the same width and heat Q flows from left to right through the slabs. In steady state,

*(A) Heat flow through A and E slabs are same.

(B) Heat flow through slab E is maximum

*(C) Temperature difference across slab E is smallest.

*(D) Heat flow through C is heat flow through B plus heat flow through D

6. A metal rod AB of length 10x has its one end A in ice at 0^0 C and the other end B in water at 100^0 C. If the point P on the rod is maintained at 400^0 C, then it is found that equal amounts of water and ice evaporate and melt per unit time. The latent heat of evaporation of water is 540 cal/g and latent heat of melting of ice is 80 cal/g. If the point P is at a distance of λx from the ice end A, find the value of λ. Neglect any heat loss to the surrounding.

Ans: 9

7. A point source of heat of power P is placed at the center of the spherical shell of mean radius R. The material of the shell has a thermal conductivity k. If the temperature difference between the outer and the inner surface of the shell is not to exceed T, the thickness of the shell should not be less than?

Ans: $\dfrac{4\pi kTR^2}{P}$

8. A substance of mass m kg requires a power input of P watts to remain in the molten state at its melting point. When the power source is turned off, the sample completely solidifies in t seconds. The latent heat of fusion of the substance is?

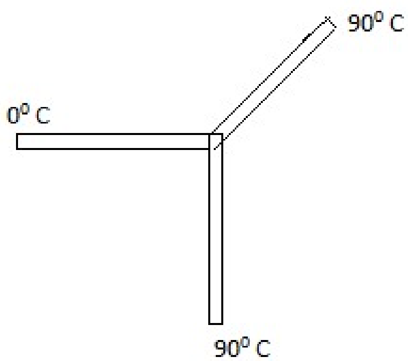
Ans: $L = \dfrac{Pt}{m}$

9. A cylinder of radius R made of a material of thermal conductivity K_1 is surrounded by a cylindrical shell of inner radius R and outer radius 2R made of material of thermal conductivity K_2. The two ends of the combined system are maintained at two different temperatures. There is no loss of heat across the cylindrical surface and the system is in steady state. The effective thermal conductivity of the system is?

(A) $K_1 + K_2$ (B) $\dfrac{K_1K_2}{K_1+K_2}$ *(C) $\dfrac{K_1+3K_2}{4}$ (D) $\dfrac{3K_1+K_2}{4}$

10. Three rods of identical cross section area and made from the same metal form the sides of an isosceles triangle ABC right angled at B. The points A and B are maintained at temperatures T and T√2 respectively. In the steady state the temperature of the point C is T_c. Assuming only heat conduction to take place T_c/T is?

(A) $\dfrac{1}{2(\sqrt{2}-1)}$ (B) $\dfrac{3}{(\sqrt{2}+1)}$ (C) $\dfrac{1}{\sqrt{3}(\sqrt{2}-1)}$ (D) $\dfrac{1}{(\sqrt{2}+1)}$



11. Three rods made of the same material and having the same cross section are joined as shown. Each rod is of the same length. The temperature of different ends is as shown. The temperature of the junction of the three rods is?

(A) 45^0 * (B) 60^0 (C) 30^0 (D) 20^0

12. Two identical conducting rods are first connected independently to two vessels one containing water at 100^0 C and the other containing ice at 0^0 C. In the second case the rods are joined end to end and connected to the same vessels. Let q_1 and q_2 g/s be the rate of melting of ice in the two cases respectively. Then q_1/q_2 is

(A) ½ (B) 2 (C) 4 (D) ¼

13. An electric heater is used in a room of total wall area 137 m^2 to maintain 20^0 C inside it, when the temperature outside is -10^0 C. The walls have three different layers of materials. The inner most is wood of thickness 2.5 cm, the middle is of cement of thickness 1.0 cm and the outer most is of brick of thickness 25 cm. Find the power of the electric heater. Assume that there is no loss of heat through the floor or the ceiling. The thermal conductivities of wood, cement and brick are 0.125, 1.5 and 1.0 S.I units respectively.

    Ans: 9kW

14. A cylindrical block of length 0.4 m and area of cross section 0.04 m^2 is placed coaxially on a thin metal disc of mass 0.4 kg and of the same cross section. The upper face of the cylinder is maintained at a constant temperature of 400 K and the initial temperature of the disc is 300 K. If the thermal conductivity of the material of the cylinder is 10 W/mK and the specific heat capacity of the material of the disc is 600 J/kg-K, how long will it take for temperature of the disc to increase to 350 K? Assume for the purpose of calculation, the thermal conductivity of the disc to be very high and the system to be thermally insulated except for the upper face of the cylinder.

    Ans: 166.32 s