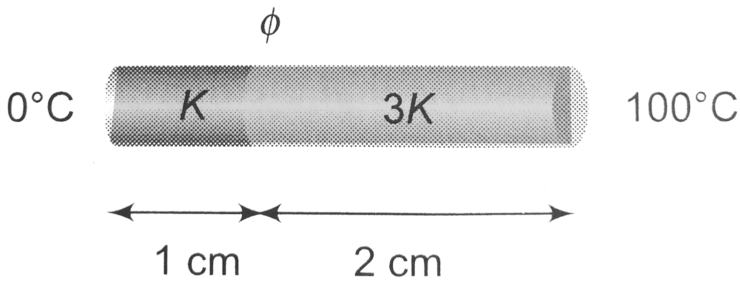
PHYSICS

BOOKS - CENGAGE PHYSICS (ENGLISH)

TRANSMISSION OF HEAT

Single Correct Answer Type

1. Two bars of thermal conductivities K and $3K$ and lengths $1cm$ and $2cm$ respectively have equal cross-sectional area, they are joined lengths wise as shown in the figure. If the temperature at the ends of this composite br is $0^\circ C$ and $100^\circ C$ respectively (see figure), then the temperature ϕ of the interface is



A. 50° C

B. $\left(\frac{100}{3}\right)^\circ$ C

C. 60° C

D. $\left(\frac{200}{3}\right)^\circ$ C

Answer: C

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2. A wall is made of equally thick layers A and B of different matierals. Thermal conduvtivity of A is twice that of B. In the stedy state, the temperature difference across the wall is $36^\circ C$. The temperature difference across the layer A is

A. 6° C

B. 12° C

C. 18° C

D. 24° C

Answer: B

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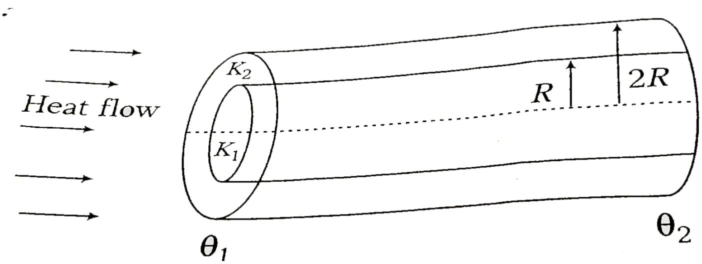
3. A cylinder of radius r made of a material of thermal conductivity $K_1 = K$ is surrounded bt cylendrical shell of inner radius R and outer radius 3R made of a material of thermal conductivity $K_2 = 2K$. The two ends of the combined system are maintained at two different temperatures .

there is no loss of heat across the cylendrical surface and system is in steadt state . what is the effective thermal conductivity of the system ?



A. $K_1 + K_2$

B. $\dfrac{K_1K_2}{K_1 + K_2}$

C. $\frac{K_1 + 3K_2}{4}$

D. $\frac{3K_1 + K_2}{4}$

Answer: C

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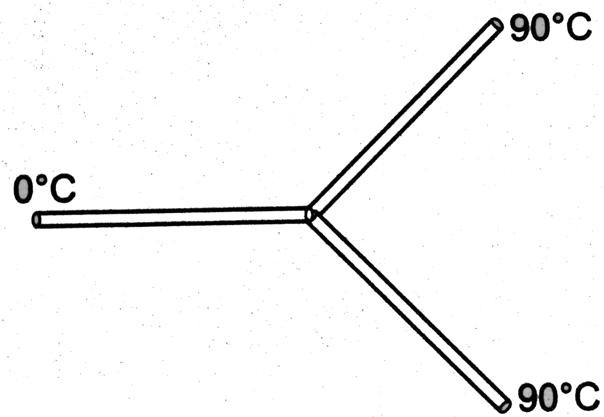
4. Three rods made of the same material and having the same cross-section have been joined as shown in the figure. Each rod is of the same length. The left and right ends are kept at $0^\circ C$ and $90^\circ C$, respectively. The temperature of junction of the three rods will

be

(a) $45^{\circ} C$ (b) $60^{\circ} C$

(c) $30^{\circ} C$ (d) $20^{\circ} C$.



A. 45° C

B. 60° C

C. 30° C

D. 20° C

Answer: B

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5. Ice has formed on a shallow pond, and a steady state has been reached, with the air above the ice at $-5.0^\circ C$ and the bottom of the pond at $40^\circ C$. If the total depth of ice + water is $1.4m$, (Assume that the thermal conductivities of ice and water are 0.40 and

$0.12 cal / m C^{\circ} s$, respectively.)

The thickness of ice layer is

A. 1.1 m

B. 0.4 m

C. 2.1 m

D. 3.6 m

Answer: A

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6. Two identical conducting rods are first connected independently to two vessels, one containing water at $100^\circ C$ and the other containing ice at $0^\circ C$. In the second case, the rods are joined end to end and connected to the same vessels. Let q_1 and q_2 gram per second be the rate of melting of ice in the two cases respectively. The ratio $\frac{q_1}{q_2}$ is

(a) $\frac{1}{2}$ (b) $\frac{2}{1}$ (c) $\frac{4}{1}$ (d) $\frac{1}{4}$

A. $\frac{1}{2}$

B. $\frac{2}{1}$

C. $\frac{4}{1}$

D. $\frac{1}{4}$

Answer: C

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7. A solid cube and a solid sphere of the same material have equal surface area. Both are at the same temperature $120^\circ C$, then

A. Both the cube and the sphere cool down at the same rate

B. The cube cools down faster than sphere

C. The sphere cools down faster than the cube

D. Whichever is having more mass will cool down faster

Answer: B

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8. The two opposite faces of a cubical piece of iron (thermal conductivity = 0.2 CGS units) are at $100^\circ C$ and $0^\circ C$ in ice. If the area of a surface is $4cm^2$, then the mass of ice melted in 10 minutes will b

A. 30 gm

B. 300 gm

C. 5 gm

D. 50 gm

Answer: B

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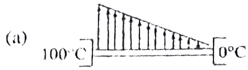
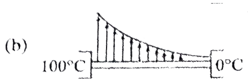
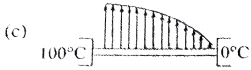
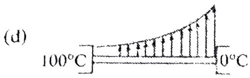
9. A conducting cylindrical rod of uniform cross-sectional area is kept between two large chambers which are at temperatures 100°C and 0°C, respectively. The cconductivety of the rod increases with x, where x is distance from 100°C end. The temperature profile of the rod in steady -state will be as

A. 

B. 

C. 

D. 

Answer: B

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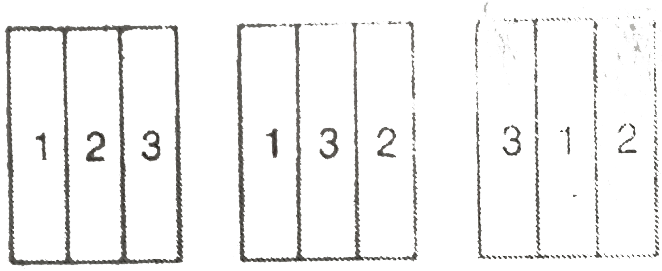
Multiple Correct Answer Type

1. Figure, shown three different arrangements of materials 1, 2 and 3 to from a wall. Thermal conductivities are $k_1 > k_2 > k_3$. The left side of the wall is $20^\circ C$ higher than the right side. The temperature difference ΔT across the material 1 has following relation in three cases



(a) (b) (c)

A. In steady state, the rate of energy conduction through the wall III is greatest

B. In steady state, the rate of energy conduction though all the walls (I), (II) and (III) are same

C. In steady state, temperature difference across material I is greatest in wall II.

D. In steady state, temperature differnce across material I is same in all the walls

Answer: B::D

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2. The ends of a rod of uniform thermal conductivity are maintained at different (constant) temperatures. Afer the steady state is achieved:

A. heat flows in the rod from high temperature to low temperature even if the rod has the non-unform cross sectional area

B. temperature gradient along length is same even if the rod has the non-unform cross sectional area

C. heat current is same even if the rod hasnon-unform cross sectional area

D. If the rod has uniform cross-sectional area the temperature is same all the point at rod.

Answer: A::C

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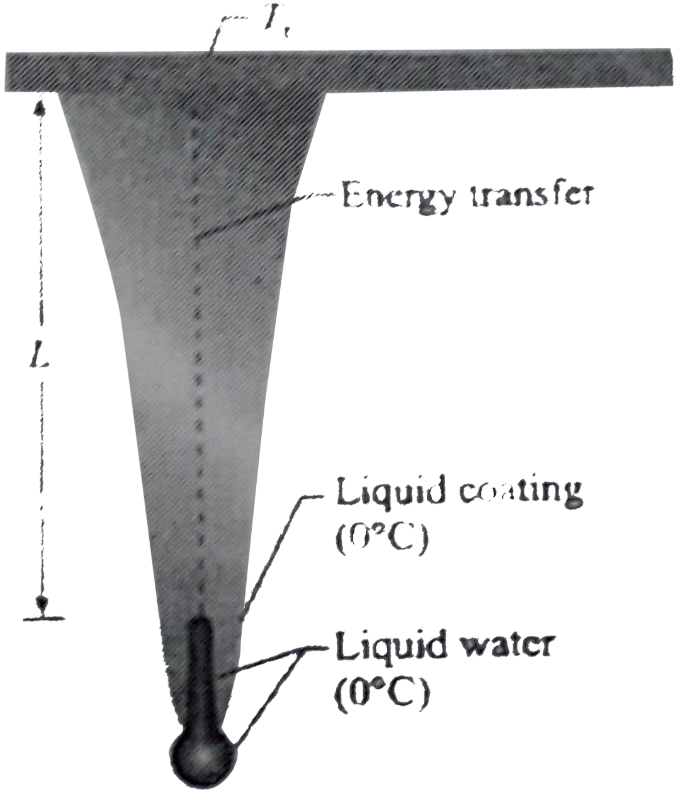
Comprehension Type

1. Liquid water coats an active (growing) icicle and extends up a short, narrow tube along the central axis. Because the water-ice interface must have a temperature of 0°C, the water in the tube cannot lose energy through the sides of the icicle or down through the tip because there is no temperature change in those directions . It can lose energy and freeze only by sending energy up(through distance L) to the top of the icicle, where the temperature T_r can be below 0°C. Take L=0.10m and T_r=-5° C.Assume that the central tube and the upward conduction path both have crosse-sectional area A=0.5m^2. The thermal conductivity of ice is 0.40 W$/m \cdot K$, latent heat of fusion is $L_F = 4.0 \times 10^5 J/K$ and the density of liquid water is 1000 kg$/m^3$.



The rate at which mass converted from liquid to ice at the top of the central tube is

A. $7.5 \times 10^{-3} kg / s$

B. $2.5 \times 10^{-5} kg / s$

C. $5 \times 10^{-3} kg / s$

D. $5 \times 10^{-5} kg / s$

Answer: B

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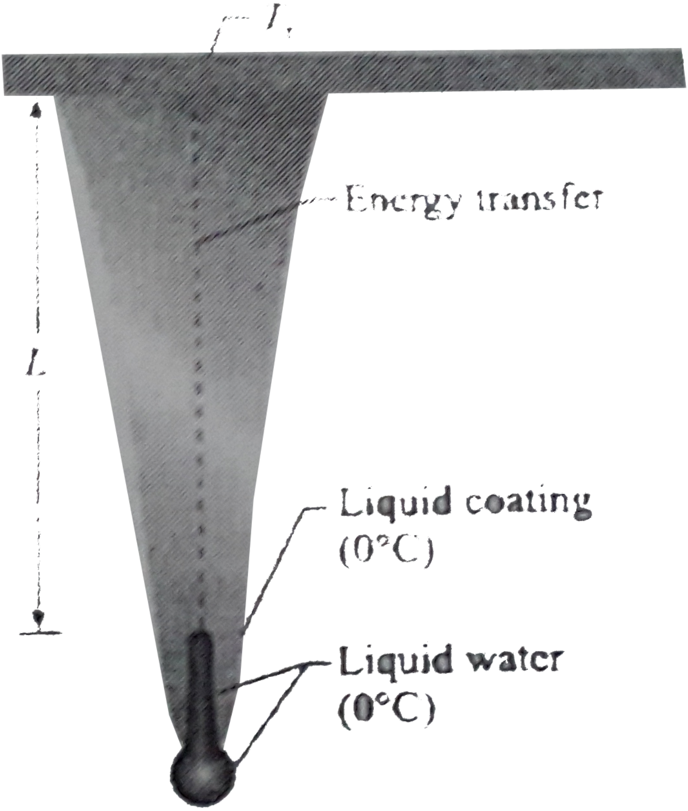
2. Liquid water coats an active (growing) icicle and extends up a short, narrow tube along the central axis. Because the water-ice interface must have a temperature of 0°C, the water in the tube cannot lose energy through the sides of the icicle or down through the tip because there is no temperature change in those directions . It can lose energy and freeze only by sending energy up(through distance L) to the top of the icicle, where the temperature T_r can be below 0°C. Take L=0.10m and T_r=-5° C.Assume that the central tube and the upward conduction path both have crosse-sectional area A=0.5m^2. The thermal conductivity of ice is 0.40 W$/m\cdot K$, latent heat of fusion is $L_F = 4.0\times10^5 J/K$ and the density of liquid water is 1000 kg$/m^3$.



At what rate does the top of the tube move downward because of water freezing there?

A. $5 \times 10^{-8} m / s$

B. $2.5 \times 10^{-3} m / s$

C. $2.5 \times 10^{-8} m / s$

D. $4.5 \times 10^{-2} m / s$

Answer: C

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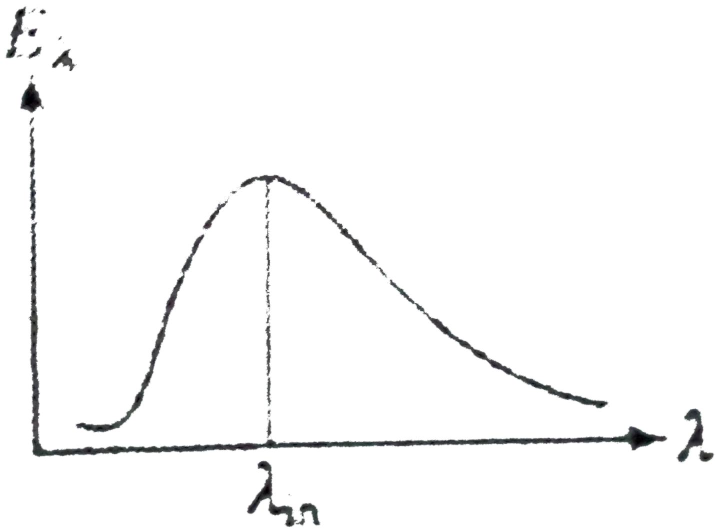
3. The radiations emitted by the sun are analyzed and the spectral energy distribution curve is plotted. as shown. The radius of the sun is R, the earth is situated a distance $'d'$ from the sun. Treat the sun as perfectly black body which radiates power at constant rate fill till its store of hydrogen gets exhausted. (Stefan's constant $= \sigma$, Wien's constant $= b$, speed of light $= c$)



Assume the sun produces energy only by nuclear fusion of hydrogen nuclei and the fraction of nuclear mass of hydrogen that can be converted to energy is η. How long will the sun keep on emittied the energy if the mass of hydrogen at present in Sun's core is m?

A. $\dfrac{\eta m c^2 \lambda_m^4}{\pi R^2 \sigma b^4}$

B. $\dfrac{\eta m c^2 \lambda_m^4}{4\pi R^2 \sigma b^4}$

C. $\dfrac{\eta m c^2 \lambda_m^4}{2\pi R^2 \sigma b^4}$

D. $\dfrac{2\eta m c^2 \lambda_m^4}{\pi R^2 \sigma b^4}$

Answer:

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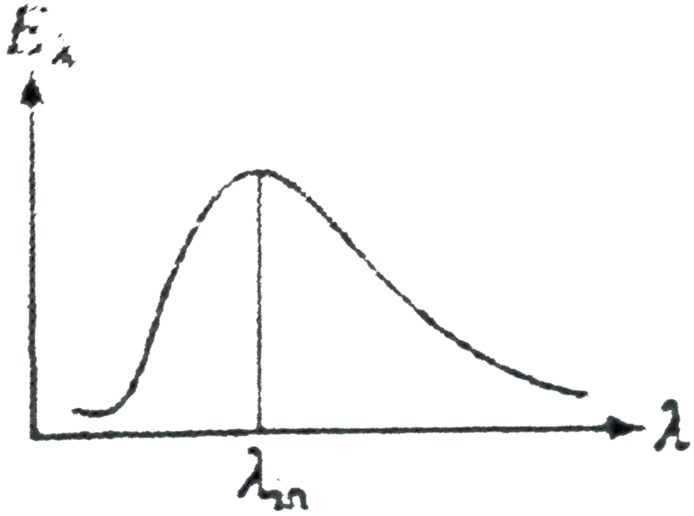

If the earth is at a distance $'d'$ from the sun the intensity of light falling on the earth (called solar constant S) is

A. (A) $S = \sigma\left(\frac{R}{d}\right)^2\left(\frac{b}{\lambda_m}\right)^4$

B. (B) $S = \sigma\left(\frac{R}{d}\right)\left(\frac{b}{\lambda_m}\right)^4$

C. (C) $S = 2\sigma\left(\frac{R}{d}\right)^2\left(\frac{b}{\lambda_m}\right)^4$

D. (D) $S = \sigma / 2\left(\frac{R}{d}\right)^2 \left(\frac{b}{\lambda_m}\right)^4$

Answer:

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Fill In The Blanks Type

1. The thermal conductivity of a material in CGS system is 0.4. In steady state, the rate of flow of heat 10 cal/sec-cm, then the thermal gradient will be

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2. Two vessels of different materials are similar in size in every respect. The same quantity of ice filled in them gets melted in 20 minutes and 40 minutes respectively. The ratio of thermal conductivities of the metals is

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3. Two walls of thickness d_1 and d_2 and thermal conductivites K_1 and K_2 are in contact. In the steady state, if the temperature at the outer surfaces are T_1 and T_2 the temperature at the common wall is

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4. Two identical plates of different metals are joined to form a single plate whose thickness is double the thickness of each plate. If the coefficients of conductivity of each plate are 2 and 3 respectively, Then the conductivity of composite plate will be

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5. The ratio of the diameters of two metallic rods of the same material is $2:1$ and their lengths are in the ratio $1:4$. If the temperature difference between their ends are equal, the rate of flow of heat in them will be in the ratio

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6. Two cylinders P and Q have the same length and diameter and are made of different materials having thermal conductivities in the ratio $2:3$. These two cyinders ar combined to make a cylinder. One end of P is kept at $100^{\circ}C$ and another end of Q at $0^{\circ}C$. THe temperature at the interface of P and Q is

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Single Corrct Answer

1. Half part of ice block is covered with black cloth and rest half is covered with white cloth and then it is kept in sunlight. After some time clothes are removed to see the melted ice. Which of the following statements is correct

A. Ice covered with white cloth will melt more.

B. Ice covered with black cloth will melt more.

C. Equal ice will melt under both clothes.

D. It will depend on the temperature of surroundings of ice.

Answer: (b)

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2. Two thermometers A and B are exposed in sunlight. The bulb of A is painted black, But that of B is not painted. The correct statement regarding this case is

A. Temperature of A will rise faster than b but the final temperature will be the same in both

B. Both A and B show equal rise in beginning

C. Temperature of A will remain more than B

D. Temperature of b will rise faster

Answer: (a)

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3. If 'p' calorie of heat energy is incident on a body and absorbs 'q' calories of heat absorbed then its coefficient of absorption is .

A. p/q

B. q/p

C. p^2/q^2

D. q^2/p^2

Answer: (b)

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4. The total energy radiated from a block body source at constant temperature is collected for one minute and is used to heat a quantity of water. The temperature of water is found to increase from $20^{\circ} C$ to $20.5^{\circ} C$. If the absolute temperature of the blackbody is doubled and the experiment is repeated with the same quantity of water of $20^{\circ} C$, the temperature of water will be:

A. $21^{\circ} C$

B. $22^{\circ} C$

C. $24^{\circ} C$

D. $28^{\circ} C$

Answer: (d)

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5. The surface temperature of the sun is T_0 and it is at average distance d from a planet. The radius of the sun is R. The temperature at which planet radiates the energy is

A. $T_0\sqrt{\frac{R}{2d}}$

B. $T_0\sqrt{\frac{2R}{d}}$

C. $T_0\sqrt{\frac{R}{d}}$

D. $T_0\left(\frac{R}{d}\right)^{1/4}$

Answer: (a)

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6. In the previous problem, if θ is the angle sbtended by the Sun at the planet, then temperature at which planet radiates energy is proportional to

A. θ

B. θ^2

C. $\theta^{1/2}$

D. $\theta^{-1/2}$

Answer: C

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7. A black body radiates poer P and maximum energy is radiated by it around a wavelength λ_0. The temperature of the black body is now changed such that it radiates maximum energy around the wavelength $\frac{3\lambda_0}{4}$. The power radiated by it now is

A. $4/3$

B. 16/9

C. 64/27

D. 256/81

Answer: (d)

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Multiple Correct Answer

1. A heated body emits radiation which has maximum intensity at frequency v_m If the temperature of the body is doubled:

A. the maximum intensity radiation will be at frequency $2v_m$

B. the maximum intensity radiation will be

at frequency $(1/2)v_m$

C. the total emitted energy will increase by

a factor16

D. the total emitted energy will increase by

a factor 2

Answer: (A, C)

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2. The solar constant for a planet is S. The surface temperature of the sun is TK. The sun subtends an angle θ at the planet:

A. $S \propto T^4$

B. $S \propto T^{\theta}$

C. $S \propto \theta^2$

D. $S \propto \theta$

Answer: (A, C)

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Comprehension

1. A body is kept inside a cotainer the temperature of the body is T_1 and the temperature of container is T_2. The rate at which body absorbs the energy is α. The emissivity of the body is e. The radiation striking the body is either absorbed or reflected.

A good absorber is

A. T_1

B. T_2

C. $T_1 + \frac{(T_2 - T_1)}{2}$

D. None the these

Answer: (b)

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2. A body is kept inside a container the temperature of the body is T_1 and the temperature of the container is T_2 the rate at which body absorbs the energy is α The emissivity of the body is e The radiation striking the body is either absorbed or reflected

At what rate of body will absorb the radiant energy .

A. if t is the time , rate is $(T_1 - T_2)/t$

B. e

C. Both of the above

D. None the above

Answer: (b)

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3. A body is kept inside a container the temperature of the body is T_1 and the temperature of the container is T_2 the rate at which body absorbs the energy is α The emissivity of the body is e The radiation striking the body is either absorbed or reflected

At what rate of body will absorb the radiant energy .

A. $\alpha, \quad \text{but} \quad \alpha \neq e$

B. $(T_1 - T_2)/t$, where t is the time

C. e, but e = α

D. None of above

Answer: C

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4. A body is kept inside a container the temperature of the body is T_1 and the temperature of the container is T_2 the rate at which body absorbs the energy is α The emissivity of the body is The radiation striking the body is either absorbed or reflected

A good absorber is .

A. good reflector

B. poor reflector

C. average reflector

D. Assessment not possible

Answer: (b)

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Fill In The Blacks Type

1. If wavelength of maximum intensity of radiation emitted by sun and moon are 0.5×10^{-6} m and 10^{-4} m respectively then the ratio of the temperature is

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2. A black body emits radiations of maximum intensity at a wavelength of Å 5000 , when the temperature of the body is $1227^{\circ} C$. If the temperature of the body is increased by $1000^{\circ} C$, the maximum intensity of emitted radiation would be observed at

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3. 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, then the ratio of the surface temperature of the sun and North star is

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4. A black body radiates energy at the rate of E W/m at a high temperature TK . When the temperature is reduced to $\frac{T}{2}K$, the radiant energy will b

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5. Energy is being emitted from the surface of a black body at $127^{\circ} C$ temperature at the rate of $1.0 \times 10^{6} J / \sec - m^{2}$. Temperature of the black at which the rate of energy emission is $16.0 \times 10^{6} J / \sec - m^{2}$ will be

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6. The rectangular surface of area $8cm \times 4cm$ of a black body at temperature of $127^{\circ} C$ emits energy at the rate of E per second. If the length and breadth of the surface are each reduced to half of the initial value and the temperature is raised to $327^{\circ}C$, the rate of emission of energy will become

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Single Correct

1. Consider two hot bodies B_1 and B_2 which have temperature $100^{\circ}\mathrm{C}$ and $80^{\circ}\mathrm{C}$ respectively at t = 0. The temperature of surroundings is 40° C. The ratio of the respective rates of cooling R_1 and R_2 of these two bodies at $t = 0$ will be

A. $R_1 : R_2 = 3 : 2$

B. $R_1 : R_2 = 5 : 4$

C. $R_1 : R_2 = 2 : 3$

D. $R_1 : R_2 = 4 : 5$

Answer:

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2. Equal masses of two liquids are filled in two similar calorimeters. The rate of cooling will

A. Depend on the nature of the liquids

B. Depend on the specific heats of liquids

C. Be same for both the liquids

D. Depend on the mass of the liquids

Answer:

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3. A body takes 4 minutes to cool from $100^{\circ} C$ to $70^{\circ} C$. To cool from $70^{\circ} C$ to $40^{\circ} C$ it will take (room temperture os $15^{\circ} C$)

A. 7 min

B. 6 min

C. 5 min

D. 4 min

Answer:

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4. A body cools from 60°C to 50°C in 10 min. If room temperature is 95°C. Temperature of body at the end of next 10 min, will be

A. $38.5^{\circ}C$

B. $40^{\circ}C$

C. $42.85^{2}C$

D. $45^{\circ}C$

Answer:

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5. The temperature of a liquid drops from 365 K to 361 K in 2 minutes . Find the time during which temperature of the liquid drops from 344 K to 342 K.Temperature of room is 293 K

A. 84 sec

B. 72 sec

C. 66 sec

D. 60 sec

Answer:

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6. Hot water kept in a beaker placed in a room cools from $70^{\circ} C$ to 60° C in 4 minutes . The time taken by it to cool from $69^{\circ} C$ to $59^{\circ} C$ will be

A. The same 4 minutes

B. More than 4 minutes

C. Less than 4 minutes

D. We cannot say definitely

Answer:

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7. In a room, where the temperature is 30°C a body cools from 61°C to 59°C in 4 minutes. The time taken by the body to cool from 51°C to 49°C will be

A. 4 min

B. 6 min

C. 5 min

D. 8 min

Answer:

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8. A calorimeter of mass $0.2kg$ and specific heat $900J/kg-K$. Containing $0.5kg$ of a liquid of specific heat $2400J/kg-K$. Its temperature falls from $60^\circ C$ to $55^\circ C$ in one minute. Find the rate of cooling.

A. $5J/s$

B. $15J/s$

C. $100J/s$

D. $115J/s$

Answer:

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9. A cane is taken out from a refrigerator at 0°C. The atmospheric temperature is 25°C. If t1 is the time taken to heat from 0°C to 5°C and t_2 is the time taken from 10°C to 15°C, then the wrong statements are

(1) $t_1 > t_2$

(2)$t_1 = t_2$

(3) There is no relation

(4)$t_1 < t_2$

A. $t_1 > t_2$

B. $t_1 < t_2$

C. $t_1 = t_2$

D. There is no relation

Answer:

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