

Properties of Matter

JEE Advanced (Archive)

Level -2

SINGLE OPTION CORRECT TYPE

- A metal ball immersed in alcohol weighs W_1 at 0°C and W_2 at 50°C . The coefficient of cubical expansion of the metal is less than that of the alcohol. Assuming that the density of the metal is large compared to that of alcohol, it can be shown that : [1980]

(A) $W_1 > W_2$ (B) $W_1 = W_2$ (C) $W_1 < W_2$ (D) can't determine
- A wall has two layers A and B, each made of different materials. 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°C . The temperature difference across the layer A is : [1980]

(A) 6°C (B) 12°C (C) 18°C (D) 24°C
- The following four wires are made of the same material. Which of these will have the largest extension when the same tension is applied? [1981]

(A) length 50 cm, diameter = 0.5 mm (B) length 100 cm, diameter = 1 mm
(C) length 200 cm, diameter = 2 mm (D) length 300 cm, diameter = 3 mm
- Steam at 100°C is passed into 1.1 kg of water contained in a calorimeter of water equivalent 0.02 kg at 15°C till the temperature of the calorimeter and its contents rises to 80°C . The mass of the steam condensed in kilograms is : [1986]

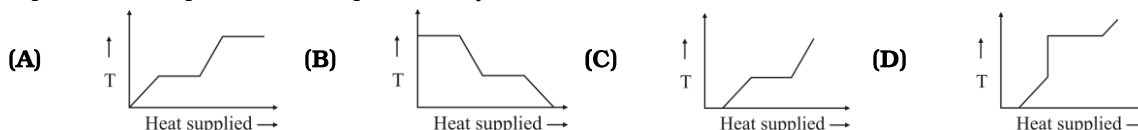
(A) 0.130 (B) 0.065 (C) 0.260 (D) 0.135
- A cylinder of radius R made of a material of thermal conductivity K_1 is surrounded by a cylindrical shell of inner radius R and outer radius $2R$ made of a material of thermal conductivity K_2 . The two ends of the combined system are maintained at two different temperatures. There is no loss of heat across the cylindrical surface and the system is in the steady state. The effective thermal conductivity of the system is : ▶ [1988]

(A) $K_1 + K_2$ (B) $\frac{K_1 K_2}{(K_1 + K_2)}$ (C) $\frac{(K_1 + 3K_2)}{4}$ (D) $\frac{(3K_1 + K_2)}{4}$
- Two rods of different materials having coefficients of thermal expansion α_1, α_2 and Young's modulus Y_1, Y_2 respectively are fixed between two rigid massive walls. The rods are heated such that they undergo the same increase in temperature. There is no bending of the rods. If $\alpha_1 : \alpha_2 = 2 : 3$, the thermal stresses developed in the two rods are equal provided $Y_1 : Y_2$ is equal to [1989]

(A) 2 : 3 (B) 1 : 1 (C) 3 : 2 (D) 4 : 9

7. A point source of heat of power P is placed at the centre of a spherical shell of mean radius R . The material of the shell has thermal conductivity K . If the temperature difference between the outer and the inner surface of the shell is not to exceed T , then the thickness of the shell should not be less than :  [1991]
- (A) $\frac{2\pi R^2 KT}{P}$ (B) $\frac{4\pi R^2 KT}{P}$ (C) $\frac{\pi R^2 KT}{P}$ (D) $\frac{\pi R^2 KT}{4P}$
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 time t seconds. The specific latent heat of fusion of the substance is :  [1992]
- (A) Pt (B) $\frac{Pt}{M}$ (C) PtM (D) $\frac{PM}{t}$
9. Three rods of identical cross-sectional area are made from the same metal and form the sides of an isosceles triangle ABC , right-angled at B . The points A and B are maintained at temperatures T and $(\sqrt{2})T$, respectively. In the steady state, the temperature of the point C is T_c . Assuming that only heat conduction takes place, T_c / T is : [1995]
- (A) $\frac{1}{2(\sqrt{2}-1)}$ (B) $\frac{3}{\sqrt{2}+1}$ (C) $\frac{1}{\sqrt{3}(\sqrt{2}-1)}$ (D) $\frac{1}{\sqrt{2}+1}$
10. Two metallic spheres S_1 and S_2 are made of the same material and have got identical surface finish. The mass of S_1 is thrice that of S_2 . Both the spheres are heated to the same high temperature and placed in the same room having lower temperature but are thermally insulated from each other. The ratio of the initial rate of cooling of S_1 to that of S_2 is :  [1995]
- (A) $\frac{1}{3}$ (B) $\frac{1}{\sqrt{3}}$ (C) $\frac{\sqrt{3}}{1}$ (D) $\left(\frac{1}{3}\right)^{\frac{1}{3}}$
11. 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, the ratio of the surface temperature of the sun and the North star is : [1997]
- (A) 1.46 (B) 0.69 (C) 1.21 (D) 0.83
12. 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 watts would be : [1997]
- (A) 225 (B) 450 (C) 900 (D) 1800
13. A black body is at a temperature of 2880 K . The energy of radiation emitted by this body with wavelength between 499 nm and 500 nm is U_1 , between 999 nm and 1000 nm , is U_2 and between 1499 nm and 1500 nm is U_3 . Wien's constant, $b = 2.88 \times 10^6 \text{ nm-K}$. Then :  [1998]
- (A) $U_1 = 0$ (B) $U_3 = 0$ (C) $U_1 > U_2$ (D) $U_2 > U_1$

14. A block of ice at -10°C is slowly heated and converted to steam at 100°C . Which of the following curves represents the phenomenon qualitatively? [2000]



15. When a block of iron floats in mercury at 0°C , fraction k_1 of its volume is submerged, while at the temperature 60°C , a fraction k_2 is seen to be submerged. If the coefficient of volume expansion of iron is γ_{Fe} and that of mercury is γ_{Hg} , then the ratio k_1 / k_2 can be expressed as : [2001]

(A) $\frac{1+60\gamma_{Fe}}{1+60\gamma_{Hg}}$ (B) $\frac{1-60\gamma_{Fe}}{1+60\gamma_{Hg}}$ (C) $\frac{1+60\gamma_{Fe}}{1-60\gamma_{Hg}}$ (D) $\frac{1+60\gamma_{Hg}}{1+60\gamma_{Fe}}$

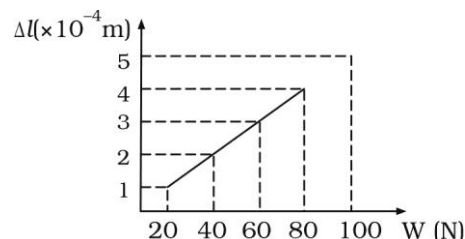
16. Two rods, one of aluminium and the other made of steel, having initial lengths l_1 and l_2 are connected together to form a single rod of length $l_1 + l_2$. The coefficients of linear expansion for aluminium and steel are α_a and α_s , respectively. If the length of each rod increases by the same amount when their temperatures are raised by $t^{\circ}\text{C}$, then find the ratio $\frac{l_1}{l_1 + l_2}$. [2003]

(A) α_s / α_a (B) α_a / α_s (C) $\alpha_s / (\alpha_a + \alpha_s)$ (D) $\alpha_a / (\alpha_s + \alpha_a)$

17. 2kg of ice at -20°C is mixed with 5 kg of water at 20°C in an insulating vessel having negligible heat capacity. Calculate the final mass of water remaining in the container. It is given that the specific heats of water and ice are $1 \text{ kcal/kg}^{\circ}\text{C}$ and $0.5 \text{ kcal/kg}^{\circ}\text{C}$ respectively, while the latent heat of fusion of ice is 80 kcal/kg . [2003]

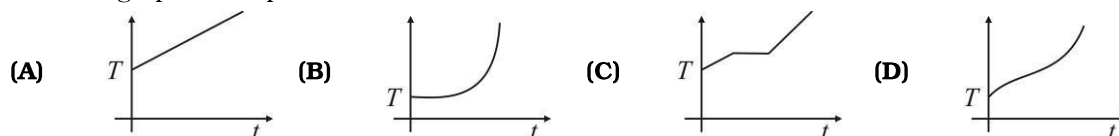
(A) 7 kg (B) 6 kg (C) 4 kg (D) 2 kg

18. A 1 m long metal wire of cross sectional area 10^{-6} m^2 is fixed at one end from a rigid support and a weight W is hanging at its other end. The graph shows the observed extension of length Δl of the wire as a function of W . young's modulus of material of the wire in SI units is : [2003]



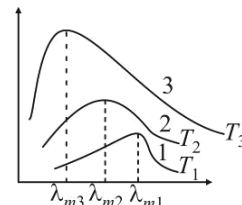
(A) 5×10^4 (B) 2×10^5 (C) 2×10^{11} (D) 5×10^{11}

19. If liquified oxygen at 1 atmospheric pressure is heated from 50 K to 300 K by supplying heat at constant rate, the graph of temperature vs. time will be: [2004]



20. Variation of radiant energy E_λ emitted by sun, filament of tungsten lamp and welding arc as a function of its wavelength as shown in the figure. Which of the following option is the correct match ?

- (A) Sun $-T_3$, tungsten filament $-T_1$, welding arc $-T_2$ [2004]
(B) Sun $-T_2$, tungsten filament $-T_1$, welding arc $-T_3$
(C) Sun $-T_3$, tungsten filament $-T_2$, welding arc $-T_1$
(D) Sun $-T_1$, tungsten filament $-T_2$, welding arc $-T_3$



21. A spherical body of area A and emissivity $\epsilon = 0.6$ is kept inside a perfectly black body. Total heat radiated by the body at temperature T is :

- (A) $0.4\sigma AT^4$ (B) $0.8\sigma AT^4$ (C) $0.6\sigma AT^4$ (D) $1.0\sigma AT^4$ [2005]

22. Calorie is defined as the amount of heat required to raise temperature of $1g$ of water by 1°C and it is defined under which of the following conditions ?

- (A) From 14.5°C to 15.5°C at 760mm of Hg
(B) From 98.5°C to 99.5°C at 760mm of Hg
(C) From 13.5°C to 14.5°C at 76mm of Hg
(D) From 3.5°C to 4.5°C at 76mm of Hg [2005]

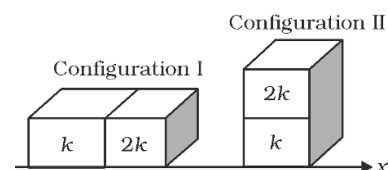
23. In a dark room with ambient temperature T_0 , a black body is kept at a temperature T . Keeping the temperature of the black body constant (at T), sunrays are allowed to fall on the black body through a hole in the roof of the dark room. Assuming that there is no change in the ambient temperature of the room, which of the following statement(s) is/are correct? [2006]

- (A) The quantity of radiation absorbed by the black body in unit time will increase
(B) Since emissivity = absorptivity, hence the quantity of radiation emitted by black body in unit time will increase
(C) Black body radiates more energy in unit time in the visible spectrum
(D) The reflected energy in unit time by the black body remains same

24. Three very large plates of same area are kept parallel and close to each other. They are considered as ideal black surface and have very high thermal conductivity. The first and third plates are maintained at temperatures $2T$ and $3T$ respectively. The temperature of the middle (i.e., second) plate under steady state condition is : [2012]

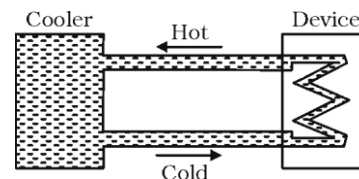
- (A) $\left(\frac{65}{2}\right)^{1/4} T$ (B) $\left(\frac{97}{4}\right)^{1/4} T$ (C) $\left(\frac{97}{2}\right)^{1/4} T$ (D) $(97)^{1/4} T$

25. Two rectangular blocks, having identical dimensions, can be arranged either in configuration I or in configuration II as shown in the figure. One of the blocks has thermal conductivity k and the other $2k$. The temperature difference between the ends along the x -axis is the same in both the configurations. It takes 9 s to transport a certain amount of heat from the hot end to the cold end in the configuration I. The time to transport the same amount of heat in the configuration II is : [2013]



- (A) 2.0 s (B) 3.0 s (C) 4.5 s (D) 6.0 s

26. A water cooler of storage capacity 120 litres can cool water at a constant rate of P watts. In a closed circulation system (as shown schematically in the figure), the water from the cooler is used to cool an external device that generates constantly 3 kW of heat (thermal load). The temperature of water fed into the device cannot exceed 30°C and the entire stored 120 litres of water is initially cooled to 10°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 water is $4.2 \text{ kJ kg}^{-1} \text{ K}^{-1}$ and the density of water 1000 kg m^{-3})

[2016]

- (A) 1600 (B) 2067 (C) 2533 (D) 3933

27. The ends Q and R of two thin wires, PQ and RS , are soldered (joined) together. Initially, each of the wire has a length of 1 m at 10°C . Now, the end P is maintained at 10°C , while the end S is heated and maintained at 400°C . The system is thermally insulated from its surroundings. If the thermal conductivity of wire PQ is twice that of the wire RS and the coefficient of linear thermal expansion of PQ is $1.2 \times 10^{-5} \text{ K}^{-1}$, the change in length of the wire PQ is : 

[2016]

- (A) 0.78 mm (B) 0.90 mm (C) 1.56 mm (D) 2.34 mm

28. One end of a horizontal thick copper wire of length $2L$ and radius $2R$ is welded to an end of another horizontal thin copper wire of length L and radius R . When the arrangement is stretched by applying forces at two ends, the ratio of the elongation in the thin wire to that in the thick wire is : 

[2013]

- (A) 0.25 (B) 0.50 (C) 2.00 (D) 4.00

29. Parallel rays of light of intensity $I = 912 \text{ Wm}^{-2}$ are incident on a spherical black body kept in surroundings of temperature 300 K . Take Stefan's constant $\sigma = 5.7 \times 10^{-8} \text{ Wm}^{-2} \text{ K}^{-4}$ and assume that the energy exchange with the surrounding is only through radiation. The final steady temperature of the black body is close to: 

- (A) 330 K (B) 660 K (C) 990 K (D) 1550 K [2014]

30. A current carrying wire heats a metal rod. The wire provides a constant power (P) to the rod. The metal rod is enclosed in an insulated container. It is observed that the temperature (T) in the metal rod changes with time

(t) as $T(t) = T_0 \left(1 + \beta t^{\frac{1}{4}} \right)$. Where β is a constant with appropriate dimension while T_0 is a constant with

dimension of temperature. The heat capacity of the metal is :



[2019]

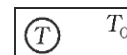
- (A) $\frac{4P(T(t) - T_0)^2}{\beta^4 T_0^3}$ (B) $\frac{4P(T(t) - T_0)^3}{\beta^4 T_0^4}$ (C) $\frac{4P(T(t) - T_0)^4}{\beta^4 T_0^5}$ (D) $\frac{4P(T(t) - T_0)}{\beta^4 T_0^2}$

MULTIPLE OPTIONS CORRECT TYPE

- *31. A bimetallic strip is formed out of two identical strips-one of copper and the other of brass. The coefficients of linear expansion of the two metals are α_C and α_B . On heating, the temperature of the strip goes up by ΔT and the strip bends to form an arc of radius of curvature R . then R is : [1999]

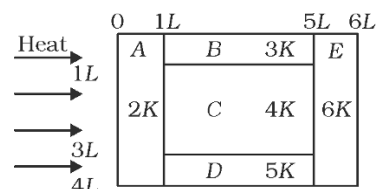
- (A) Proportional to ΔT (B) Inversely proportional to ΔT
(C) Proportional to $|\alpha_B - \alpha_C|$ (D) inversely proportional to $|\alpha_B - \alpha_C|$

- *32. A black body of temperature T is inside the chamber of temperature T_0 initially. Sun rays are allowed to fall from a very small hole in the top of the chamber. If the temperature of black body (T) and chamber (T_0) remain constant, then : [2006]



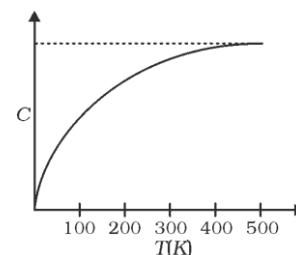
- (A) Black body will absorb more radiation
(B) Black body will absorb less radiation
(C) Black body will emit more energy
(D) Black body will emit energy equal to energy absorbed by it

- *33. A composite block is made of slabs A, B, C, D and E of different thermal conductivities (given in terms of a constant K) and sizes (given in terms of length, L) as shown in the figure. All slabs are of same width. Heat Q flows only from left to right through the blocks. Then, in steady state :



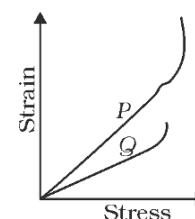
- (A) Heat flow through slabs A and E is same [2011]
(B) Heat flow through slab E is maximum
(C) Temperature difference across slab E is smallest
(D) Heat flow through C = heat flow through B + heat flow through D

- *34. The figure below 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, the following statement(s) is (are) correct to reasonable approximation. [2013]



- (A) the rate at which heat is absorbed in the range 0-100 K varies linearly with temperature T
(B) heat absorbed in increasing the temperature from 0-100 K is less than the heat required for increasing the temperature from 400-500 K
(C) there is no change in the rate of heat absorption in the range 400-500 K
(D) the rate of heat absorption increases in the range 200-300 K

- *35. In plotting stress versus strain curves for two materials P and Q , a student by mistake puts strain on the Y-axis and stress on the X-axis as shown in the figure. Then the correct statements is/are : [2015]



- (A) P has more tensile strength than Q
(B) P is more ductile than Q
(C) P is more brittle than Q
(D) The Young's modulus of P is more than that of Q

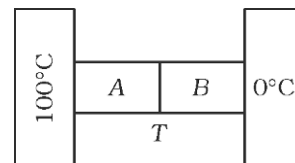
- *36. A human body has a surface area of approximately 1 m^2 . The normal body temperature is 10 K above the surrounding room temperature T_0 . Take the room temperature to be $T_0 = 300\text{ K}$. For $T_0 = 300\text{ K}$, the value of $\sigma T_0^4 = 460\text{ W m}^{-2}$ (where σ is the Stefan Boltzmann constant). Which of the following options is/are correct?  [2017]
- (A) If the body temperature rises significantly, then the peak in the spectrum of electromagnetic radiation emitted by the body would shift to longer wavelengths
- (B) If the surrounding temperature reduced by a small amount $\Delta T_0 \ll T_0$, then to maintain the same body temperature the same (living) human being needs to radiate $\Delta W = 4\sigma T_0^3 \Delta T_0$ more energy per unit time
- (C) The amount of energy radiated by the body in 1 s is close to 60 J
- (D) Reducing the exposed surface area of the body (e.g. by curling up) allows humans to maintain the same body temperature while reducing the energy lost by radiation

NUMERICAL VALUE TYPE

37. A room is maintained at 20°C by a heater of resistance 20Ω connected to 200 V mains. The temperature is uniform throughout the room and the heat is transmitted through a glass window of area 1 m^2 and thickness 0.2 cm . Calculate the outside temperature (in $^\circ\text{C}$). Thermal conductivity of glass is $0.2\text{ cal m}^{-1}\text{ s}^{-1} (^\circ\text{C})^{-1}$ and mechanical equivalent of heat is 4.2 J cal^{-1} .  [1978]
38. A lead bullet just melts when stopped by an obstacle. Assuming that 25 per cent of the heat is absorbed by the obstacle, find the velocity of the bullet in m/s , if its initial temperature is 27°C [1981]
(Melting point of lead = 327°C , specific heat of lead = $0.03\text{ cal/g}^\circ\text{C}$, latent heat of fusion of lead = 6 cal/g , $J = 4.2\text{ J/cal}$).
39. An electric heater is used in a room of total wall area 137 m^2 to maintain a temperature of $+20^\circ\text{C}$ inside it, when the outside temperature is -10°C . The walls have three different layers. The innermost layer is of wood of thickness 2.5 cm , the middle layer is of cement of thickness 1.0 cm , the outermost layer is of brick of thickness 25.0 cm . Find the power of the electric heater (in Watt). Assume that there is no heat loss through the floor and the ceiling. The thermal conductivities of wood, cement and brick are 0.125 , 1.5 and $1.0\text{ W/m}^\circ\text{C}$ respectively. [1986]
40. 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 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 watt/m-K and the specific heat of the material of the disc is $600\text{ J/kg}^\circ\text{K}$, how long will it take for the temperature of the disc to increase to 350 K ? Assume, for purposes 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.  [1992]

41. The temperature of 100 g of water is to be raised from 24°C to 90°C by adding steam to it. Calculate the mass of the steam required for this purpose (in gram) . [1996]

42. 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 coefficients of thermal conductivity of A and B are $300 \text{ W/m}^{\circ}\text{C}$ and $200 \text{ W/m}^{\circ}\text{C}$, respectively. After steady state is reached, find the temperature T of the interface (in $^{\circ}\text{C}$). [1996]



43. A thin rod of negligible mass and area of cross-section $4 \times 10^{-6} \text{ m}^2$, suspended vertically from one end, has a length of 0.5 m at 100°C . The rod is cooled to 0°C , but prevented from contracting by attaching a mass at the lower end. Find [1997]

(i) this mass in kg

(ii) the energy stored (in J) in the rod

(given for rod: Young's modulus $= 10^{11} \text{ N/m}^2$, coefficient of linear expansion $= 10^{-5} \text{ K}^{-1}$ and $g = 10 \text{ m/s}^2$)

44. A 5 m long cylindrical steel wire with radius $2 \times 10^{-3} \text{ m}$ is suspended vertically from a rigid support and carries a bob of mass 100 kg at the other end. If the bob gets snapped, the change in temperature of the wire, ignoring losses, is $x \times 10^{-3}^{\circ}\text{C}$. Find x . (For the steel wire: Young's modulus $= 2.1 \times 10^{11} \text{ Pa}$; Density $= 7860 \text{ kg/m}^3$; Specific heat $= 420 \text{ J/kg-K}$). [2001]

45. A cube of coefficient of linear expansion α_s is floating in a bath containing a liquid of coefficient of volume expansion γ_l . When the temperature is raised by ΔT , the depth upto which the cube is submerged in the liquid remains the same. If the relation between α_s and γ_l is $\gamma_l = n\alpha_s$, then n is . [2004]

46. A cylinder of mass 1 kg is given heat of 20,000 J at atmospheric pressure. If initially temperature of cylinder is 20°C , find [2005]

(i) final temperature of the cylinder.

(ii) work done by the cylinder.

(iii) change in internal energy of the cylinder.

(Given that Specific heat capacity of cylinder $= 400 \text{ J kg}^{-1}^{\circ}\text{C}^{-1}$, Coefficient of volume expansion $= 9 \times 10^{-5}^{\circ}\text{C}^{-1}$, Atmospheric pressure $= 10^5 \text{ N/m}^2$ and Density of cylinder $= 9000 \text{ kg/m}^3$)

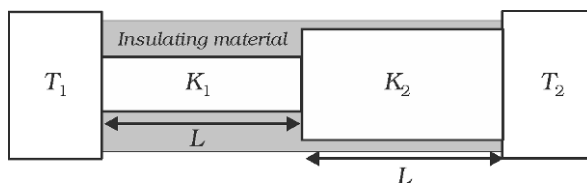
47. In an insulated vessel, 0.05 kg steam at 373 K and 0.45 kg of ice at 253 K are mixed. Find the final temperature of the mixture (in kelvin). [2006]

Given, $L_{\text{fusion}} = 80 \text{ cal/g} = 336 \text{ J/g}$,

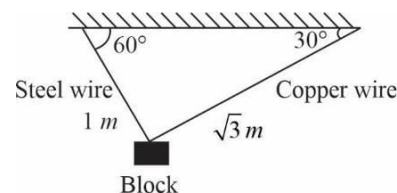
$L_{\text{vaporisation}} = 540 \text{ cal/g} = 2268 \text{ J/g}$,

$S_{\text{ice}} = 2100 \text{ J/kg-K}$, $K = 0.5 \text{ cal/g-K}$ and $S_{\text{water}} = 4200 \text{ J/kg-K}$, $K = 1 \text{ cal/g-K}$

48. A metal rod AB of length $10x$ has its one end A in ice at 0°C and the other end B in water at 100°C . If a point P on the rod is maintained at 400°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 surroundings)  [2009]
49. Two spherical bodies A (radius 6 cm) and B (radius 18 cm) are at temperature T_1 and T_2 respectively. The maximum intensity in the emission spectrum of A is at 500 nm and in that of B is at 1500 nm . Considering them to be black bodies, what will be the ratio of the rate of total energy radiated by A to that of B ? [2010]
50. A piece of ice (specific heat capacity $= 2100 \text{ J kg}^{-1}^\circ\text{C}^{-1}$ and latent heat $= 3.36 \times 10^5 \text{ J kg}^{-1}$) of mass m gram is at -5°C at atmospheric pressure. It is given 420 J of heat so that the ice starts melting. Finally when the ice-water mixture is in equilibrium, it is found that 1 g of ice has melted. Assuming there is no other heat exchange in the process, the value of m is . [2010]
51. Steel wire of length ' L ' at 40°C is suspended from the ceiling and then a mass ' m ' is hung from its free end. The wire is cooled down from 40°C to 30°C to regain its original length ' L '. The coefficient of linear thermal expansion of the steel is $10^{-5}/^\circ\text{C}$. Young's modulus of steel is 10^{11} N/m^2 and radius of the wire is 1 mm . assume that $L \gg$ diameter of the wire. Then the value of ' m ' in kg is nearly . [2011]
52. Two spherical stars A and B emit blackbody radiation. The radius of A is 400 times that of B and A emits 10^4 times the power emitted from B . The ratio $\left(\frac{\lambda_A}{\lambda_B}\right)$ of their wavelengths λ_A and λ_B at which the peaks occur in their respective radiation curves is . [2015]
53. A metal is heated in a furnace where a sensor is kept above the metal surface to read the power radiated (P) by the metal. The sensor has a scale that displays $\log_2(P/P_0)$, where P_0 is a constant. When the metal surface is at a temperature of 487°C , the sensor shows a value 1. Assume that the emissivity of the metallic surface remains constant. What is the value displayed by the sensor when the temperature of the metal surface is raised to 2767°C ?  [2016]
54. Two conducting cylinders of equal length but different radii are connected in series between two heat baths kept at temperatures $T_1 = 300 \text{ K}$ and $T_2 = 100 \text{ K}$, as shown in the figure. The radius of the bigger cylinder is twice that of the smaller one and the thermal conductivities of the materials of the smaller and the larger cylinders are K_1 and K_2 respectively. If the temperature at the junction of the two cylinders in the steady state is 200 K , then K_1/K_2 is . [2018]



55. A block of weight 100N is suspended by copper and steel wires of same cross sectional area 0.5 cm^2 and, length $\sqrt{3}\text{ m}$ and 1 m , respectively. Their other ends are fixed on a ceiling as shown in figure. The angles subtended by copper and steel wires with ceiling are 30° and 60° , respectively. If elongation in copper wire is (Δl_C) and elongation in steel wire is (Δl_S) , then the ratio $\frac{\Delta l_C}{\Delta l_S}$ is x . Find x .



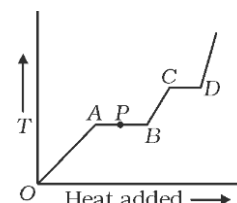
[Young's modulus for copper and steel are $1 \times 10^{11}\text{ N/m}^2$ and $2 \times 10^{11}\text{ N/m}^2$, respectively.] **[2019]**

56. A liquid at 30°C is poured very slowly into a Calorimeter that is at temperature of 110°C . The boiling temperature of the liquid is 80°C . It is found that the first 5 gm of the liquid completely evaporates. After pouring another 80 gm of the liquid the equilibrium temperature is found to be 50°C . The ratio of the Latent heat of the liquid to its specific heat will be $x^\circ\text{C}$. Find x . [Neglect the heat exchange with surrounding] **[2019]**



FILL IN THE BLANKS TYPE

57. The variation of temperature of a material as heat is given to it at a constant rate as shown in figure. The material is in solid state at the point O. The state of the material at the point P is _____. **[1985]**

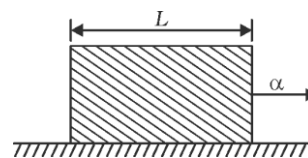


58. A wire of length L and cross-sectional area A is made of a material of Young's modulus Y . If the wire is stretched by an amount x , the work done is _____. **[1987]**
59. A solid sphere of radius R made of a material of bulk modulus k is surrounded by a liquid in a cylindrical container. A massless piston of area A floats on the surface of the liquid. When a mass M is placed on the piston to compress the liquid, the fractional change in the radius of the sphere, $\delta R / R$, is _____. **[1988]**
60. 300 g of water at 25°C is added to 100 g of ice at 0°C . The final temperature of the mixture is _____ $^\circ\text{C}$. **[1989]**
61. A piece of metal floats on mercury. The coefficients of volume expansion of the metal and mercury are γ_1 and γ_2 respectively. If the temperatures of both mercury and the metal are increased by an amount ΔT , the fraction of the volume of the metal submerged in mercury changes by the factor _____. **[1991]**

62. A solid copper sphere (density ρ 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 100 K is _____ $\rho r c$ [1991]



63. A uniform rod of length L and density ρ is being pulled along a smooth floor with a horizontal acceleration α (see figure). The magnitude of the stress at the transverse cross-section through the mid-point of the rod is _____ . [1993]



64. A double-pane window used for insulating a room thermally from outside consists of two glass sheets each of area 1 m^2 and thickness 0.01 m separated by a 0.05 m thick stagnant air space. In the steady state, the room glass interface and the glass-outdoor interface are at constant temperatures of 27°C and 0°C respectively. [1997]

(i) The rate of heat flow (in Watt) through the window pane _____

(ii) The temperatures (in $^\circ\text{C}$) of other interfaces _____ & _____

(Given, thermal conductivities of glass and air as 0.8 and $0.08\text{ W m}^{-1}\text{K}^{-1}$ respectively).

65. Earth receives 1400 W/m^2 of solar power. If all the solar energy falling on a lens of area 0.2 m^2 is focussed onto a block of ice of mass 280 g , the time taken to melt the ice will be _____ minutes. (Latent heat of ice $= 3.3 \times 10^5\text{ J/kg}$) [1997]

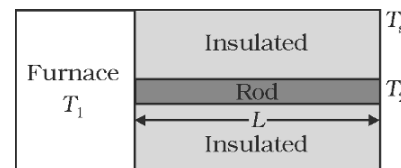
66. A solid body X of heat capacity C is kept in an atmosphere whose temperature is $T_A = 300\text{ K}$. At time $t = 0$, the temperature of X is $T_0 = 400\text{ K}$. It cools according to Newton's law of cooling. At time t_1 its temperature is found to be 350 K . [1998]



At this time (t_1) the body X is connected to a large body Y at atmospheric temperature T_A through a conducting rod of length L , cross-sectional area A and thermal conductivity K . The heat capacity of Y is so large that any variation in its temperature may be neglected. The cross-sectional area A of the connecting rod is small compared to the surface area of X . Find the temperature of X at time $t = 3t_1$ (in Kelvin). _____ [1998]

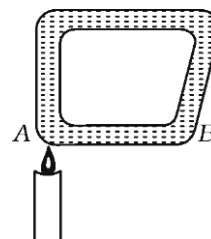
67. One end of a rod of length L and cross-sectional area A is kept in a furnace of temperature T_1 . The other end of the rod is kept at a temperature T_2 . The thermal conductivity of the material of the rod is K and emissivity of the rod is e . [2004]

It is given that $T_2 = T_s + \Delta T$, where $\Delta T \ll T_s$, T_s being the temperature of the surroundings. If $\Delta T \propto (T_1 - T_s)$, find the proportionality constant. Consider that heat is lost only by radiation at the end where the temperature of the rod is T_2 . _____ [2004]

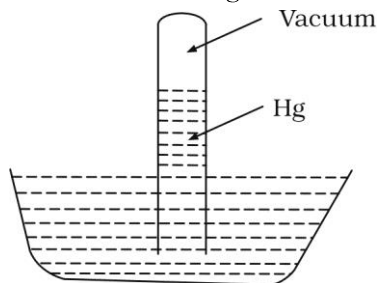


TRUE / FALSE TYPE

68. Water in a closed tube (see figure) is heated with one arm vertically placed above a lamp. Water will begin to circulate along the tube in counter-clockwise direction. [1983]



69. A barometer made of a very narrow tube is placed at normal temperature and pressure. The coefficient of volume expansion of mercury is 0.00018 per $^{\circ}\text{C}$ and that of the tube is negligible. The temperature of mercury in the barometer is now raised by 1°C , but the temperature of the atmosphere does not change. Then the mercury height in the tube remains unchanged. [1983]



70. Two spheres of the same material have radii 1 m and 4 m, temperature 4000 K and 2000 K respectively. The energy radiated per second by the first sphere is greater than that by the second. [1988]

MATRIX MATCH TYPE

71. Column I gives some devices and Column II gives some processes on which the functioning of these devices depend. Match the devices in Column I with the processes in Column II. [2007]

Column I

- (A) Bimetallic strip
- (B) Steam engine
- (C) Incandescent lamp
- (D) Electric fuse

Column II

- (P) Radiation from a hot body
- (Q) Energy conversion
- (R) Melting
- (S) Thermal expansion of solids