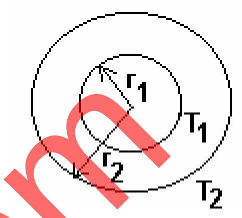
12 - TRANSFERENCE OF HEAT

(Answers at the end of all questions)

1) The figure shows a system of two concentric spheres of radii r_1 and r_2 and kept at temperatures T_1 and T_2 respectively. The radial rate of flow of heat in a substance between the two concentric spheres is proportional to



(a) $\ln (r_2 / r_1)$ (b) $\dfrac{r_2 - r_1}{r_1 r_2}$ (c) $r_2 - r_1$ (d) $\dfrac{r_1 - r_2}{r_1 r_2}$

[AIEEE 2005]

2) If the temperature of the sun were to increase from T to 2T and its radius from R to 2R, then the ratio of the radiant energy received on the earth to what it was previously, will be

(a) 4 (b) 16 (c) 32 (d) 64 [AIEEE 2004]

3) The temperatures of the two outer surfaces of a composite slab, consisting of two materials having coefficients of thermal conductivity K and 2K and thickness x and 4x, respectively are T_2 and T_1 ($T_2 > T_1$). The rate of heat transfer through the slab, in a steady state, is $\dfrac{A (T_2 - T_1)}{x} \times f$ with f equal to

(a) 1 (b) 1 / 2 (c) 2 / 3 (d) 1 / 3 [AIEEE 2004]

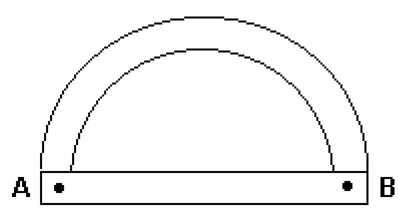
4) According to Newton's law of cooling, the rate of cooling of a body is proportional to $(\Delta\theta)^n$, where $\Delta\theta$ is the difference of the temperatures of the body and its surroundings and n is equal to

(a) one (b) two (c) three (d) four [AIEEE 2003]

5) The luminous intensity of a star is 8100 times that of the sun and its temperature is 4500 K. Assuming the surface temperature of the sun to be 6000 K, the ratio of radius of the star to that of the sun will be

(a) 1 : 160 (b) 1 : 320 (c) 160 : 1 (d) 320 : 1 [AIEEE 2002]

6) Two rods (one straight and other semicircular) of the same material and same cross-sectional area are joined as shown in the figure. The points A and B are maintained at different temperatures. The ratio of the heat transferred through the semicircular rod to the heat transferred through the straight rod in a given time is



(a) $2 : \pi$ (b) 1 : 2 (c) $\pi : 2$ (d) 3 : 2

[AIEEE 2002]

7) A body with area A and temperature T and emissivity e = 0.6 is kept inside a spherical black body. What will be the maximum energy radiated ?

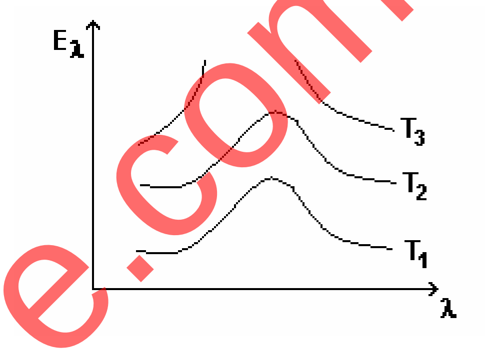
(a) $0.60\ \sigma A T^4$ (b) $0.80\ \sigma A T^4$ (c) $1.00\ \sigma A T^4$ (d) $0.40\ \sigma A T^4$ [IIT 2005]

8) In which of the following processes, heat loss is primarily NOT due to convection ?

(a) boiling of water (b) land and sea breeze
(c) heating of glass surface of a bulb due to current in filament
(d) circulation of air around blast furnace [IIT 2005]

9) One calorie is defined as heat required for rise of temperature by 1° C of one gram of water at which of the following specific conditions ?
(a) 98.5 to 99.5° C, 760 mm Hg (b) 3.5 to 4.5° C, 76 mm of Hg
(c) 13.5 to 14.5° C, 76 mm Hg (d) 14.5 to 15.5° C, 760 mm Hg [IIT 2005]

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



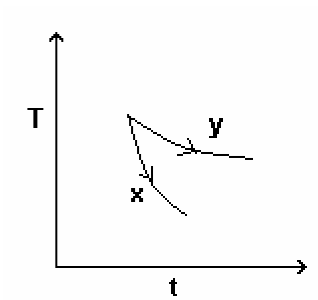
(a) Sun-T_1, tungsten filament - T_2, welding arc - T_3
(b) Sun-T_2, tungsten filament - T_2, welding arc - T_1
(c) Sun-T_3, tungsten filament - T_2, welding arc - T_1
(d) Sun-T_1, tungsten filament - T_3, welding arc - T_2

[IIT 2005]

11) Two identical conducting rods are first connected independently to two vessels, one containing water at 100° C and the other containing ice at 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. The ratio q_1 / q_2 is
(a) 1 : 2 (b) 2 : 1 (c) 4 : 1 (d) 1 : 4 [IIT 2004]

12) Three discs, A B and C having radii 2 m, 4 m and 6 m respectively are coated with carbon black on their outer surfaces. The wavelengths corresponding to maximum intensity are 300 nm, 400 nm and 500 nm respectively. If the power radiated by them are Q_A, Q_B and Q_c respectively, then
(a) Q_A is maximum (b) Q_B is maximum
(c) Q_C is maximum (d) $Q_A = Q_B = Q_C$ [IIT 2004]

13) The graph, shown in the adjacent diagram, represents the variation of temperature (T) of two bodies, x and y having same surface area, with time (t) due to the emission of radiation. Find the correct relation between the emissivity and absorptivity power of the two bodies.



(a) $E_x > E_y$ and $a_x < a_y$ (b) $E_x < E_y$ and $a_x > a_y$
(c) $E_x > E_y$ and $a_x > a_y$ (d) $E_x < E_y$ and $a_x < a_y$

[IIT 2003]

14) 2 kg of ice at - 20° C is mixed with 5 kg of water at 20° C in an insulating vessel having a negligible heat capacity. Calculate the final mass of water remaining in the container. It is given that the specific of water and ice are 1 kcal / kg / °C and 0.5 kcal / kg / °C while the latent heat of fusion of ice is 80 Kcal / kg:
(a) 7 kg (b) 6 kg (c) 4 kg (d) 2 kg [IIT 2003]

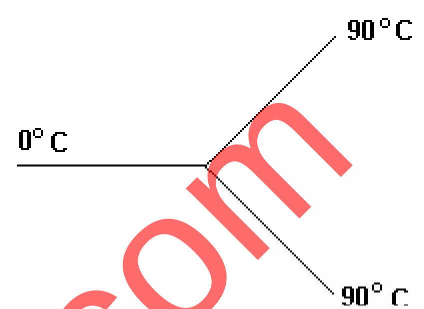
15) An ideal black-body at room temperature is thrown into a furnace. It is observed that
(a) initially it is the darkest body and at later times the brightest.
(b) it is the darkest body at all times.
(c) it cannot be distinguished at all times.
(d) initially it is the darkest body and at later times it cannot be distinguished.

(Answers at the end of all questions)

16) Three rods made of the same material and having the same cross-section have been joined as shown in the figure. Each rod is of the same length. The left and right ends are kept at 0° C and 90° C respectively. The temperature of the junction of the three rods will be

(a) 45° C (b) 60° C (c) 30° C (d) 20° C

[IIT 2001]

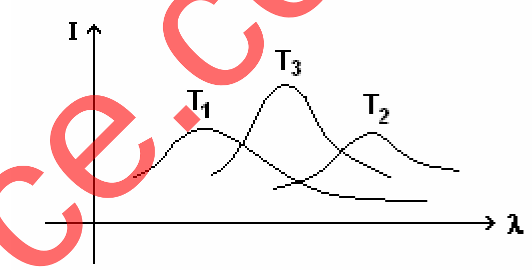


17) The plots of intensity versus wavelength for three black bodies at temperatures T_1, T_2 and T_3 respectively are as shown. Their temperatures are such that

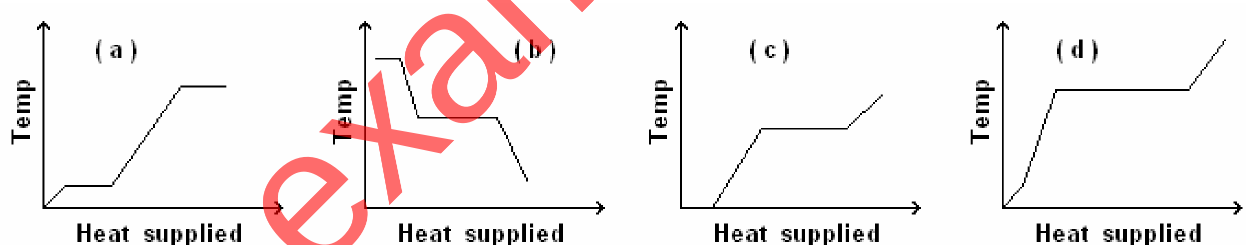
(a) $T_1 > T_2 > T_3$ (b) $T_1 > T_3 > T_2$

(c) $T_2 > T_3 > T_1$ (d) $T_3 > T_2 > T_1$

[IIT 2000]



18) A block of ice at - 10° C is slowly heated and converted into steam at 100° C. Which of the following curves represents the phenomena qualitatively? [IIT 2000]



19) A bimetallic strip is formed out of two identical strips - one f 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

(a) proportional to ΔT (b) inversely proportional to ΔT

(c) proportional to $| \alpha_B - \alpha_C |$ (d) inversely proportional to $| \alpha_B - \alpha_C |$ [IIT 1999]

20) A black body is at a temperature of 2880 K. The energy of radiation emitted by this object 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. The Wein constant, b = 2.88×10^6 nm-K. Then

(a) $U_1 = 0$ (b) $U_3 = 0$ (c) $U_1 > U_2$ (d) $U_2 > U_1$ [IIT 1998]

21) 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 watt would be

(a) 225 (b) 450 (c) 900 (d) 1800

[IIT 1997]

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(Answers at the end of all questions)

22) Two bodies A and B have thermal emissivities of 0.01 and 0.81 respectively. The outer surface areas of the two bodies are the same. The two bodies emit total radiant power at the same rate. The wavelength λ_B corresponding to maximum spectral radiancy in the radiation from B is shifted from the wavelength corresponding to maximum spectral radiancy in the radiation from A, by 1.0 μm. If the temperature of A is 5802 K

(a) the temperature of B is 1934 K (b) λ_B = 1.5 μm
(c) the temperature of B is 11604 K (d) the temperature of B is 2901 K [IIT 1994]

23) Two rods of different materials having coefficients of thermal expansion a_1, a_2 and Young's moduli Y_1, Y_2 respectively are fixed between two rigid massive walls. The rods are heated such that undergo the same increase in temperature. There is no bending of the rods. If $a_1 : a_2 = 2 : 3$, the thermal stresses developed in the two rods are equal provided $Y_1 : Y_2$ is equal to

(a) 2 : 3 (b) 1 : 1 (c) 3 : 2 (d) 4 : 9 [IIT 1989]

24) 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 steady state. The effective thermal conductivity of the system is

(a) $K_1 + K_2$ (b) $K_1 K_2 / (K_1 + K_2)$ (c) $(K_1 + 3K_2) / 4$ (d) $(3K_1 + K_2) / 4$
[IIT 1988]

25) 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 rise to 80° C. The mass of the steam condensed in kilogram is

(a) 0.130 (b) 0.065 (c) 0.260 (d) 0.195 [IIT 1986]

26) A constant volume gas thermometer works on

(a) the principle of Archimedes (b) Pascal's law
(c) Boyle's law (d) Charles' law [IIT 1980]

27) A wall has two layers A and B, each made of a different material. 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

(a) 6° C (b) 12° C (c) 18° C (d) 24° C [IIT 1980]

28) 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

(a) $W_1 > W_2$ (b) $W_1 = W_2$ (c) $W_1 < W_2$ [IIT 1980]

29) Ice starts forming in a lake with water at 0° C when the atmospheric temperature is - 10° C. If the time taken for 1 cm of ice to be formed is 7 hours, the time taken for the thickness of ice to change from 1 cm to 2 cm is

(a) 7 hr (b) < 7 hr (c) > 14 hr (d) > 7 hr but < 14 hr [NCERT 1971]

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(Answers at the end of all questions)

30) The temperature of a piece of metal is raised from 27° C to 51.2° C. The rate at which metal radiates energy increases nearly
(a) 2 times (b) 1.36 times (c) 2.72 times (d) 4 times

31) A body takes 4 minutes to cool from 100° C to 70° C. If the room temperature is 15° C, the time taken to cool from 70° C to 40° C will be
(a) 7 minutes (b) 6 minutes (c) 5 minutes (d) 2 minutes

32) With cold wind keeping the surface at - 20° C, a layer of ice on a pond grows in thickness from 20 mm to 21 mm in 10 min. Later with the surface at the same temperature, it will grow from 40 mm to 42 mm in approximately
(a) 10 min. (b) 10.2 min. (c) 20 min. (d) 40 min.

33) Two solid spheres of radii R_1 and R_2 are made of the same material and have similar surfaces. The spheres are raised to the same temperature and then allowed to cool under identical conditions. Assuming spheres to be perfect conductors of heat, their ratio of initial rate of heat loss is

(a) $\left(\frac{R_1}{R_2}\right)^2$ (b) $\frac{R_1}{R_2}$ (c) $\frac{R_2}{R_1}$ (d) $\left(\frac{R_2}{R_1}\right)^2$

34) In the above question, the ratio of the initial rates of cooling is

(a) $\left(\frac{R_1}{R_2}\right)^2$ (b) $\frac{R_1}{R_2}$ (c) $\frac{R_2}{R_1}$ (d) $\left(\frac{R_2}{R_1}\right)^2$

35) Two bodies A and B are placed in an evacuated vessel maintained at a temperature of 27° C. The temperature of A is 327° C and that of B is 227° C. The ratio of heat losses from A to B is about
(a) 2 : 1 (b) 1 : 2 (c) 4 : 1 (d) 1 : 4

Answers

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
d	d	d	a	c	a	a	c	d	c	c	b	c	b	a	b	b	a	b,d	d

21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
d	a,b	c	c	a	d	b	b	c	b	a	d	a	c	a