CBSE

THERMAL PROPERTIES OF MATTER WS 7

Class 11 - Physics

Section A

1. A cylindrical metallic rod in thermal contact with two reservoirs of heat at its two ends conducts an amount of heat Q in time t. The metallic rod is melted and the material is formed into a rod of half the radius of the original rod. What is the amount of heat conducted by the new rod, when placed in thermal contact with the two reservoirs in time t? **[1]**

   a) 2Q
   b) $\frac{Q}{4}$
   c) $\frac{Q}{2}$
   d) $\frac{Q}{16}$

2. Consider two rods of same length and different specific heats (c_1, c_2), thermal conductivities (K_1, K_2) and area of cross-sections (A_1, A_2) and both having temperatures (T_1, T_2) at their ends. If their rate of loss of heat due to conduction is equal, then: **[1]**

   a) $\frac{K_2A_1}{c_2} = \frac{K_1A_2}{c_1}$
   b) $K_1A_1 = K_2A_2$
   c) $K_2A_1 = K_1A_2$
   d) $\frac{K_1A_1}{c_1} = \frac{K_2A_2}{c_2}$

3. Woolen clothes keep the body warm, because wool **[1]**

   a) All of these
   b) increases the temperature of body
   c) decreases the temperature
   d) is a bad conductor

4. Thermal conductivity has units of: **[1]**

   a) J m^{-1} K^{-1}
   b) J kg^{-1} K^{-1}
   c) J ohm sec^{-2} K^{-2}
   d) Wm^{-1} K^{-1}

5. A cylindrical rod has temperatures T_1 and T_2 at its end. The rate of flow of heat is Q_1 cal s^{-1}. If all the dimensions (length and radius) are doubled keeping temperature constant, then the rate of flow of heat Q_2 will be **[1]**

   a) $Q_2 = 4Q_1$
   b) $Q_2 = \frac{Q_1}{2}$
   c) $Q_2 = 2Q_1$
   d) $Q_2 = \frac{Q_1}{4}$

6. The ratio of thermal conductivity of two rods of different materials is 5 : 4. The two rods of same area of cross-section and same thermal resistance will have the lengths in the ratio **[1]**

   a) 1 : 9
   b) 4 : 5
   c) 5 : 4
   d) 9 : 1

7. body of length 1 m having cross-sectional area 0.75 m^2 has heat flow through it at the rate of 6000 J/s. If K = 2000 $Jm^{-2}K^{-1}$ then the temperature difference across the ends of the body is: **[1]**

a) 80^oC

b) 100^oC

c) 20^oC

d) 40^oC

8. In order that the heat flows from one part of a solid to another part, what is required? **[1]**

a) uniform density

b) uniform temperature

c) temperature gradient

d) density gradient

9. Two rods of same length and material transfer a given amount of heat in 12s, when they are joined end to end (i.e., in series). But when they are joined in parallel, they will transfer same heat under same temperature difference across thier ends in **[1]**

a) 3s

b) 1.5s

c) 38s

d) 24s

10. A 'thermal' icebox is a cheap and efficient method for storing small quantities of cooked food in summer in particular. A cubical icebox of side 30 cm has a thickness of 5.0 cm. If 4.0 kg of ice is put in the box, estimate the amount of ice remaining after 6 h. The outside temperature is 45 ^oC, and the coefficient of thermal conductivity of thermal is 0.01 J $s^{-1}m^{-1}K^{-1}$. [Heat of fusion of water = 335 $\times$ $10^3 Jkg^{-1}$] **[1]**

a) 3.6 kg

b) 3.4 kg

c) 3.7 kg

d) 3.5 kg

11. Heat is flowing through the cylindrical rods of the 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, then the ratio of the amount of heat conducted through them per unit time will be **[1]**

a) 1 : 4

b) 1 : 1

c) 2 : 1

d) 1 : 8

12. Which one of the following processes depends on gravity? **[1]**

a) conduction

b) radiation

c) Conversion

d) convection

13. The bulb of one thermometer is spherical, while that of other is cylindrical. If both of them have equal amount of mercury, which one will respond quickly to the temperature? **[1]**

a) both spherical and elliptical

b) spherical

c) cylindrical

d) elliptical

14. The freezer in a refrigerator is located at the top section so that **[1]**

a) the motor is not heated

b) the entire chamber of the refrigerator is cooled quickly due to convection

c) the heat gained from the environment is low

d) the heat gained from the environment is high

15. Two rods of lengths d_1 and d_2 and coefficients of thermal conductivities K_1 and K_2 are kept in contact with each other end to end. The equivalent thermal conductivity is **[1]**

a) $K_1 + K_2$

b) $\frac{K_1 d_1 + K_2 d_2}{d_1 + d_2}$

c) $\frac{d_1+d_2}{\left(\frac{d_1}{K_1}+\frac{d_2}{K_2}\right)}$

d) $K_1d_1 + K_2d_2$

16. **Assertion (A):** Prespiration from human body helps in cooling the body. **[1]**

Reason (R): A thin layer of water on the skin enhances its emissivity.

a) Both A and R are true and R is the correct explanation of A

b) Both A and R are true but R is not the correct explanation of A.

c) A is true but R is false.

d) A is false but R is true.

17. **Assertion:** It is hotter over the top of a fire than at the same distance on the sides. **[1]**

Reason: Air surrounding the fire conducts more heat upwards.

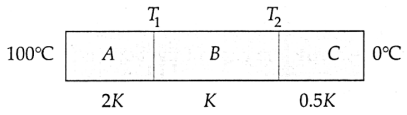
a) Assertion and reason both are correct statements and reason is correct explanation for assertion.

b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.

c) Assertion is correct statement but reason is wrong statement.

d) Assertion is wrong statement but reason is correct statement.

18. Three identical rods A, B and C of equal lengths and equal diameters are joined in series as shown in figure. **[1]**
Their thermal conductivities are 2 K, K and $\frac{K}{2}$ respectively. Calculate the temperature at two junction points.



a) 77.3, 48.3°C

b) 80.85, 50.3°C

c) 75.8, 49.3°C

d) 85.7, 57.1°C

19. A rod AB is 1 m long. The temperature of its one end A is maintained at 100°C and other end B at 10°C the temperature at a distance of 60 cm from point B is **[1]**

a) 46°C

b) 36°C

c) 72°C

d) 64°C

20. Three rods of equal length of thermal conductivities k, 2k and 3k are symmetrically joined to a point. If temperatures of ends are 0°C, 50°C and 100°C respectively, what is the temperature of the junction? **[1]**

a) $\frac{200}{7}^\circ$C

b) $\frac{100}{3}^\circ$C

c) 20°C

d) $\frac{200}{3}^\circ$C

21. Two slabs A and B of different materials but of the same thickness are joined end to end to form a composite slab. The thermal conductivities of A and B are κ_1 and κ_2 respectively. A steady temperature difference of 12° C is maintained across the composite slab. If $\kappa_1 = \frac{\kappa_2}{2}$, the temperature difference across slab A is **[1]**

a) 4°C

b) 6°C

c) 8°C

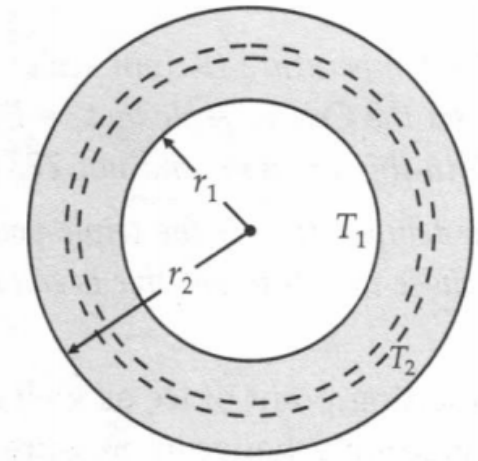
d) 10°C

22. Define Joule's mechanical equivalent of heat. Give its value. **[1]**

23. Define terms heat current and thermal resistance. Write their SI units. **[1]**

24. The figure shows a system of two concentric spherical shells of radii r_1 and r_2 and kept at temperatures T_1 and T_2. Find the radial rate of flow of heat through a substance of thermal conductivity k filled in the space between **[1]**

the two shells.



25. Fill in the blank: The dimensional formula of thermal resistance is _____ and its SI unit is _____. **[1]**

26. When two bodies are said to be in thermal equilibrium? **[1]**

27. Fill in the blank: The dimensional formula of the coefficient of thermal conductivity is _____ and its CGS unit is _____. **[1]**

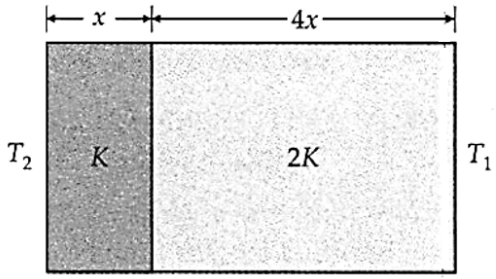
28. Name the electrical analogies of temperature and temperature gradient. **[1]**

29. A refrigerator converts 50 gram of water at 15^o C into ice at 0^o C in one hour. Calculate the quantity of heat removed per minute. Take specific heat of water = 1 cal g^{-1} $^oC^{-1}$ and latent heat of ice = 80 cal g^{-1}. **[1]**

30. Why we can easily boil water in a paper cup? **[1]**

31. A squirrel wraps its bushy tail around its body during its winter sleep. Why? **[1]**

32. The temperature of the two outer surfaces of a composite slab, consisting of two materials having coefficients of thermal conductivity K and 2 K and thickness x and 4x, respectively are T_2 and ($T_2 > T_1$). What is the rate of flow of heat through the slab in a steady-state? **[1]**



33. Why felt rather than air is employed for thermal insulation? **[1]**

34. Name three modes of transmission of heat energy from one place to another. **[1]**

35. Explain why a new quilt is warmer than an old one. **[1]**

36. Arrange the metals Cu, Al and Ag in the order of their increasing thermal conductivity. **[1]**

Section B

37. **State True or False:** **[2]**
    (a) The earth without its atmosphere would be inhospitably cold. **[1]**
    (b) Snow is a better insulator than ice. **[1]**

38. **Fill in the blanks:** **[2]**
    (a) A hole in the cavity of a radiator is a _____. **[1]**
    (b) The ability of material to conduct the heat through it is known as _____ conductivity. **[1]**

39. Define thermal conduction and convection. How are these modes of transfer different from thermal. **[2]**

40. Define thermal radiation. State Prevost's theory of heat exchange **[2]**

41. A solid sphere of copper of radius R and a hollow sphere of the same material of inner radius r and outer radius **[2]**

R are heated to the same temperature and allowed to cool in the same environment. Which of them starts cooling faster?

42. Two rods A and B are of equal length. Each rod has its ends at temperatures T_1, and T_2. What is the condition that will ensure equal rates of flow of heat through the rods A and B? **[2]**

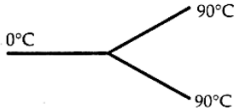
43. Define thermal convection. Briefly explain how convection currents are set up in water. **[2]**

44. Briefly explain the formation of land and sea breezes. **[2]**

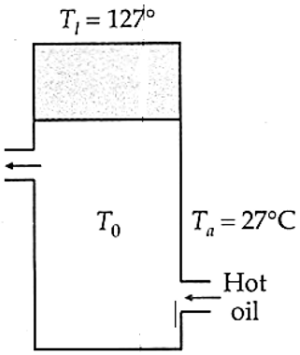
45. How does tea in a thermo flask remain hot for a long time? **[2]**

46. Define thermal resistance. On what factors does it depend? Deduce its dimensions. **[2]**

47. Three rods made of the same material and having the same cross-section have been joined as shown in Figure. Each rod is of the same length. The left and right ends are kept at 0°C and 90° C respectively. What will be the temperature of the junction of the three rods? **[2]**



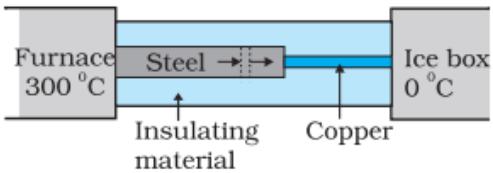
48. Hot oil is circulated through an insulated container with a wooden lid at the top whose conductivity K = 0.149 J/(m-°C-sec), thickness t = 5 mm, emissivity = 0.6. Temperature of the top of the lid is maintained at T(= 127°C. If the ambient temperature T_l = 127°C, calculate **[2]**



i. rate of heat loss per unit area due to radiation from the lid.

ii. temperature of the oil. (Given $\sigma = \frac{17}{3} \times 10^{-8}$)

49. What is the temperature of the steel-copper junction in the steady state of the system shown in figure? Length of the steel rod = 15.0 cm, length of the copper rod = 10.0 cm, temperature of the furnace = 300°C, temperature of the other end = 0°C. The area of cross section of the steel rod is twice that of the copper rod. (Thermal conductivity of steel = 50.2 J s^{-1} $m^{-1}K^{-1}$; and of copper = 385 J $s^{-1}m^{-1}K^{-1}$). **[2]**



50. A layer of ice 0.15 m thick has formed on the surface of a deep pond. If the temperature of upper surface of ice is constant and equal to that of the air which is - 12°C, determine the time it will take to increase the thickness of ice layer by 0.2 mm. Take latent heat of ice = 80 cal g^{-1}, density of ice = 0.91 g cm^{-3} and thermal conductivity of ice = 0.5 cal $s^{-1}m^{-1}$ K^{-1}. **[2]**

51. One end of a 0.25 m long metal bar is in steam and the other is in contact with ice. If 12 g of ice melts per minute, what is the thermal conductivity of the metal? Given cross-section of the bar = 5 $\times$ $10^{-4}m^2$ and latent heat of ice is 80 cal g^{-1}. **[2]**

52. Why does a metal bar appear hotter than a wooden bar at the same temperature? Equivalently it also appears **[2]**

cooler than wooden bar if they are both colder than room temperature.

53. Suppose you want to cool your drink. Should you keep ice cubes floating on the top or should you arrange to keep the ice cubes at the bottom? **[2]**

Section C

54. A layer of ice 1 cm thick is formed on a pond. The temperature of the air is -20°C. Calculate how long it will take for the thickness of ice to increase by 1 mm. The density of ice = 1 g cm^{-3}. Latent heat of ice = 80 cal g^{-1}. Conductivity of ice = 0.008 cal s^{-1} cm^{-1} $°C^{-1}$. **[3]**

55. Two vessels A and B of different materials but having identical shape, size and wall thickness are filled with ice and kept at the same place. Ice melts at the rate of 100 g min^{-1} and 150g min^{-1} in A and B, respectively. Assuming that heat enters the vessels through the walls only, calculate the ratio of thermal conductivities of their materials. **[3]**

56. Briefly explain the formation of trade wind. **[3]**

57. Distinguish between conduction, convection and radiation. **[3]**

58. Explain the following **[3]**

i. Hot tea cools rapidly when poured into the saucer from the cup.

ii. Temperature of a hot liquid falls rapidly in the begining but slowly afterwards.

iii. A hot liquid cools faster if outer surface of the container is blackened.

59. Define thermal conduction. Briefly explain its molecular mechanism. **[3]**

60. Answer the following questions: **[3]**

i. A vessel with a movable piston maintained at a constant temperature by a thermostat contains a certain amount of liquid in equilibrium with its vapour. Does this vapour obey Boyle's law? In other words, what happens when the volume of vapour is decreased? Does the vapour pressure increase?

ii. What is meant by **superheated water** and **supercooled vapour**? Do these states of water lie on its P -V -T surface? Give some practical applications of these states of water.

61. Define the three modes of transfer of heat from one object to another. Also cite one example for each one of them. **[3]**

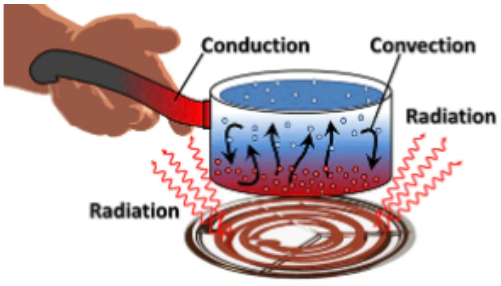
62. What is a black body? How can it be realised in practice? **[3]**

63. Two rods of the same area of cross-section, but of lengths l_1 and l_2 and conductivities K_1 and K_2 are joined in series. Show that the combination is equivalent of a material of conductivity $K = \frac{l_1 + l_2}{\left(\frac{l_1}{K_1}\right)\left(\frac{l_2}{K_2}\right)}$ **[3]**

Section D

Question No. 64 to 68 are based on the given text. Read the text carefully and answer the questions: **[5]**

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.



64. The sea breeze is caused by:

a) radiation
b) disseminating
c) conduction
d) convection

65. 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 these

66. When heat is transferred by molecular collision, it is referred to as heat transfer by

a) radiation
b) convection
c) conduction
d) convection and radiation

67. Thermal conductivity of air with rising in temperature:

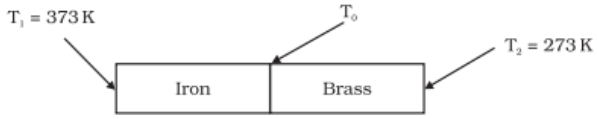
a) increase
b) Fall
c) decrease
d) constant

68. Mass transfer does not take place in

a) relegation
b) conduction
c) convection
d) radiation

69. What are convection currents? What role do they play in relation to trade winds and monsoons? **[5]**

70. An iron bar (L_1 = 0.1 m, A_1 = 0.02 m^2, K_1 = 79 W m^{-1} K^{-1}) and a brass bar (L_2 = 0.1 m, A_2 = 0.02 m^2, K_2 = 109 W $m^{-1}K^{-1}$) are soldered end to end as shown in Figure. The free ends of the iron bar and brass bar are maintained at 373 K and 273 K respectively. Obtain expressions for and hence compute **[5]**



a. the temperature of the junction of the two bars
b. the equivalent thermal conductivity of the compound bar, and
c. the heat current through the compound bar

71. State and explain the three modes of transference of heat. Explain how the loss of heat due to these three modes is minimised in a thermos flask. **[5]**

72. What is meant by Steady state heat flow by conduction in case of a thick copper bar with its two ends maintained at two different temperatures? On what factors does the amount of heat flowing through the bar depend? **[5]**

73. **Read the case study given below and answer any four subparts:** **[5]**

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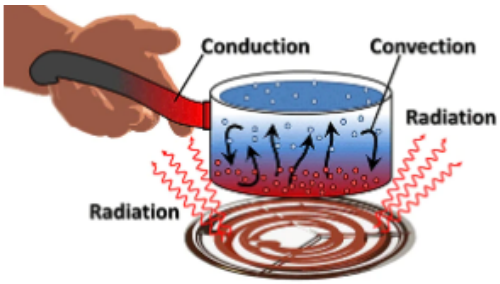

i. The sea breeze is caused by:

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