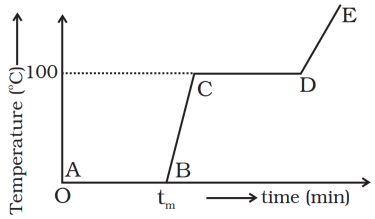
KD EDUCATION ACADEMY [9582701166]

Time : 7 Hour | STD 11 Science Physics | Total Marks : 320

kd 90+ ch-10 thermal properties of matter

* **Choose The Right Answer From The Given Options.[1 Marks Each]** [25]

1. Refer to the plot of temperature versus time showing the changes in the state of ice on heating (not to scale). Which of the following is correct?



(A) The region AB represents ice and water in thermal equilibrium.

(B) At B water starts boiling.

(C) At C all the water gets converted into steam.

(D) C to D represents water and steam in equilibrium at boiling point.

2. Time taken to heat water upto a temperature of 40°C (from room temperature) is t_1 and time taken to heat mustard oil (of same mass and at room temperature) upto a temperature of 40°C is t_2, then (given mustard oil has smaller heat capacity).

(A) $t_1 = t_2$ (B) $t_1 > t_2$

(C) $t_2 > t_1$ (D) t_1 and t_2 both are less than 10min.

3. The high thermal conductivity of metal is due to free electrons. The relevant electron property is

(A) Its being charged. (B) Its high average energy.

(C) Its high average thermal speed. (D) Its low volume.

4. It is hotter at the some distance over the top of a fire than it is on the side of it mainly because:

(A) Heat is radiated upwards.

(B) Air conducts heat upwards.

(C) Convection takes more heat upwards.

(D) Conduction, convection and radiation all contribute significantly in transferring heat up wards.

5. At about 4°C, a certain amount of water has maximum:

(A) Energy. (B) Specific heat. (C) Density. (D) Volume.

6. A cup of tea cools from 65.5°C to 62.5°C in one minute in a room of 22.5°CC. How long will the same cup of tea take to cool from 46.5°C to 40.5°C in the same room. (Choose the nearest value in min.)

(A) 1. (B) 2. (C) 3. (D) 4.

7. If there are no heat losses, the heat released by the condensation of x gram of steam at 100°C into water at 100°C can be used to convert y gram of ice at 0°C into water at 100°C. Then the ratio y : x is nearly:

(A) 1 : 1 (B) 2 : 1 (C) 3 : 1 (D) 2.5 : 1

8. A uniform metallic rod rotates about its perpendicular bisector with constant angular speed. If it is heated uniformly to raise its temperature slightly:
   (A) Its speed of rotation increases.
   (B) Its speed of rotation decreases.
   (C) Its speed of rotation remains same.
   (D) Its speed increases because its moment of inertia increases.

9. The latent heat of vaporisation of a substance is always:
   (A) Greater than its latent heat of fusion.
   (B) Greater than its latent heat of sublimation.
   (C) Equals to its latent heat of sublimation.
   (D) Less than its latent heat of fusion.

10. Change of state from solid to vapour state without passing through the liquid state is called:
   (A) Regelation. (B) Sublimation.
   (C) Condensation. (D) Sedimentation.

11. 70 calories of heat are required to increase the temperature of 2 moles of an ideal gas from 30°C to 35°C at constant pressure. The amount of heat required to increase the temperature of the same gas through same temperature range (30°C to 35°C) at constant volume will be (R = 2cal/ mole/ K).
   (A) 30 cals. (B) 50 cals. (C) 70 cals. (D) 90 cals.

12. A spherical body with radius 12cm radiates 450W power at 500K. If the radius were halved and the temperature doubled, what would be the power radiated?
   (A) 2000W (B) 1500W (C) 1800W (D) 2500W

13. Temperature of atmosphere in Kashmir falls below -10°Cin winter. Due to this water animal and plant life of Dal-lake:
   (A) Is destroyed in winters.
   (B) Frozen in winter and regenerated in summers.
   (C) Survives as only top layer of lake in frozen.
   (D) None of the above.

14. As the temperature is increased, the time period of a pendulum:
   (A) Increases as its effective length increases even though its centre of mass still remains at the centre of the bob.
   (B) Decreases as its effective length increases even though its centre of mass still remains at the centre of the bob.
   (C) Increases as its effective length increases due to shifting of centre of mass below the centre of the bob.
   (D) Decreases as its effective length remains same but the centre of mass shifts above the centre of the bob.

15. The amount of heat that a body can absorb by radiation:
   (A) Depends on colour and temperature both of body.

(B) Depends on colour of body only.

(C) Depends on temperature of body only.

(D) Depend on density of body.

16. The scale on a steel meter rod is calibrated at 20°C. What will be the error in the reading of 50cm at 27°C? Take, $\alpha = 1.2 \times 10^{-5}\ ^{\circ}\mathrm{C}^{-1}$.

(A) 0.042cm. (B) 0.0042cm. (C) 0.021cm. (D) 0.0021cm.

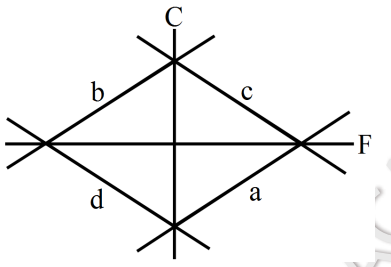
17. The temperature of water at the surface of a deep lake is 2°C. The temperature expected at the bottom is:

a. 0°C
b. 2°C
c. 4°C
d. 6°C

18. A metal sheet with a circular hole is heated. The hole:

a. Gets larger.
b. Gets smaller.
c. Remains of the same size.
d. Gets deformed.

19. Which of the curves in figure represents the relation between Celsius and Fahrenheit temperatures.



20. An aluminium sphere is dipped into water at 10°C. If the temperature is increased, the force of buoyancy:

a. Will increase.
b. Will decrease.
c. Will remain constant.
d. May increase or decrease depending on the radius of the sphere.

21. If the temperature of a uniform rod is slightly increased by Δt, its moment of inertia I about a perpendicular bisector increases by:

a. Zero
b. $\alpha I \Delta t$
c. $2\alpha I \Delta t$
d. $3\alpha I \Delta t$

22. If the temperature of a uniform rod is slightly increased by Δt, its moment of inertia Iabout a line parallel to itself will increase by:

a. Zero
b. $\alpha I \Delta t$
c. $2\alpha I \Delta t$
d. $3\alpha I \Delta t$

23. Two bodies A and B having equal surface areas are maintained at temperatures 10°C and 20°C. 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

24. A body cools down from 65°C to 60°C in 5 minutes. It will cool down from 60°C to 55°C 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 1kg.

25. The thermal conductivity of a rod depends on:
    a. Length.
    b. Mass.
    c. Area of cross section.
    d. Material of the rod.

*** Answer The Following Questions In One Sentence.[1 Marks Each] [10]**

26. A blacksmith fixes iron ring on the rim of the wooden wheel of a horse cart. The diameter of the rim and the iron ring are 5.243 m and 5.231 m, respectively at 27 °C. To what temperature should the ring be heated so as to fit the rim of the wheel?

27. Answer the following : The triple-point of water is a standard fixed point in modern thermometry. Why? What is wrong in taking the melting point of ice and the boiling point of water as standard fixed points (as was originally done in the Celsius scale)?

28. What is the value of latent heat of ice?

29. Why is a gap left between the ends of two railway lines in a railway track?

30. Why the temperature above 1200°C cannot be measured accurately by a platinum resistance thermometer?

31. What is the shift in the colour of light when the temperature increases?

32. Each side of a cube increases by 0.01% on heating. How much is the area of its faces and volume increased?

33. Tea gets cooled when sugar is added to it. Why?

34. Can we boil water inside in the earth satellite?

35. Why birds are often seen to swell their feathers in winter?

*** Given Section consists of questions of 2 marks each. [36]**

36. When $0.15kg$ of ice at $0^{\circ}C$ is mixed with $0.30kg$ of water at $50^{\circ}C$ in a container, the resulting temperature is $6.7^{\circ}C$. Calculate the heat of fusion of ice. $\left(s_{\text{water}} = 4186Jkg^{-1}K^{-1}\right)$

37. Distinguish the radiation and convection methods of heat transfer.

38. A copper calorimeter of mass 100g contains a lump of ice at 4°C. When 520 calories of heat are given to the calorimeter and its contents, the temperature rises from -4°C to -2°C. The addition of another 41540 calories of heat brings the temperature of the calorimeter and its contents to 2°C. Determine the specific heat capacity of copper and the mass of ice present in the calorimeter. Given: Latent heat of fusion of ice = 80cal/ g^{-1} Specific heat capacity of ice = 0.5cal/ $g^{-1}(°C)^{-1}$

39. Calculate the power developed by a person, while eating 100g of ice per minute. Latent heat of ice = 80cal/ g^{-7}.

40. Calculate the heat of combustion of coal, when 10 gm of coal, on burning raises the temperature of 2kg of water from 20°C to 55°C.

41. Calculate the temperature whose value is the same on the Celsius and Fahrenheit scale?

42. A cylinder of diameter exactly 1cm at 30°C is to be slid into a hole in a steel plate. The hole has a diameter of 0.99970cm at 30°C. To what temperature must the plate be heated? For steel $\alpha - 1.1 \times 10^{-5}(^{\circ}\mathrm{C}^{-1})$.

43. A glass flask of volume 250cm^3 is just filled with mercury at 20°C. How much mercury overflows when the temperature of the system is raised to 100°C? The coefficient of volume expansion of glass is 12 × $10^{-6}(°C)^{-1}$ and that of mercury is 18 × 10^{-5} $(°C)^{-1}$.

44. Two vessels made of two different metals are identical in all respects. They are completely filled with ice at 0°C. The ice in one is melted in 30 minutes and that in another in 10 minutes by heat coming from outside. Compare the thermal conductivities of metals.

45. The design of some physical instrument requires that there be a constant difference in length of 10cm between an iron rod and copper rod laid side by side at all temperatures. Find their lengths. $\alpha_{\mathrm{Fe}} = 11 \times 10^{-6}\ ^{\circ}\mathrm{C}^{-1}$, $\alpha_{\mathrm{Cu}} = 17 \times 10^{-6}\ ^{\circ}\mathrm{C}^{-1}$.

46. A metallic wire has resistance of 20 ohm at 20°C and a resistance of 21.2 ohm at 40°C. Calculate the temperature coefficient of resistance.

47. A steel scale measures the length of a copper rod as 80.00cm when both are at 20°C, the calibration temperature for the scale. What would the scale read for the length of the rod when both are at 40°C? α for steel = 11 × $10^{-6}(°C^{-1})$ and α for copper = 17 × $10^{-6}(°C^{-1})$.

48. Define triple point of water. Why is it unique?

49. Two vessels of different materials are identical in size and wall thickness. They are filled with equal quantities of ice at 0°C. If the ice melts completely in 10 and 25 min respectively, compare the coefficients of thermal conductivity of the materials of the vessels.

50. These days people use steel utensils with copper bottom. This is supposed to be good for uniform heating of food. Explain this effect using the fact that copper is the better conductor.

51. 2kg water at 80°C is mixed with 3kg water at 20°C. Assuming no heat losses, find the final temperature of the mixture.

52. Does a body at 20°C radiate in a room, where the room temperature is 30°C? If yes, why does its temperature not fall further?

53. Why is a white dress more comfortable than a dark dress in summer?

*** Given Section consists of questions of 3 marks each. [42]**

54. State Wien's displacement law. Draw graph showing energy emitted versus wavelength for a blackbody at different temperature.

55. What is the temperature of the steel-copper junction in the steady state of the system shown in figure. The area of cross-section of steel rod is twice that of the copper rod, $K_{steel} = 50.2\ Js^{-1}m^{-1}K^{-1}$

56. A steel wire of 2.0mm^2 cross-section is held straight (but under no tension) by attaching it firmly to two points a distance 1.50m apart at 30°C. If the temperature now decreases to 5°C and if the two points remain fixed, what will be the tension in the wire? Given that Young's modulus of steel = 2×10^{11}Nm^{-2} and coefficient of thermal expansion of steel a = 1.1×10^{-5}°C.

57. When 0.2kg of a body at 100°C is dropped into 0.5kg of water at 10°C, the resulting temperature is 16°C. Find the specific heat of the body. Specific heat of water is 4.2×10^3J/ kg/ °C.

58. A copper block of mass 2.5kg is heated in a furnace to a temperature of 500°C and then placed on a large ice block. What is the maximum amount of ice that can melt? (Specific heat of copper = 0.39 J g^{-1} K^{-1}; heat of fusion of water = 335 J g^{-1}).

59. A pan filled with hot food cools from 94 °C to 86 °C in 2 minutes when the room temperature is at 20 °C. How long will it take to cool from 71 °C to 69 °C?

60. A copper block of mass 2.5kg is heated in a furnace to a temperature of 500°C and then placed on a large ice block. What is the maximum amount of ice that can melt? (Specific heat of copper = 0.39 J g^{-1} K^{-1}; heat of fusion of water = 335 J g^{-1}).

61. Calculate the heat required to convert 3kg of ice at -12°C kept in a calorimeter to steam at 100°C at atmospheric pressure. Given specific heat capacity of ice = 2100 Jkg^{-1}K^{-1}, specific heat capacity of water = 4186J kg^{-1}K^{-1}, latent heat of fusion of ice = 3.35×10^5J kg^{-1} and latent heat of steam = 2.256×10^6J kg^{-1}. (No heat is absorbed by the calorimeter).

62. Define Coefficient of Thermal Conductivity and derive its SI unit. Calculate the rate of loss of heat through a glass window of area 1000 cm^2 and thickness 0.4 cm when temperature inside is 37°C and outside is -5 °C. Coefficient of thermal conductivity of glass is 2.2. 10-^{3}cals^{-1}cm^{-1}K^{-1}.

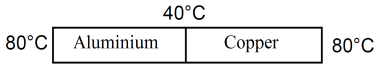
63. A copper plate has an area of 250cm^2 at 0°C. Calculate the area of this plate at 60°C. Given coefficient of linear expansion of copper is 1.7×10^{-5}°C^{-1}.

64. Why does a metal bar appear hotter than a wooden bar at the same temperature? Equivalently it also appears cooler than wooden bar if they are both colder than room temperature.

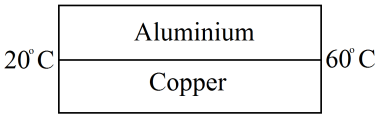
65. 100 g of water is supercooled to -10°C. At this point, due to some disturbance mechanised or otherwise some of it suddenly freezes to ice. What will be the

temperature of the resultant mixture and how much mass would freeze? [Sw = 1cal/ g/ °C and L^{W}_{Fusion} = 80cal/ g]

66. Figure, shows an aluminium rod joined to a copper rod. Each of the rods has a length of 20cm and area of cross section 0.20cm^2. The junction is maintained at a constant temperature 40°C and the two ends are maintained at 80°C. Calculate the amount of heat taken out from the cold junction in one minute after the steady state is reached. The conductivities are KAl = 200wm^{-1}°C^{-1} and K_{cu} = 400wm^{-1}°C^{-1}.



67. An aluminium rod and a copper rod of equal length 1.0m and cross-sectional area 1cm^2 are welded together as shown in figure. One end is kept at a temperature of 20°C and the other at 60°C. Calculate the amount of heat taken out per second from the hot end. Thermal conductivity of aluminium = 200Wm^{-1}°C^{-1} and of copper = 390Wm^{-1}°C^{-1}.



*** Given Section consists of questions of 5 marks each.** **[175]**

68. An iron bar $(L_1 = 0.1m, A_1 = 0.02m^2, K_1 = 79Wm^{-1}K^{-1})$ and a brass bar $(L_2 = 0.1m, A_2 = 0.02m^2, K_2 = 109Wm^{-1}K^{-1})$ are soldered end to end as shown in Fig. 10.16. The free ends of the iron bar and brass bar are maintained at $373K$ and $273K$ respectively. Obtain expressions for and hence compute (i) the temperature of the junction of the two bars, (ii) the equivalent thermal conductivity of the compound bar, and (iii) the heat current through the compound bar.

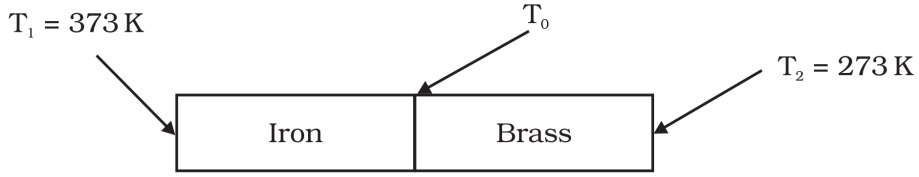
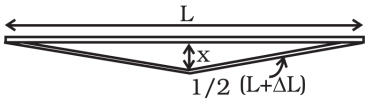
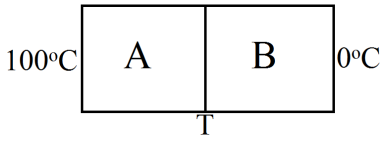


Fig 10.16

69. A rail track made of steel having length 10m is clamped on a raillway line at its two ends. On a summer day due to rise in temperature by 20°C , it is deformed as shown in figure. Find x(displacement of the centre) if $\alpha_{steel} = 1.2 \times 10^{-5}/^{\circ}C$.



70. Two metal cubes A and B of same size are arranged as shown in figure. The extreme ends of the combination are maintained at the indicated temperatures. The arrangement is thermally insulated. The coefficient of thermal conductivity of A and B are 300 W/m°C and 200 W/m°C respectively. After steady state is reached, what will be the temperature T of the interface?



71. In a room, where the temperature is 30°C, a body cools from 61°C to 59°C in 4 minute s. What time will the body take to cool from 51°C to 49°C in the same room?

72. A brass wire 1.8m long at 27°C is held taut with little tension between two rigid supports. If the wire is cooled to a temperature of –39°C, what is the tension developed in the wire, if its diameter is 2.0mm? Co-efficient of linear expansion of brass = 2.0 × 10^{-5} K^{-1}; Young's modulus of brass = 0.91 × 1011Pa.

73. A copper calorimeter of mass 100g contains 200g of a mixture of ice and water. Steam at 100°C under normal pressure is passed into the calorimeter and the temperature of the mixture is allowed to rise to 50°C. If the mass of the calorimeter and its contents is now 330g, what was the ratio of ice and water in the beginning? Neglect heat losses. Given. Specific heat capacity of copper 0.42 × 10^3J/ $kg^{-1}K^{-1}$ Specific heat capacity of water = 4.2 × 10^3J/ $kg^{-1}K^{-1}$ Latent heat of fusion of ice = 3.36 × 10^5J/ kg^{-1} Latent heat of condensation of steam = 22.5 × 10^5J/ kg^{-1}

74. The ratio of the coefficients of thermal conductivity of two different materials is 4 : 3. If the thermal resistance of the rods of the same thickness of these materials is same, then what is the ratio of the lengths of these rods?

75. State and explain Newton's law of cooling. Calculate the increase in the temperature of water which falls from a height of 100m. Assume that 90% of the energy due to fall is converted into heat and is retained by water. J = 4.2J/ Cal^{-1}.

76. A body cools from 60°C to 50°C in 10 minutes. Find its temperature at the end of the next 10 minutes if the room temperature is 25 °C. Assume Newton's law of cooling.

77. A liquid cools from 70°C to 60°C in 5 minutes. Calculate the time taken by the liquid to cool from 60°C to 50°C, if the temperature of the surrounding is constant at 30°C.

78. A body cools from 80 °C to 50 °C in 5 minutes. Calculate the time it takes to cool from 60°C to 30 °C. The temprature of the surroundings is 20°C.

79. A 10kW drilling machine is used to drill a bore in a small aluminium block of mass 8.0kg. How much is the rise in temperature of the block in 2.5 minutes,assuming 50% of power is used up in heating the machine itself or lost to the surroundings. Specific heat of aluminium = 0.91J g^{-1} K^{-1}.

80. A sphere of $0.047kg$ aluminium is placed for sufficient time in a vessel containing boiling water, so that the sphere is at $100^\circ C$. It is then immediately transfered to $0.14kg$ copper calorimeter containing $0.25kg$ water at $20^\circ C$. The temperature of water rises and attains a steady state at $23^\circ C$. Calculate the specific heat capacity of aluminium.

81. Calculate the heat required to convert $3kg$ of ice at $-12^\circ C$ kept in a calorimeter to steam at $100^\circ C$ at atmospheric pressure. Given specific heat capacity of ice $= 2100Jkg^{-1}K^{-1}$, specific heat capacity of water $= 4186J^{-1}Kg^{-1}$, latent heat of fusion of ice $= 3.35 \times 10^5 Jkg^{-1}$ and latent heat of steam $= 2.256 \times 10^6 Jkg^{-1}$.

82. A brass wire 1.8m long at 27°C is held taut with little tension between two rigid supports. If the wire is cooled to a temperature of –39°C, what is the tension developed

in the wire, if its diameter is 2.0mm? Co-efficient of linear expansion of brass = 2.0 × 10^{-5} K^{-1}; Young's modulus of brass = 0.91 × 1011Pa.

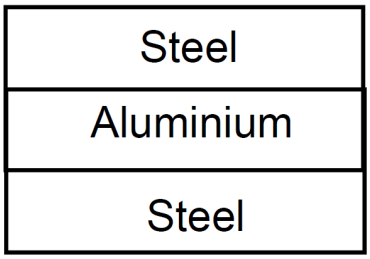
83. The coefficient of volume expansion of glycerine is 49 × 10^{-5} K^{-1}. What is the fractional change in its density for a 30°C rise in temperature?

84. A hole is drilled in a copper sheet. The diameter of the hole is 4.24cm at 27.0 °C. What is the change in the diameter of the hole when the sheet is heated to 227°C? Coefficient of linear expansion of copper = 1.70 × 10–5 K^{-1}.

85. A large steel wheel is to be fitted on to a shaft of the same material. At 27°C, the outer diameter of the shaft is 8.70cm and the diameter of the central hole in the wheel is 8.69cm. The shaft is cooled using 'dry ice'. At what temperature of the shaft does the wheel slip on the shaft? Assume coefficient of linear expansion of the steel to be constant over the required temperature range: asteel = 1.20 × 10^{-5} K^{-1}.

86. A body cools from 80 °C to 50 °C in 5 minutes. Calculate the time it takes to cool from 60°C to 30 °C. The temprature of the surroundings is 20°C.

87. Two steel rods and an aluminium rod of equal length l_0 and equal cross section are joined rigidly at their ends as shown in the figure below. All the rods are in a state of zero tension at 0°C. Find the length of the system when the temperature is raised to θ. Coefficient of linear expanaion of aluminium and steel are α_a and $\alpha_s$respectively.



Young's modulus of aluminium is Y_a and of steel is Y_s.

88. A pendulum clock gives correct time at 20°C at a place where g = 9.800m s^{-2}. The pendulum consists of a light steel rod connected to a heavy ball. It is taken to a different place where g = 9.788m s^{-2}. At what temperature will it give correct time ? Coefficient of linear expansion of steel = 12 × 10^{-6} °C^{-1}.

89. A resistance thermometer reads R =20.0Ω, 27.5Ω, and 50.0Ω at the ice point (0°C), the steam point (100°C) and the zinc point (420°C) respectively. Assuming that the resistance varies with temperature as$R_\theta = R_0(1 + \alpha\theta + \beta\theta^2)$, find the values of R_0, α and β. Here θ represents the temperature on Celsius scale.

90. The volume of a glass vessel is 1000 cc at 20°C. What volume of mercury should be poured into it at this temperature so that the volume of the remaining space does not change with temperature? Coefficients of cubical expansion of mercury and glass are 1.8 × 10^{-4} °C and 9·0 × 10^{-6} °C^{-1} respectively.

91. A glass window is to be fit in an aluminium frame. The temperature on the working day is 40°C and the glass window measures exactly 20cm × 30cm. What should be the size of the aluminium frame so that there is no stress on the glass in winter even if the temperature drops to 0°C ? Coefficients of linear expansion for glass and aluminium are 9.0 × 10^{-6} °C^{-1} and 24 × 10^{-6} °C^{-1} respectively.

92. The temperatures of equal masses of three different liquids A, B and C are 12°C, 19°C and 28°C respectively. The temperature when A and B are mixed is 16°C, and when B and C are mixed, it is 23°C. What will be the temperature when A and C are mixed?

93. An aluminium vessel of mass 0.5kg contains 0.2kg of water at 20°C. A block of iron of mass 0.2kg at 100°C is gently put into the water. Find the equilibrium temperature of the mixture. Specific heat capacities of aluminium, iron and water are $910 Jkg^{-1}\text{-}K^{-1}$, $470 Jkg^{-1}\text{-}K^{-1}$ and $4200 Jkg^{-1}\text{-}K^{-1}$ respectively.

94. A cubical block of mass 1.0kg and edge 5.0cm is heated to 227°C. It is kept in an evacuated chamber maintained at 27°C. Assuming that the block emits radiation like a blackbody, find the rate at which the temperature of the block will decrease. Specific heat capacity of the material of the block is $400 Jkg^{-1}K^{-1}$.

95. Two bodies of masses m_1 and m_2 and specific heat capacities s_1 and s_2 are connected by a rod of length l, cross-sectional area A, thermal conductivity K and negligible heat capacity. The whole system is thermally insulated. At time t = 0, the temperature of the first body is T_1 and the temperature of the second body is T_2 ($T_2 > T_1$). Find the temperature difference between the two bodies at time t.

96. Why does blowing over a spoonful of hot tea cools it? Does evaporation play a role? Does radiation play a role?

97. A spherical ball of surface area $20 cm^2$ absorbs any radiation that falls on it. It is suspended in a closed box maintained at 57°C.
    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°C. Stefan constant = $6.0 \times 10^{-8} Wm^{-2}K^{-4}$.

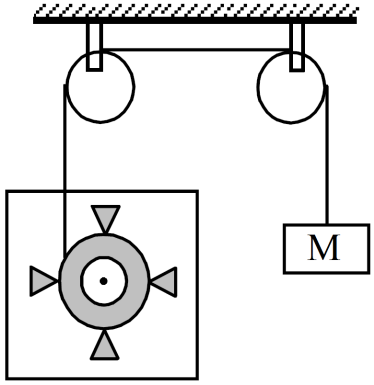
98. A body cools down from 50°C to 45°C in 5 minutes and to 40°C in another 8 minutes. Find the temperature of the surrounding.

99. Steam at 120°C is continuously passed through a 50cm long rubber tube of inner and outer radii 1.0cm and 1.2cm. The room temperature is 30°C. Calculate the rate of heat flow through the walls of the tube. Thermal conductivity of rubber = $0.15 Js^{-1}m^{-1}°C^{-1}$.

100. A steel frame $(K = 45 Wm^{-1}°C^{-1})$ of total length 60cm and cross sectional area $0.20 cm^2$, forms three sides of a square. The free ends are maintained at 20°C and 40°C. Find the rate of heat flow through a cross section of the frame.

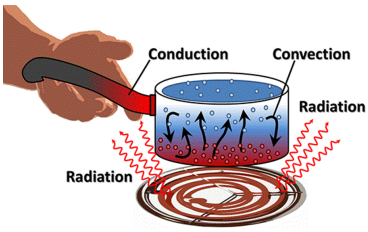
101. A calorimeter contains 50g of water at 50°C. The temperature falls to 45°C in 10 minutes. When the calorimeter contains 100g of water at 50°0, it takes 18 minutes for the temperature to become 45°C. Find the water equivalent of the calorimeter.

102. Figure, shows water in a container having 2.0mm thick walls made of a material of thermal conductivity $0.50 Wm^{-1}°C^{-1}$. The container is kept in a melting-ice bath at 0°C. 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 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 $10 cms^{-1}$ and the temperature of the water remains constant at 1.0°C. Find the mass M of the block. Assume that the heat flows out of the water only through the walls in contact. Take g = $10 ms^{-2}$.



* Case study based questions [32]

103. Read the passage given below and answer the following questions from (i) to (v). The figure shows the different modes of transfer of heat, heat transfer is defined as the movement of heat across the border of the system due to a difference in temperature between the system and its surroundings. The temperature difference exists between the two systems, heat will find a way to transfer from the higher to the lower system.



i. The sea breeze is caused by:
   a. conduction
   b. convection
   c. radiation
   d. none of these

ii. At what factor heat absorbed on radiation by the body depends on?
   a. distance between body
   b. source of heat
   c. its color
   d. all of the above

iii. When heat is transferred by molecular collision, it is referred to as heat transfer by:
   a. convection
   b. conduction
   c. radiation
   d. convection and radiation

iv. Thermal conductivity of air with rise in temperature:
   a. increase
   b. decrease
   c. constant
   d. none of these

v. Mass transfer does not take place in:
   a. conduction
   b. convection
   c. radiation

d. none of these

104. Why do marine animals live deep inside a lake when the surface of the lake freezes?

105. If an automobile engine is overheated, it is cooled by putting water on it. It is advised that the water should be put slowly with engine running. Explain the reason.

106. Indian style of cooling drinking water is to keep it in a pitcher having porous walls. Water comes to the outer surface very slowly and evaporates. Most of energy needed for evaporation is taken from the water itself and the water is cooled down. Assume that a pitcher contains 10kg of water and 0.2g of water comes out per second. Assuming no backward heat transfer from the atmosphere to the water, calculate the time in which the temperature decrease by 5°C. Specific heat capacity of water = 4200J $kg^{-1}°C^{-1}$ and latent heat of vaporization of water = 2.27×10^6 J kg^{-1}.

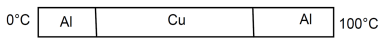
107. On a winter day when the atmospheric temperature drops to -10°C, ice forms on the surface of a lake.

a. Calculate the rate of increase of thickness of the ice when 10cm of ice is already formed.

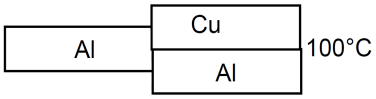
b. Calculate the total time taken in forming 10cm of ice. Assume that the temperature of the entire water reaches 0°C before the ice starts forming. Density of water = 1000kgm^{-3}, latent heat of fusion of ice $= 3.36 \times 10^5 \mathrm{Jkg}^{-1}$ and thermal conductivity of ice $= 1.7 \mathrm{Wm}^{-1}\circ\mathrm{C}^{-1}$. Neglect the expansion of water on freezing.

108. The three rods shown in figure, have identical geometrical dimensions. Heat flows from the hot end at a rate of 40 Win the arrangement (a) Find the rates of heat flow when the rods are joined as in arrangement (b) and in (c) Thermal conductivities of aluminium and copper are 200$Wm^{-1}°C^{-1}$ and 400$Wm^{-1}°C^{-1}$ respectively.

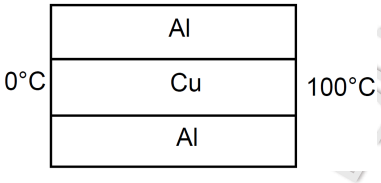
a.



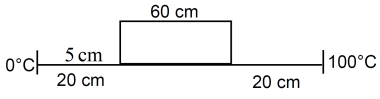
b.



c.



109. Consider the situation shown in figure. The frame is made of the same material and has a uniform cross-sectional area everywhere. Calculate the amount of heat flowing per second through a cross section of the bent part if the total heat taken out per second from the end at 100°C is 130J.



110. Cloudy nights are warmer than the nights with clean sky. Explain.

----- जब हौसला बना लिया ऊंची उड़ान का,फिर देखना फिजूल है कद आसमान का। -----