PHYSICS

BOOKS - CENGAGE PHYSICS (ENGLISH)

CALORIMETRY

Illustration

1. The boiling point of liquid nitrogen is $-195.81^\circ C$ at atmospheric pressure. Express this temperature in (a) $^\circ F$ and (b) K.

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2. What will be the following temperatures on the kelvin scale: a. 37°, b. $80^\circ F$, c. $-196^\circ C$?

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3. What is the change is potential energy (in calories) of a 10 kg mass after 41.8m fall?

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4. In the Joule experiment, a mass of 20 kg falls through 1.5m at a constant velocity to stir the water in a calorimeter. If the calorimeter has a water equivalent of 2 g and contains 12 g of water, what is f, the mechanical equivalent of heat, for a temperature rise of $5.0^{\circ} C$?

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5. The temperature of a silver bar rised by 10.0°C when it absorbs $1.23kJ$ of energy by heat. The mass of bar is 525g. Determine the specific heat of silver.

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6. A 60 kg boy running at $5.0m/s$ while playing basketball falls down on the floor and skids along on his leg until he stopes. How many calories of heat are generated between his leg and the floor? Assume that all this heat energy is confined to a volume of $2.0cm^3$ of his flesh. What will be temperature change of the flesh? Assume $c = 1.0\frac{cal}{g^\circ C}$ and $\rho = 950\frac{kg}{m^3}$ for flesh.

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7. An electric heater supplies 1.8 kW of power in the form of heat to a tank of water. How long will it take to heat the 200 kg of water in the tank from 10° to 70°C ? Assume heat losses to the surroundings to be negligible.

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8. What is wrong with following statement Given any two bodies, the one with the higher temperature contains more heat.

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9. Two bodies have the same heat capacity. If they are combined to form a single composite body, show that the equivalent specific heat of this composite body is independent of the masses of the individual bodies.

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10. The air temperature above coastal areas is profoundly influenced by the large specific heat of water. One reason is that the energy released when $1m^3$ of water cools by $1^\circ C$ will raise the temperature of a much larger volume of air by $1^\circ C$. Find this volume of air. The specific heat of air is approximately $1kJ/kg^{\circ}C$. Take the density of air to be $1.3kg/m^3$.

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11. Some water at $0^{\circ}C$ is placed in a large insulated enclosure (vessel). The water vapour formed is puped out continuously. What fraction of the water will ultimately freeze, if the latent heat of vapourization is seven times the latent heat of fusion?

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12. Calculate the heat of fusion of ice from the following data of ice at $0^{\circ}C$ added to water. Mass of calorimeter $= 60g$, mass of calorimeter $+$ water $= 460g$,

mass of calorimeter $+$ water $+$ ice $= 618g$, initial temperature of water $= 38^{\circ}C$, final temperature of the mixture $= 5^{\circ}C$. The specific heat of calorimeter $= 0.10 cal / g / ^{\circ} C$. Assume that the calorimeter was also at 0°C initially

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13. A piece of ice of mass of $100 g$ and at temperature $0^{\circ} C$ is put in $200 g$ of water of $25^{\circ} C$ .How much ice will melt as the temperature of the water reaches $0^{\circ} C$? The specific heat capacity of water $= 4200 J kg^{-1} K^{-1}$ and the specific latent heat of ice $= 3.4 \times 10^{5} J kg^{-1}$

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14. How should 1 kg of water at $5^{\circ} C$ be divided into two parts so that if one part turned into ice at $0^{\circ} C$, it would release enough heat to vapourize the other part? Latent heat of steam $= 540 cal / g$ and latent heat of ice $= 80 cal / g$.

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15. When a block of metal of specific heat $0.1 cal / g / ^\circ C$ and weighing 110 g is heated to $100^\circ C$ and then quickly transferred to a calorimeter containing $200 g$ of a liquid at $10^\circ C$, the resulting temperature is $18^\circ C$. On repeating the experiment with 400 g of same liquid in the same calorimeter at same initial temperature, the resulting temperature is $14.5^\circ C$. find

a. Specific heat of the liquid.

b. The water equivalent of calorimeter.

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16. The temperature of equal masses of three different liquids A, B and C are $12.^\circ C$, $19.^\circ C$ and $28.^\circ C$ respectively. The temperature when A and B are mixed is $16.^\circ C$ and when B and C are mixed is $23^\circ C$. The temperature when A and C are mixed is

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17. A tube leads from a flask in which water is boiling under atmospheric pressure to a calorimeter. The mass of the calorimeter is 150 g, its specific heat capacity is $0.1 cal / g / ^\circ C$, and it contains originally 340g of water at $15^\circ C$. Steam is allowed to condense in the colorimeter until its temperature increases to $71^\circ C$, after which total mass of calorimeter and contents are found to be 525g. Compute the heat of condensation of steam.

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18. Determine the final result when 200g of water and 20 g of ice at $0^\circ C$ are in a calorimeter having a water equivalent of 30g and 50 g of steam is passed into it at $100^\circ C$

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19. What will be the final temperature when 150 g of ice at $0^{\circ} C$ is mixed with 300 g of water at $50^{\circ} C$. Specific heat of water $= 1cal / g /^{\circ} C$. Latent heat of fusion of ice $= 80cal / g$.

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20. In a calorimeter (water equivalent $= 40g$) are 200g of water and 50 g of ice all at $0^{\circ} C$. 30 g of water at 90°C is poured into it. What will be the final condition of the system?

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21. $1kg$ ice at $-20^{\circ} C$ is mixed with $1kg$ steam at $200^{\circ} C$. The equilibrium temperature and mixture content is

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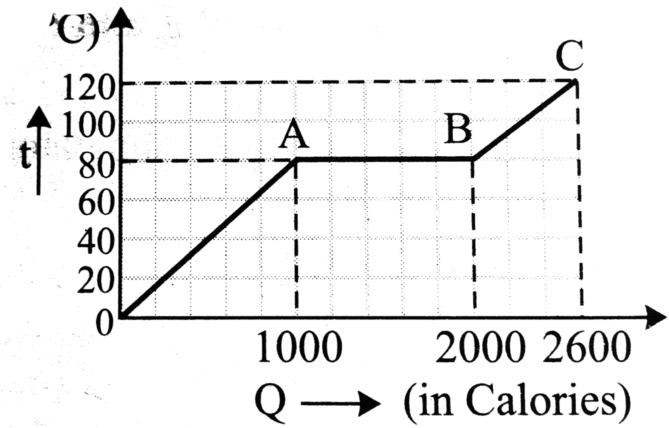

22.

A substance is in the solid form at 0° C. The amount of heat added to this substance and its temperature are plotted in the following graph. If the relative specific heat capacity of the solid substance is 0.5, find from the graph (i) the mass of the substance, (ii) the specific latent heat of the melting process and (ii) the specific heat of the substance in the liquid state.

Specific heat capacity of water $= 1000 cal / kg / K$

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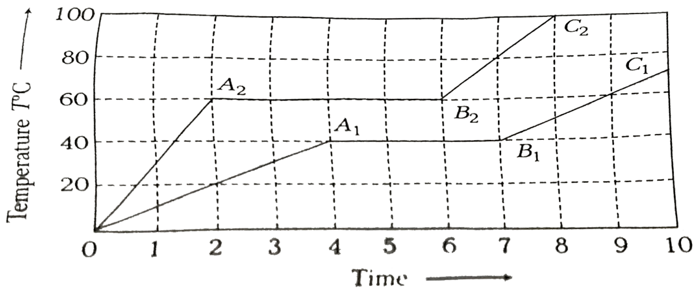
23. Two bodies of equal mass m are heated at a uniform rate under identical conditions . Their change in temperature are shown graphically in figure .

(i) what are their melting points ?

(ii) what is the ratio of their latent heats?

(iii) what is the ratio of their specific heats?



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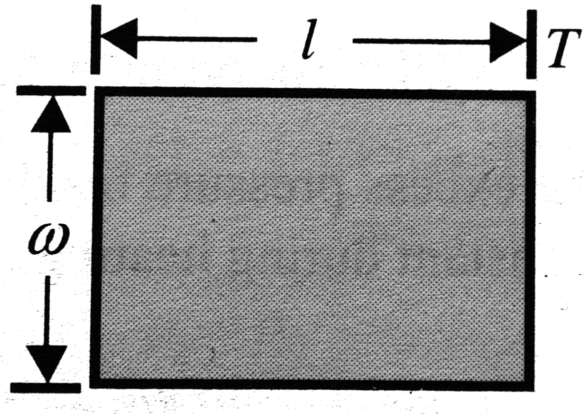

24.

The rectangular plate shown if Fig. 1.7 has an area A_i. If the temperature increases by ΔT, each dimension increases according to $\Delta L = \alpha L \Delta T$, where α is the average coefficient of linear expansion. Show that the increase in area is $\Delta A = 2\alpha A_i \Delta T$. What approzimation does this expansion assume?

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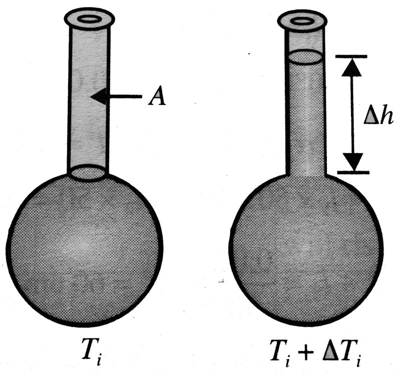

25.

A mercury thermometer is constructed as shown if Fig. 1.9. The capillary tube has a diameter of 0.004 00 cm, and the bulb has a diameter of 0.250 cm. neglecting the expansion of the glass, find the change in height of the mercury column with a temperature change of $30.0^\circ C$.

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26. A metal rod (A) of $25cm$ length expands by $0.050cm$ when its temperature is raised from $0^\circ C$ to $100^\circ C$. Another rod (B) of a different metal of length $40cm$ expands by $0.040cm$ for the same rise in temperature. A third rod (C) of $50cm$ length is made up of pieces of rods (A) and (B) placed end to end expands by $0.03cm$ on heating from $0^\circ C$ to $50^\circ C$. Find the lengths of each portion of the composite rod.

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27. Determine the lengths of an iron rod and copper ruler at 0° C if the difference in their lengths at 50°C and 450°C is the same and is equal to 2 cm. the coefficient of linear expansion of iron $= 12 \times 10^{-6} / K$ and that of copper $= 17 \times 10^{-6} / K$.

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28. A steel ball initially at a pressure of $1.0 \times 10^5 Pa$ is heated from $20^\circ C$ to $120^\circ C$ keeping its volume constant. Find the pressure inside the ball. Coefficient of linear expansion of steel $= 12 \times 10^{-6} C^{-1}$ and bulk modulus of steel $= 1.6 \times 10^{11} Nm^{-2}$

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29. A steel rail 30 m long is firmly attached to the roadbed only at its ends. The sun raises the temperature of the rail by $5^{\circ} C$, causing the rail to buckle. Assuming that the buckled rail consists of two straight parts meeting in the centre, calculate how much the centre of the rail rises. coefficient of linear expansion of steel is $12 \times 10^{-6} / K$.

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30. A small quantity of a liquid which dows not mix with water sinks to the bottom at 20°C, the densities of the liquid and water being 1021 and $990 kg / m^{3}$, respectively. To what teperature must the mixture be uniformly heated in order that the liquid forms globules which just float on water ? the cubical expansion of the liquid and water over the temperature ranges is $85 \times 10^{-5} / K$ and $45 \times 10^{-5} / K$ respectively.

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31. A one litre flask contains some mercury. It is found that at different temperatures the volume of air inside the flask remains tha same. What is the volume of mercury in the flask? Given the cofficients of linear expansion of glass is $9 \times 10^{-6} / ^\circ C$ and the coefficient of volume expansion of mercury is $1.8 \times 10^{-4} / ^\circ C$

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32. A hollow aluminium cylinder 20.0 cm deep has an internal capacity of 2.000 L at 20.0° C. It is completely filled with tupentine and then slowly warmed to 80.0°C a. How much turpentine

overflows? B. If the cylindre is then cooled back to 20.0°C, how far below the cylinder's rim dows the tupentine's surface recede?

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33. A glass flask whose volume is exactly 1000cm^3 at $0^{\circ}C$ is filled level full of mercury at this temperature. When the flask and mercury are heated to $100^{\circ}C$, $15.2cm^3$ of mercury overflows. The coefficient of cubical expansion of Hg is $1.82 \times 10^{-4} / {}^{\circ}C$. Compute the coefficient of linear expansion of glass.

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34. A $250cm^3$ glass bottle is completely filled with water at $50^{\circ}C$. The bottle and water are heated to $60^{\circ}C$. How much water runs over if:

a. the expansion of the bottle is neglected:

b. the expansion of the bottle is included? Given the coefficient of areal expansion of glass $\beta = 1.2 \times 10^{-5} / K$ and $\gamma_{\text{water}} = 60 \times 10^{-5} /^{\circ} C$.

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35. A solid floats in a liquid at 20°C with 75 % of it immersed. When the liquid is heated to 100°C, the same solid floats with $80\,\%$ of it immersed in the liquid. Calculate the coefficient of expansion of the liquid. Assume the volume of the solid to be constant.

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36. A sinker of weight w_0 has an apparent weight w_1 when weighed in a liquid at a temperature t_1 and w_2 when weight in the same liquid at temperature t_2. The coefficient of cubical expansion of the material of sinker is β. What is the coefficient of volume expansion of the liquid.

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37. A copper and a tungsten plate having a thickness $\sigma = 2$mm eacha re riveted together so that at 0°C They form a flat bimetallic plate. Find the average radius of cuvature of this plate at $t = 200^\circ C$. The coefficients of linear expansion for copper and tungsten are $\alpha_{cu} = 1.7 \times 10^{-5} / K$ and $\alpha_W = 0.4 \times 10^{-5} / K$, respectively.

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38. A clock with a brass pendulum shaft keeps correct time at a certain temperature.

a. How closely must the temperature be controlled if the clock is not to gain or lose more that 1 s a day? Does the answer depend on the period of the pendulum?

b. Will an increase of temperature cause the clock to gain or lose? $(\alpha_{\text{brass}} = 2 \times 10^{-5} /^\circ C)$

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39. A pendulum clock loses 12 s a day if the temperature is 40° and gains 4 s a day if the temperature is $20^\circ C$. The temperature at which the clock will show correct time, and the co-efficient of linear expansion (α) of the metal of the pendulum shaft are respectively :

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40. A rod of length 2 m is at a temperature of 20° C. find the free expansion of the rod, if the temperature is increased to 50°C, then find stress produced when the rod is (i) fully prevented to expand, (ii) permitted to expand by 0.4mm. $Y = 2 \times 10^{11} N/m^2, \alpha = 15 \times 10^{-6/\circ} C.$

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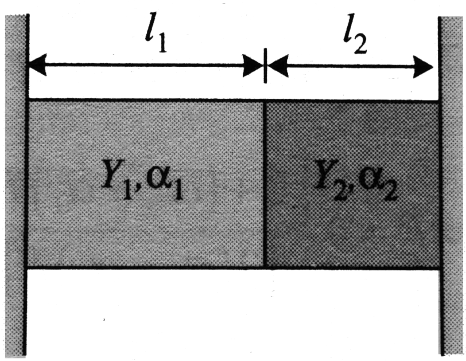
41. Two rods of different metals having the same area of cross section A are placed between the two massive walls as shown is Fig. The first rod has a length l_1, coefficient of linear expansion α_1 and Young's modulus Y_1. The correcsponding quantities for second rod are l_2, α_2 and Y_2. The temperature of both the rods is now raised by $t^\circ C$.

i. Find the force with which the rods act on each other (at higher temperature) in terms of given quantities.

ii. Also find the length of the rods at higher temperature.



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42. Two rods of equal cross sections, one of copper and the other of steel, are joined to form a composite rod of length 2.0 m at $20^\circ C$, the length of the copper rod is 0.5 m. When the temperature is raised to $120^\circ C$, the length of composite rod increases to 2.002m. If the composite rod is fixed between two rigid walls and thus not allowed to expand, it is found that the lengths of the component rods also do not change with increase in temperature. Calculate Young's moulus of steel. (The coefficient of linear expansion of copper, $\alpha_c = 1.6 \times 10^{-5\circ} C$ and Young's modulus of copper is $1.3 \times 10^{13} N/m^2$).

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43. A surveyor's 30 m steel tape is correct at a temperature of $20^\circ C$. The distance between two points, as measured by this tape on a day when the temperature is $35^\circ C$. Is 26m. What is the true distance between the point?

$(a_{\text{steel}} = 1.2 \times 10^{-5} {}^{\circ}C)$

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44. A barometer with a brass scale reads 755 mm on a day when the temperatures is $25^{\circ}C$. If the scale is correctly graduated at $0^{\circ}C$, find the true pressure at $0^{\circ}C$ (interms of height of Hg) given that the coefficient of linear expansion of brass is $18 \times 10^{-6} / K$. Coefficient of cubical expansion of mercury $= 182 \times 10^{-6} / K$.

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45. At room temperature $(25^{\circ}C)$ the length of a steel rod is measured using a brass centimetre scale. The measured length is 20 cm. If the scale is calibrated to read accurately at temperature $0^{\circ}C$, find the actual length of steel rod at room temperature.

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46. A refrigerator door is 150 cm high, 80 cm wide, and 6 cm thick. If the coefficient of conductivity is 0.0005 $cal/cms^{\circ}C$ and the inner and outer surfaces are at $0^{\circ}C$ and $30^{\circ}C$, respectively, what is the heat loss per minute through the door, in calories?

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47. A refrigerator is thermally equivalent to a box of cork board 90 mm thick and $6m^2$ in iner surface area, the thermal conductivity of cork being $0.05W/mK$. The motor of the refrigerator runs 15% of the time while the door is closed. The inside wall of the door, when it is closed is kept, on an average, $22^{\circ}C$ below the temperature of the outside wall. The rate at which heat is taken from the interior wall while the motor is running is

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48. Water is being boiled in a flat bottomed kettle placed on a stove . The area of the bottom is $300cm^2$ and the thickness is 2 mm. If the amount of steam produced is 1 g $\min^{-1}$, then the difference of the temperature between the inner and outer surfaces of the bottom is (thermal conductivity of the material of the lettle = $0.5calcm^{-1}\hat{}(\circ)Cs^{-1}$ and latent heat of the steam is equal to to $540calg^{-1}$)

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49. A closed cubical box is made of perfectly insulating material and the only way for heat to enter or leave the box is through two solid cylindrical metal plugs, each of cross sectional area $12cm^2$ and length 8cm fixed in the opposite walls of the box. The outer surface of one plug is kept at a temperature of $100^\circ C$. while the outer surface of the plug is maintained at a temperature of $4^\circ C$. The thermal conductivity of the material of the plug is $2.0 W m^{-1} C^{-1}$. A source of energy generating 13W is enclosed inside the box. Find the equilibrium temperature of the inner surface of the box assuming that it is the same at all points on the inner surface.

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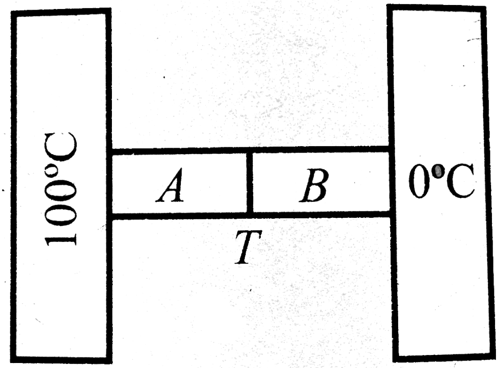
50. Two metal cubes A and B of same size are arranged as shown in figure. The extreme ends of the combination are maintained at the indicated temperature. The arrangement is thermally insulated. The coefficients of thermal conductivity of A and B are $300 W / m^\circ C$ and $200 W / m^\circ C$, respectively. After steady state is reached, the temperature t of the interface will be______.



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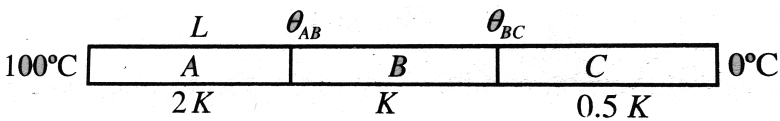

51.

Three cylindrical rods A, B and C of equal lengths and equal diameters are joined in series as shown if Fig. Their thermal conductivities are 2K, K and 0.5K, respectively. In steady state, if the free ends of rods A and C are at $100^\circ C$ and $0^\circ C$, respectively, calculate the temperature at the two junction points. Assume negligible loss by radiaiotn through the curved surface. What will be the equivalent thermal conductivity?

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52. Two walls of thickness in the ratio 1:3 and thermal conductivities in the ratio 3:2 form a composite wall of a building. If the free surfaces of the wall be at temperatures $30^\circ C$ and $20^\circ C$, respectively, what is the temperature of the interface?

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53. One end of a uniform brass rod 20 cm long and $10cm^2$ cross-sectional area is kept at $100^\circ C$. The other end is in perfect thermal contact with another rod of identical cross-section and length 10 cm. The free end of this rod is kept in melting ice and when the steady state has been reached, it is found that 360 g of ice melts per hour. Calculate the thermal conductivity of the rod, given that the thermal conductivity of brass is $0.25 cal/s cm^{\circ} C$ and $L = 80 cal/g$.

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54. An electric heater is used in a room of total wall area $137 m^2$ to maintain a temperature of $20^{\circ} C$ inside it, when the outside temperature is $-10^{\circ} C$ .The walls have three different layers of materials. The innermost layer is of wood of thickness 2.5cm, the middle layer is of cement of thickness 1.0cm and the outermost layer is of brick of thickness 25.0cm. Find the power of the electric heater. Assume that there is no heat loss through the floor and the celling. The thermal conductivities of wood, cement and brick are $0.125 Wm^{-1} C^{-1}$, $1.5 Wm^{-1} C^{-1}$. and $1.0 Wm^{-1} C^{-1}$ respectively.

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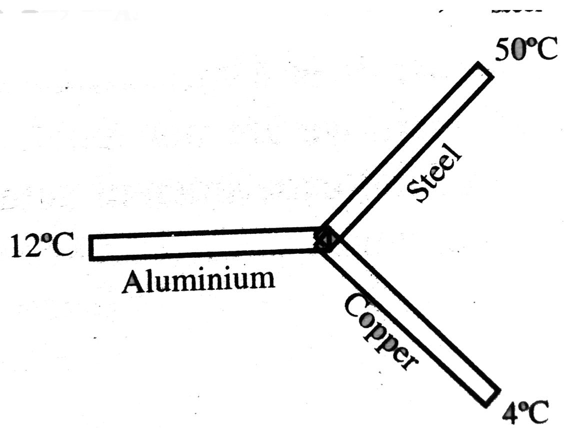

55.

Three identical rods of length 1 m each, having cross-sectional area of $1cm^2$ each and made of aluminium, copper and steel, respectively, are maintained at temperatures of $12^\circ C$,$4^\circ C$ and $50^\circ C$, respectively, at their separate ends. Find the teperature of their common junction.

$[K_{Cu} = 400W/m - K, K_{Al} = 200W/m - K, K_{\text{steel}} = 50W/m - K]$

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56. An electric heater of surface area $200cm^2$ emits radiant energy of 60 kJ at time interval of 1 min. Determine its emissive power. If its emissivity be 0.45, what would be the radiant energy emitted by a black body in one hour, identical to the electrical heater in all respects?

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57. A spherical black body with a radius of 12 cm radiates 450 watt power at $500K$. if the radius were halved and the temperature doubled, the power radiated in watt would be

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58. The operating temperature of an in candescent bulb (with tungsten filament) of power 60 W is 3000 K. If the surface area of the filament be 25 mm^2, find its emissivity e.

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59. A copper sphere is suspended in an evacuated chamber maintained at 300 K . The sphere is maintained at a constant temperature of 500 K by heating it electrically. A total of 210 W of electric power is needed to do it. When the surface of the copper sphere is completely blackened, 700 W is needed to maintain the same temperature of the sphere. Calculate the emissivity of copper.

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60. Two bodies A and B have thermal emissivities of 0.01 and 0.81 respectively. The outer surface areas of the two bodies are same. The two bodies emit total radiant power at the same rate. The wavelength λ_B corresponding to maximum spectral radiancy 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, calculate (a) the temperature of B, (b) wavelength λ_B.

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61. The emissivity of tungsten is aproximately 0.35. A tungsten sphere 1 cm in radius is suspended within a large evacuated enclosure whose walls are at 300 K. What power input is required to maintain the sphere at a temperature of 3000 K if heat conduction along the support is neglected?$\sigma = 5.67 \times 10^{-8}$ SI units.

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62. A solid copper sphere of density ρ, specific heat c and radius r is at temperature T_1. It is suspended inside a chamber whose walls are at temperature $0K$. What is the time required for the temperature of sphere to drop to T_2? Take the emmissivity of the sphere to be equal to e.

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63. Two solid copper spheres of radii $r_1 = 15cm$ and $r_2 = 20cm$ are both at a temperature of 60°C. If the temperature of surrounding is $50^\circ C$, then find

a. The ratio of the heat loss per second from their surfaces initially.

b. the ratio of rates of cooling initially.

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64. Two identical spheres A and B are suspended in an air chamber which is maintained at a temperature of $50^\circ C$. Find the ratio of the heat lost per second from the surface of the spheres if

a. A and B are at temperatures $60^\circ C$ and $55^\circ C$, respectively.

b. A and B are at temperatures $250^\circ C$ and $200^\circ C$, respectively.

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65. A body cools down from $60\% =^{\circ} C$ to $55^{\circ} C$ in 30 s. Using newton's law of cooling calculate the time takken by same body to cool down from $55^{\circ} C$ to $50^{\circ} C$. Assume that the temperature of surrounding is $45^{\circ} C$.

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66. 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

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67. A thin brass rectangular sheet of sides 10 cm and 5 cm is heated in a furnace to 500° C and taken out. How much electric power is needed to maintain the sheet at this temperature ? Its emissivity is 0.25.

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68. A hot body placed in air is cooled down according to Newton's law of cooling, the rate of decrease of temperature being k times the temperature difference from the surrounding. Starting from $t = 0$, find the time in which the body will lose half the maximum heat it can lose.

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69. The spectral energy distribution of the sun has a maximum at 4754Å. If the temperature of the sun is 6050 K, what is the temperature of a star for which this maximum is at 9506Å?

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70. The light from th sun is found to have a maximum intensity near the wavelength of $470nm$. Assuming that the surface of the sun emits as a blackbody, calculate the temperature of the surface of the sun.

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71. If the filament of a 100 W bulb has an area $0.25cm^2$ and behaves as a perfect black body. Find the wavelength corresponding to the maximum in its energy distribution. Given that Stefan's constant is $\sigma = 5.67 \times 10^{-8} J/m^2 sK^4$.

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72. A hot black body emits the enegy at the rate of 16 $Jm^{-2}s^{-1}$ and its most intense radiation corresponds to 20000Å. When the temprerature of this body is further increased and its most intense radiation corresponds to 10000Å, then find the value of energy radiated in $Jm^{-2}s^{-1}$.

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73. The intensity of solar radiation just outside the earth's atmosphere is measured to be $1.4kW/m^2$. If the radius of the sun $7 \times 10^8 m$, while the earth-sun distance is $150 \times 10^6 km$, then find

i. the intensity of salr radiation at the surface of the sun.

ii. the temperature at the surface of the sun assuming it to be a black body,

iii. the most probable wavelength in solar radiation.

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74. The earth receives solor radiation at a rate of $8.2 Jcm^{-2}\min^{-1}$. Assuming that the sun radiates like a blackbody, calculate the surface temperature of the sun. The angle subtended by the sun on the earth is 0.53° and the stefan constant $\sigma = 5.67 \times 10^{-s} Wm^{-2} K^{-4}$

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75. Consider a cylindrical container of cross-section area A length h and having coefficient of linear expansion α_c. The container is filled by liquid of real expansion coefficient γ_L up to height h_1. When temperature of the system is increased by $\Delta\theta$ then

(a). Find out the height, area and volume of cylindrical container and new volume of liquid.

(b). Find the height of liquid level when expansion of container is neglected.

(c). Find the relation between γ_L and α_c for which volume of container above the liquid level

(i) increases

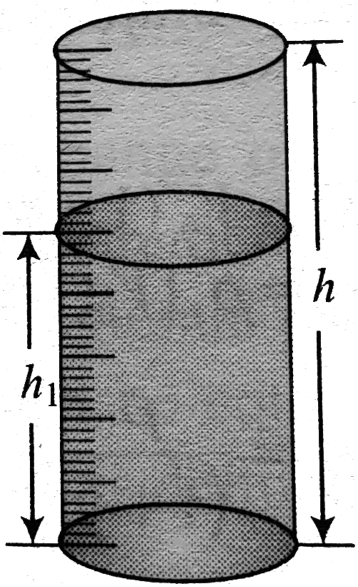
(ii). decreases

(iii). remains constant.

(d). On the surface of a cylindrical container a scale is attached for the measurement of level of liquid of liquid filled inside it. If we increase the temperature of the temperature of the system by $\Delta\theta$, then

(i). Find height of liquid level as shown by the scale on the vessel. Neglect expansion of liquid.

(ii). Find the height of liquid level as shown by the scale on the vessel. Neglect expansion of container.



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Exercise 1.1

1. The greater the mass of a body the greater is its heat capacity is this true of false?

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2. The greater the mass of a body , the greater is its latent heat capacity. Is this true of false?

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3. The greater the mass of a body, the greater is its specific heat capacity. True of false?

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4. Can heat be added to a substance without causing the temperature of the body of rise? If so does this contradict the concept of heat as energy in the process of transfer because of temperature differece?

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5. Can heat be considered to be a form of stored energy?

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6. Give an example of a process in which no heat is transferred to or from a system but the temperature of the system changes?

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7. The latent heat of fusion of a substance is always less than the latent heat vapourization . Explain.

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8. Suppose an astronaut on the surface of the moon took some water at about $20^\circ C$ out of his thermos and poured it into a glass bbeaker. What would happen to the water?

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9. Heat is added to a body. Does its temperature necessarily increase?

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10. When a hot body warms a cool one, are their temperature changes equal in magnitude?

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11. Steam at $100^{\circ} C$ is passed into a calorimeter of water equivalent 10 g containing 74 cc of water and 10 g of ice at $0^{\circ} C$. If the temperature of the calorimeter and its contents rises to $5^{\circ} C$, calculate the amount of steam passed. Latent heat of steam $= 540 kcal / kg$, latent heat of fusion $= 80 kcal / kg$.

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12. Ice of mass 600 kg and at a temperature of $-10^{\circ} C$ is placed in a copper vessel heated to $350^{\circ} C$. The resultant mixture is 550 g of ice and water. Find the mass of the vessel. The specific heat capacity of copper $(c) = 100 cal / kg - K$

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13. When a small ice crystal is placed in overcooled water it begins to freeze instantaneously.

i. What amount of ice is formed from 1 kg of water over cooled to $-8^\circ C$? L of water $= 336 \times 10^3 J/kg$ and s of water $= 4200 J/kg/K$.

ii. What should be the temperature of the overcooled water in order that all of it be converted into ice at $0^\circ C$?

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14. An electric heater whose power is 54 W is immersed in $650 cm^3$ water in a calorimeter. In 3 min the water is heated by $3.4^\circ C$. What part of the energy of the heater passes out of the calorimeter in the form of radiant energy?

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15. An ice cube whose mass is 50 g is taken from a refrigerator where its temperature was $-10^{\circ} C$. If no heat is gained or lost from outside, how much water will freeze onto the cube if it is dropped into a beaker containing water at $0^{\circ} C$? Latent heat of fusion $= 80 kcal / kg$, specific heat capacity of ice $= 500 cal / kg / K$.

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16. Equal volumes of three liquids of densities ρ_1,ρ_2 and ρ_3, specific heat capacities c_1, c_2 and c_3 and temperatures t_1, t_2 and t_3, respectively are mixed together. What is the temperature of the mixture? Assume no changes in volume on mixing.

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17. Victoria falls in Africa is 122 m in height. Calculate the rise in temperature of the water if all the potential energy lost in the fall is converted into heat.

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18. Equal masses of three liquids A,B and C are taken. Their initial temperature are $10^{\circ}C, 25^{\circ}C$ and $40^{\circ}C$ respectively. When A and B are mixed the temperature of the mixutre is $19^{\circ}C$. When B and C are mixed, the temperature of the mixture is $35^{\circ}C$. Find the temperature if all three are mixed.

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19. An earthen pitcher loses 1 g of water per minute due to evaporation. If the water equivalent of pitcher is 0.5 kg and the pitcher contains 9.5 kg of water, calculate the time required for the water in the pitcher to cool to $28^{\circ}C$ from its original temperature of $30^{\circ}C$ Neglect radiation effect. Latent heat of vapourization of water in this range of temperature is 580 cal/g and specific heat of water is $1kcal/gC^{\circ}$

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20. A certain amount of ice is supplied heat at a constant rate for 7 minutes. For the first one minute the temperature rises uniformly with time. Then, it remains constant for the next 4 minute and again the temperature rises at uniform rate for the last two minutes. Calculate the final temperature at the end of seven minutes.

(Given, L of ice $= 336 \times (10^3) J/kg$ and specific heat of water $= 4200 J/kg. K$).

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21. 1 g of ice at $0^\circ C$ is mixed with 1 g of steam at $100^\circ C$. After thermal equilibrium is achieved, the temperature of the mixture is

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22. The ratio of the densities of the two bodies is $3:4$ and the ratio of specific heats is $4:3$ Find the ratio of their thermal capacities for unit volume?

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23. In following equiation calculate value of H: 1kg ice at $-20^\circ C = H + 1$kg water at $100^\circ C$, here H means heat required to change the state of substance.

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Exercise 1.2

1. Does the change in volume of a body when its temperature is raised depend on whether the body has cavities inside, other things being equal?

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2. Explain why some rubber-like substances contract with rising temperature.

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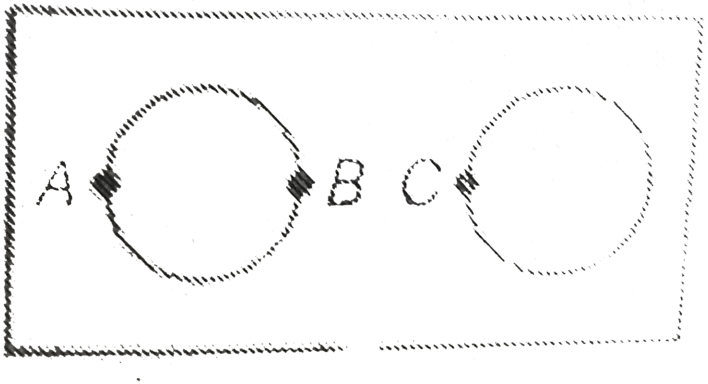
3. Two large holes are cur in a metal sheet. If this is heated, distance AB and BC, (as shown)



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4. Two large holes are cut in a metal sheet will the distance between the holes increase or decrease on heating?

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5. A long metal rod is bent to form a ring with a small gap if this is heated, will this gap increase or decrease?

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6. Two iron spheres of the same diameter are heated to the same temperature. One is soled, and the other is hollow which will expand more?

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7. A steel rod is 3.000 cm at $25^{\circ} C$. A brass ring has an interior diameter of 2.992 cm at $25^{\circ} C$. At what common temperature will the ring just slide on to the rod?

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8. A clock with a metal pendulum beating seconds keeps correct time at $0^{\circ} C$. If it loses 12.5 s a day at $25^{\circ} C$, the coefficient of linear expansion of metal of pendulum is

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9. An iron rod and a copper rod lie side by side. An the temperature is changed, the difference in the length of the rods remains constant at a value of 10 cm. Find the lengths at $0^{o}C$. Coefficients of linear expansion of iron and copper are $1.1 \times 10^{-5} C^{-1}$ and $1.7 \times 10^{-5} C^{-1}$ respectively.

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10. A metal rod of 30 cm length expands by 0.075 cm when its temperature is raised from $0^{\circ} C$ to $100^{\circ} C$. Another rod of a different metal of length 45 cm expands by 0.045 cm for the same rise in temperature. A composite rod C made by joining A and B end to end expands by 0.040 cm when its length is 45 cm and it is heated from $0^{\circ} C$ to $50^{\circ} C$. Find the length of each portion of the composite rod.

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11. A brass scale is graduated at $10^{\circ} C$. What is the true length of a zinc rod which measures 60.00 cm on this scale at $30^{\circ} C$?

Coefficient of linear expansion of brass $= 18 \times 10^{-6} K^{-1}$.

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12. A long horizontal glass capillary tube open at both ends contains a mercury thread 1 m long at $0^{\circ} C$. Find the length of the mercury thread, as read on this scale, at $100^{\circ} C$.

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13. A mercury in glass thermometer has a stem of internal diameter 0.06 cm and contains 43 g of mercury. The mercury thread expands by 10 cm when the temperature changes from $0^{\circ} C$ to $50^{\circ} C$. Find the coefficient of cubical expansion of mercury. Relative density of mercury $= 13.6$ and $\alpha_{\text{glass}} = 9 \times 10^{-6} / K$.

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14. A sphere of diameter $7cm$ and mass $266.5g$ floats in a bath of liquid. As the temperature is raised, the sphere just sinks at a temperature of $35^{\circ} C$. If the density of the liquid at $0^{\circ} C$ is $1.527g/cm^3$, find the coefficient of cubical expansion of the liquid. ignore expansion of sphere.

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15. A mercury thermometer is to be made with glass tubing of internal bore 0.5 mm diameter and the distance between the fixed point is to be 20 cm. Estimate the volume of the bulb below the lower fixed point, given that the coefficient of cubical expansion of mercury is $0.00018/K$. and the coefficient of linear expansion of glass is $0.000009/K$.

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16. On a Celsius thermometer the distance between the readings $0^\circ C$ and $100^\circ C$ is 30cm and the area of cross section of the narrow tube containing mercury is $15 \times 10^{-4} cm^2$. Find the total volume of mercuty in the thermometer at $0^\circ C. \alpha$ of glass $= 9 \times 10^{-6} / K$ and the coefficient of real expansion of mercury $= 18 \times 10^{-5} / K$.

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17. The height of a mercury column measured with a brass scale, which is correct and equal to H_0 at $0^\circ C$, is H_1 at $t^\circ C$? The coefficient of linear expansion of brass is α and the coefficient of linear expansion of brass is α and the corfficient of volume expansion of mercury is γ. Relate H_0 and H_1.

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18. A glass bulb contains air and mercury. What fraction of the bulb must be occupied by mercury if the volume of air in the bulb is to remain constant at all temperatures? The coefficent of linear expansion of glass is $9 \times 10^{-6} / K$.

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19. Two rods of equal cross sections, one of copper and the other of steel, are joined to form a composite rod of length 2.0 m at $20^\circ C$, the length of the copper rod is 0.5 m. When the temperature is raised to $120^\circ C$, the length of composite rod increases to 2.002m. If the composite rod is fixed between two rigid walls and thus not allowed to expand, it is found that the lengths of the component rods also do not change with increase in temperature. Calculate Young's moulus of steel. (The coefficient of linear expansion of copper, $\alpha_c = 1.6 \times 10^{-5 \circ} C$ and Young's modulus of copper is $1.3 \times 10^{13} N / m^2$).

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20. A glass vessel measures exactly 10cm xx 10 cm xx 10 cm at $0^{\circ} C$. It is filled completely with mercury at this temperature. When the temperature is raised to $10^{\circ} C$, $1.6 cm^{3}$ of mercury overflows. Calculate the coefficient of volume expansion of mercury. coefficient of linear expansion of glass $= 6.5 \times 10^{-6} C^{-1}$.

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21. A metal ball immersed in alcohol weighs w_1 $\text{at} 0^{\circ} C$ $\text{and} w_2$ at $59^{\circ} C$. The coefficient of cubical expansion of the metal is less than that of alcohol. Assuming that the density of the metal is large compared to that of alcohol, it can be shown that

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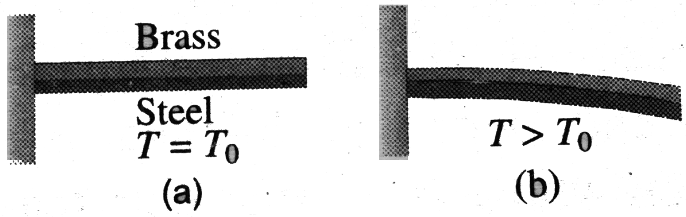

22.

In figure which strip (brass or steel) has higher coefficient of linear expansion.

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Exercise 1.3

1. Explain why the surface of a lake freezes first.

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2. In newton's law of cooling in the form

$$\frac{d\Delta\theta}{dt} = -k\Delta\theta$$

What factors does the constant k depend upon? What are the dimensions of k?

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3. A 'thermacole' 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 $45^{\circ}C$, and co-efficient of thermal conductivity of thermacole is $0.01 Js^{-1}m^{-1}K^{-1}$. [Heat of fusion of water $= 335 \times 103 Jkg^{-1}$]

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4. A brass boiler has a base area of 0.15m^2 and thickness is 1.0cm. It boils water at the rate of $6.0\text{kg}/\text{min}$. When placed on a gas stove. Estimate the temperature of the part of the flame in contact. With the boiler. Thermal conductivity of brass $= 109\text{Wm}^{-1}\text{K}^{-1}$

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5. An electric heater is placed inside a room of total wall area $137m^2$ to maintain the temperature inside at $20^\circ C$. The outside temperature is $-10^\circ C$. The walls are made of three composite materials. The inner most layer is made of wood of thickness 2.5 cm the middle layer is of cement of thickness 1 cm and the exterior layer is of brick of thickness 2.5 cm. Find the power of electric heater assuming that there is no heat losses through the floor and ceiling. The thermal conductivities of wood, cement and brick are $0.125W/m.^\circ C$, $1.5W/m.^\circ C$ and $1.0W/m.^\circ C$ respectively.

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6. An indirectly heated filament is radiating maximum energy of wavelength $2.16 \times 10^{-5} cm$. Find the net amount of heat energy lost per second per unit area, the temperature of the surrounding air is $13^{\circ} C$. Given $b = 0.288 cm - K. \sigma = 5.77 \times 10^{-5} erg / s - cm^2 - K^4$).

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7. A uniform copper bar 100 cm long is insulated on side, and has its ends exposed to ice and steam respectively. If there is a layer of water 0.1 mm thick at each end, calculate the temperature gradient in the bar. $K_{Cu} = 1.04$ and $K_{water} = 0.0014$ in CGS units.

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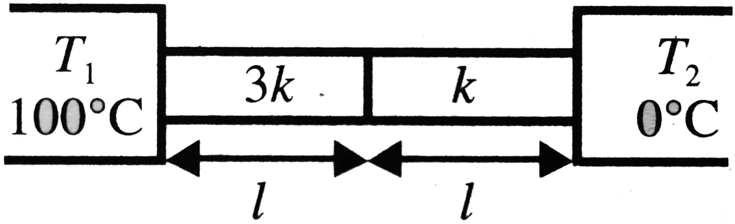

8.

Two rods A and B of same length and cross-sectional area are connected in series and a temperature difference of $100^{\circ} C$ is maintained across the combination as shoen in Fig. If the thermal conductivity of the rod A is 3 k and that of rod B is k, Then

i.Determine the thermal resistance of each rod.

ii. determine the heat current flowing through each rod.

iii. determine the heat current flowing through each rod.

iv. plot the variation of temperature along the length of the rod.

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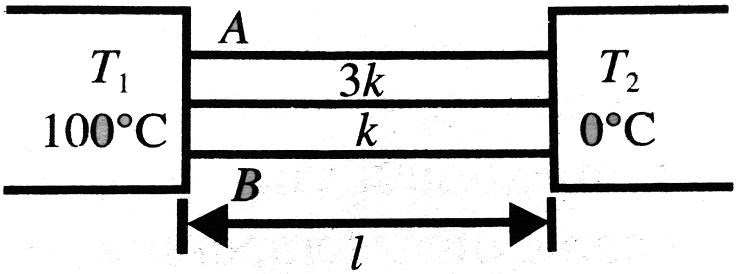
9.



Two conductors A and B are connected in parallel as shown in Fig.

i. Determine the equivalent thermal resistance.

ii. Determine the heat current in each rod.

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10. A sphere, a cube and a thin circular pate are heated to the same temperature. If they are made of same material and have equal masses, determine which of these three object cools the fastest and which one cools the slowest?

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11. One end of a brass rod of length 2.0 m and cross section $1 cm^2$ is kept in steam at $100^\circ C$ and the other end in ice at $0^\circ C$. The lateral surface of the rod is covered by heat insulator. Determine the amount of ice melting per minute. Thermal conductivity of brass is $110 W / m - K$ and specific latent heat of fusion of ice is $80 cal / g$.

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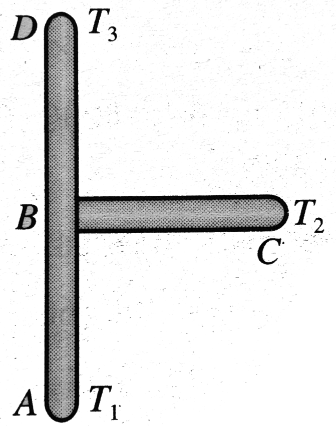
12. 

Three rods AB, BC and BD having thermal conductivities in the ratio 1:2:3 and lengths in the ratio 2:1:1 are joined as shown in Fig. The ends A, C and D are at temperature T_1,T_2 and T_3 respectively Find the temperature of the junction B. Assume steady state.

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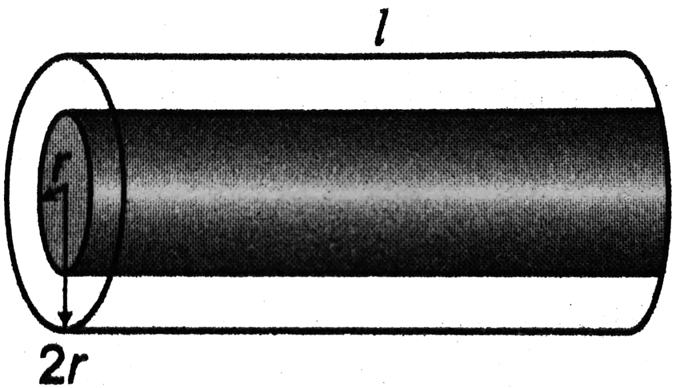
13. Thermal conductivity of inner core of radius r is K and of the outer one of radius $2r$ is 2K. Find equivalent value of thermal conductivity between its two ends.



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14. A cylinder of radius R and length l is made up of substance whose thermal conductivity K varies with the distance x from the axis as $K = K_1 x + K_2$. Determine the the effective thermal conductivity between the flat faces of the cylinder.

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15. A cube and a sphere of equal edge and radius, made of the same substance are allowed to cool under identical conditions. Determine which of the two will cool at a faster rate.

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16. A spherical ball of radius 1cm coated with a metal having emissivity 0.3 is maintained at 1000 K temperature and suspended in a vacuum chamber whose walls are maintained at 300 K temperature.

Find rate at which electrical energy is to be supplied to the ball to keep its temperature constant.

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17. A body emits maximum energy at 4253 Å and the same body at some other temperature emits maximum energy at 2342 Å. Find the ratio of the maximum energy radiated by the body in a short wavelength range.

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18. A black body at 1500K emits maximum energy of wavlength 20000 Å. If sun emits maximum energy of wavelength 5500Å, what would be the temperature of sun.

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Subjective

1. A lead ball at 25°C is dropped from a height of 2 km. It is heated due to air resistance and it is assumed that all of its kinetic energy is used in increasing the temperature of ball. Find the final temperature of the ball.

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2. The temperatures of equal masses of three different liquids A, B and C are $15^\circ C$, $20^\circ C$ and $30^\circ C$, respectively. When A and B are mixed their equilibrium temperature is $18^\circ C$. When B and C are mixed, it is $22^\circ C$ .What will be the equilibrium temperature when liquids A and C are mixed

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3. A copper cube of mass 200 g slides down a rough inclined plane of inclination $37^{\circ} C$ at a constant speed. Assuming that the loss in mechanical energy goes into the copper block as thermal energy. Find the increase in temperature of the block as it slidese down through 60 cm. Specific heat capacity of copper is equal to $420 J/kg - K. \left(Take, g = 10 m/s^{2}\right)$.

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4. Find the result of mixing 0.5 kg ice at $0^{\circ} C$ with 2 kg water at $30^{\circ} C$. Given that latent heat of ice is $L = 3.36 \times 10^{5} J/kg$ and specific heat of water is $4200 J/kg/K$.

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5. 1 g ice at $0^{\circ} C$ is placed in a calorimeter having 1 g water at $40^{\circ} C$. Find equilibrium temperature and final contents. Assuming heat capacity of calorimeter is negligible small.

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6. 1 g ice at $0^{\circ} C$ is placed in a calorimeter having 1 g water at $40^{\circ} C$. Find equilibrium temperature and final contents. Assuming heat capacity of calorimeter is negligible small.

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7. 1 g of ice at $0^{\circ} C$ is mixed with 1 g of steam at $100^{\circ} C$. After thermal equilibrium is achieved, the temperature of the mixture is

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8. A clock with a metal pendulum beating seconds keeps correct time at $0^{\circ} C$. If it loses 12.5 s a day at $25^{\circ} C$, the coefficient of linear expansion of metal of pendulum is

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9. A rod AB of length l is pivoted at an end A and freely rotated in a horizontal plane at an angular speed ω about a vertical axis passing through A. If coefficient of linear expansion of material of rod is α, find the percentage change in its angular velocity if temperature of system is incresed by ΔT

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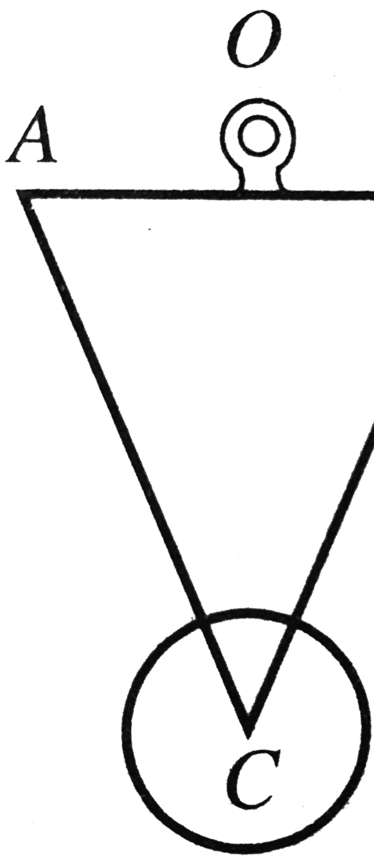

10.

A compensated pendulum shown if Fig. is in the from of an isosceles Delta of base length $l_1 = 5\text{cm}$ and coefficent of linar expansion $\alpha_1 = 18 \times 10^{-6}$ and side length l_2 and coefficient of linear expansion $\alpha_2 = 12 \times 10^{-6}$. find l_2 so the the distance of centre of mass of the bob from suspension centre O may remain the same at all the temperature.

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11. A aluminium can of cylindrical shape contains $500cm^3$ of water. The area of the inner cross section of the can is $125cm^2$. All measurements refer ti $10^\circ C$. Find the rise in the water level if the temperature increases to$80^\circ C$. The coefficient of linear expansion of aluminium $= 23 \times 10^{-6^\circ} C(-1)$ respectively.

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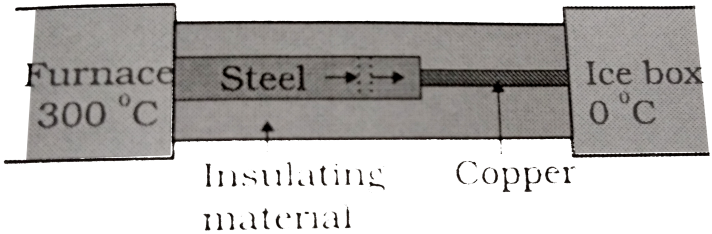
12. What is the temperature of the steel-copper junction in the steady state of the system shown in Fig. 11.15. Length of the steel rod = 15.0 cm, length of the copper rod = 10.0 cm, temperature of the furnace $= 300^\circ C$, temperature of the other end = $0^\circ C$. The area of cross section of the steel rod is twice that of the copper rod. (Thermal conductivity of steel $= 50.2 Js^{-1}m^{-1}K^{-1}$, and of copper

$= 385 J s^{-1} m^{-1} K^{-1}$).



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13. We would like to increase the length of a 15 cm long copper rod of cross section $4mm^2$ by 1 mm. The energy absorbed by the rod if it is heated is E_1. The energy absorbed by the rod if it is stretched slowly is E_2. Then find E_1 / E_2. [Various parameters of copper are density $= 9 \times 10^3 Kg / m^3$, thermal coefficient of linear expansion $= 16 \times 10^{-6} / K$, Young's modulus $= 135 \times 190 Pa$, specific heat $= 400 J / kg - K$]

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14. A uniform rod of thermal conductivity of $65J/m-s-{}^{\circ}C$ is surrounded by an insulator on its sides. One of its ends is put in a furnace, while the other end is kept exposed. If the temperature gradient of the rod is $-75^{\circ}C/m$, find the emissive power of the exposed end.

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15. A cylinderical brass boiler of radius 15 cm and thickness 1.0 cm is filled with water and placed on an elerctric heater. If the If the water boils at the rate of $200g/s$, estimate the temperature of the heater filament. Thermal conductivity of $brass = 109J/s/m^{\circ}C$ and heat of vapourization of water $= 2.256 \times 10^3 J/g$.

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16. The lower surface of a slab of stone of face-area $3600 cm^2$ and thickness $10 cm$ is exposed to steam at $100^\circ C$. A block of ice at $0^\circ C$ rests on the upper surface of the slab. $4.8 g$ of ice melts in one hour. Calculate the thermal conductivity of the stone. Latent heat of fusion of ice $= 3.36 \times 10^5 J kg^{-1}$

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17. A cube of mass 1 kg and volume $125 cm^2$ is placed in an evacuated chamber at $27^\circ C$. Initially temperature of block is $227^\circ C$. Assume block behaves like a block body, find the rate of cooling of block if specific heat of the material of block is $400 J / kg - K$.

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18. A solid metallic sphere of diameter 20 cm and mass 10 kg is heated to a temperature of $327^\circ C$ and suspended in a box in which a constant temperature of $27^{\circ} C$ is maintained. Find the rate at which the temperature of the Sphere will fall with time. Stefan's constant $= 5.67 \times 10^{-8} W/m^2/K^4$ and specific heat of metal $= 420 J/kg/^{\circ} C$.

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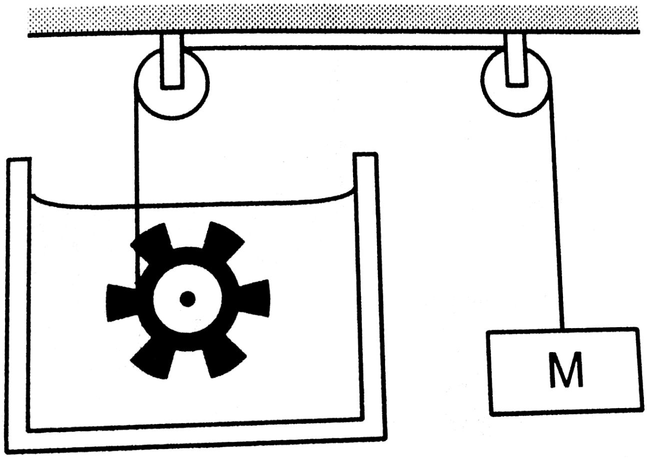
19. Figure shows water in a container having $2.0 - mm$ thick walls made of a material of thermal conductivity $0.50 W m^{-1} C^{-1}$. The container is kept in a melting-ice bath at $0^{\circ} C$. The total surface area in contact with water is$0.05 m^2$. A wheel is clamped inside the water and is coupled to a block of mass M as shown in the figure. As the 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 $10 cm s^{-1}$ and the temperature of the water remains constant at $1.0^{\circ} C$.Find the mass M of the block. Assume that the heat flow out of the water only through the walls in contact. Take

$g = 10ms^{-2}$.



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20. Let us assume that sun radiates like a black body with surface temperature at $T_0 = 6000K$ and earth absorbs radiation coming from sun only. If both earth and sun are considered perfect spheres with distance between centre of earth and centre of sun to be 200 times the radius of sun, find the temperature (in Kelvin) of surface of earth in steady state (assume radiation incident on earth to be almost parallel).

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21. Water flows at the rate of $0.1500kg/\min$ through a tube and is heated by a heater dissipating $25.2W$. The inflow and outflow water temperatures are $15.2^\circ C$ and $17.4^\circ C$, respectively. When the rate of flow is increased to $0.2318kg/\min$ and the rate of heating to $37.8W$, the inflow and outflow temperature are unaltered. Find

i. the specific heat capacity of water

ii. the rate of loss of heat from the tube.

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22. A piece of metal weighs 46 g in air and 30 g in liquid of density $1.24 \times 10^3 kgm^{-3}$ kept at $27^0 C$. When the temperature of the liquid is raised to $42^0 C$, the metal piece weights 30.5 g . The density of the liquid at $42^0 C$ is $1.20 \times 10^3 kgm^{-3}$. Calculate the coefficient of linear expansion of the metal.

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23. 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 $0^\circ C$. Find the length of the system when the temperature is raised to θ. Coefficient of linear expansion of aluminium and steel are α_a and α_s respectively. Young's modulus of aluminium is Y_a and of steel is Y_s.

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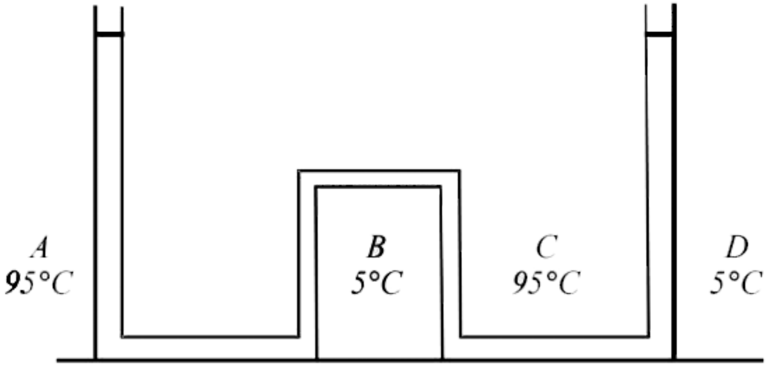
24. The apparatus shown in the figure consists of four glass columns connected by horizontal section. The height of two central column B and C are 49 cm each. The two outer columns A and D are open to the temperature. A and C are maintained at a temperature of $95^\circ C$ while the columns B and D are maintained at $5^\circ C$. The height of the liquid in A and D measured from the base the are 52.8 cm and 51cm respectively. Determine the coefficient of thermal expansion of the liquid



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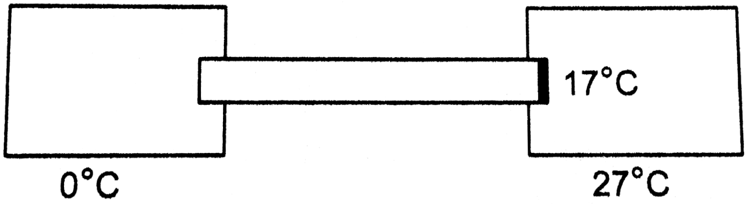
25. A cylindrical rod of length 50cm and cross sectional area $1cm^2$ is fitted between a large ice chamber at $0^\circ C$ and an evacuated chamber maintained at $27^\circ C$ as shown in figure. Only small protions of the rod are insid ethe chamber and the rest is thermally insulated from the surrounding. The cross section going inti the evacuted chamber is blackened so that it completely absorbe any radiation falling on it. The temperatuere of the blackened end is $17^\circ C$ when steady state is reachhed. Stefan constant $\sigma = 6 \times 10^{-s} W m^{-2} K^{-4}$. Find the thermal conductivity of the material of the rod.



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Single Correct

1. The design of some physical instrument requires that there be a constant difference in length of 10 cm between an iron rod and a copper cylinder laid side by side at all temperature find their lengths

$(\alpha_{Fe} = 11 \times 10^6 .^\circ C^{-1}, \alpha_{Cu} = 17 \times 10^{-6} .^\circ C^{-1})$

A. 28.3 cm, and 18.3 cm

B. 23.8 cm, 13.8 cm

C. 28.9 cm, 10.9

D. 27.5 cm, 14.5 cm

Answer: A

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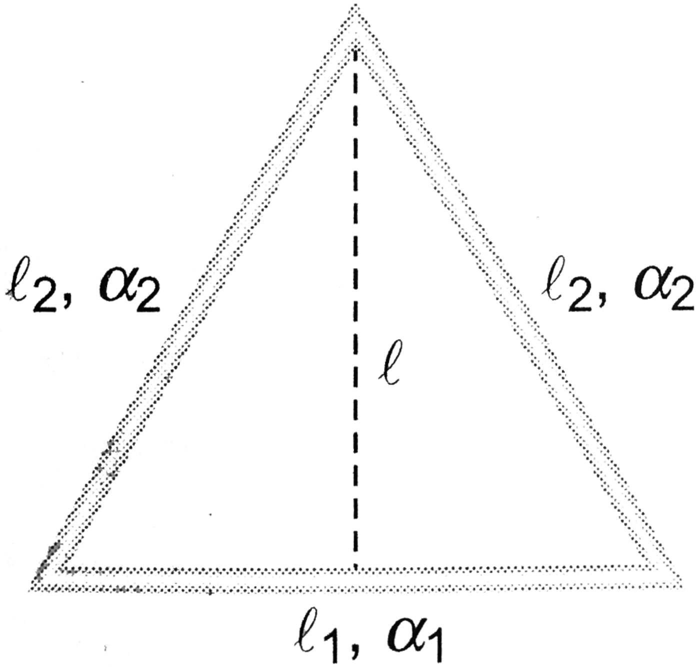
2. An isosceles triangles is formed with a thin rod of length l_1 and coefficient of linear expansion α_1, as the base and two thin rods each of length l_2 and coefficient of linear expansion α_2 as the two sides. The distance between the apex and the midpoint of the base remain unchanged as the temperature is varied. the ratio of lengths $\frac{l_1}{l_2}$ is



A. $\frac{L_1}{L_2} = \frac{\alpha_2}{\alpha_1}$

B. $\frac{L_1}{L_2} = \sqrt{\frac{\alpha_2}{\alpha_1}}$

C. $\frac{L_1}{L_2} = 2\frac{\alpha_2}{\alpha_1}$

D. $\frac{L_1}{L_2} = 2\sqrt{\frac{\alpha_2}{\alpha_1}}$

Answer: D

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3. An iron rod of length 50 cm is joined at an end to aluminium rod of length 100 cm. All measurements refer to $20^0 C$. Find the length of the composite system at $100^o C$ and its average coefficient of linear expansion. The coefficient of linear expansion of iron and aluminium are $12X10^{-6} C^{-1}$ and $24X10^{-6} C^{-1}$ respectively.

A. $36 \times 10^{-6} / ^\circ C$

B. $12 \times 10^{-6} / ^\circ C$

C. $20 \times 10^{-6} / ^\circ C$

D. $48 \times 10^{-6} / ^\circ C$

Answer: C

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4. A brass rod and a lead rod each 80 cm long at $0^{\circ} C$ are clamped together at one end with their free ends coinciding. The separatioin of free ends of the rods if the system is placed in a steam bath is ($\alpha_{\text{brass}} = 18 \times 10^{-6} / ^{\circ} C$ and $\alpha_{\text{lead}} = 28 \times 10^{-6} / ^{\circ} C$)

A. 0.2 mm

B. 0.8 mm

C. 1.4 mm

D. 1.6 mm

Answer: B

Watch Video Solution

5. The coefficient of apparent expansion of a liquid in a copper vessel is C and in a silver vessel S. The coefficient of volume expansion of copper is γ_C. What is the coefficient of linear expansion of silver

A. $(C + \gamma_C + S)/3$

B. $(C - \gamma_C + S)/3$

C. $(C + \gamma_C + S)/3$

D. $(C - \gamma_C - S)/3$

Answer: C

Watch Video Solution

6. A uniform solid brass sphere is rotating with angular speed ω_0 about a diameter. If its temperature is now increased by $100^\circ C$. What will be its new angular speed? (Given $\alpha_B = 2.0 \times 10^{-5} per ^\circ C$)

A. $1.1\omega_0$

B. $1.01\omega_0$

C. $0.996\omega_0$

D. $0.824\omega_0$

Answer: C

Watch Video Solution

7. The absolute coefficient of expansion of a liquid is 7 times that the volume coefficient of expansion of the vessel. Then the ratio of absolute and apparent expansion of the liquid is

A. $\frac{1}{7}$

B. $\frac{7}{6}$

C. $\frac{6}{7}$

D. none of these

Answer: B

Watch Video Solution

8. A solid whose volume does not change with temperature floats in a liquid. For two different temperatures t_1 and t_2 of the liqiud, fraction f_1 and f_2 of the volume of the solid remain submerged in the liquid. The coefficient of volume expansion of the liquid is equal to

A. $\frac{f_1 - f_2}{f_2 t_1 - f_1 t_2}$

B. $\frac{f_1 - f_2}{f_1 t_1 - f_2 t_2}$

C. $\frac{f_1 + f_2}{f_2 t_1 + f_1 t_2}$

D. $\frac{f_1 + f_2}{f_1 t_1 + f_2 t_2}$

Answer: A

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9. A long metal rod is bent to form a ring with a small gap if this is heated, will this gap increase or decrease?

A. x decreases, r and d increase

B. x and r increase, d decrease

C. x,r and d all increases

D. Data insufficient to arrive at a conclusion

Answer: C

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10. Two large holes are cut in a metal sheet. If this is heated, will their diameters increase or decrease?

A. Both d_1 and d_2 will decrease

B. Both d_1 and d_2 will increase

C. d_1 will increase, d_2 will decrease

D. d_1 will decrease, d_2 will increase

Answer: B

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11. An iron tyre is to be fitted onto a wooden wheel 1.0 m in diameter. The diameter of the tyre is 6 mm smaller than that of wheel the tyre should be heated so that its temperature increases by a minimum of (coefficient of volume expansion of iron is $3.6 \times 10^{-5} / ^{\circ} C$)

A. $167^{\circ} C$

B. $334^{\circ} C$

C. $500^{\circ} C$

D. $1000^{\circ} C$

Answer: C

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12. A clock with a metallic pendulum gains 5 s each day at a temperature of $15^\circ C$ and loses 10 s each day at a temperature of $30^\circ C$. Find the coefficient of thermal expansion of the pendulum metal.

A. $\frac{1}{86400} / ^\circ C$

B. $\frac{1}{43200} / ^\circ C$

C. $\frac{1}{14400} / ^\circ C$

D. $\frac{1}{28800} / ^\circ C$

Answer: B

Watch Video Solution

13. A wire of length L_0 is supplied heat to raise its temperature by T. if γ is the coefficient of volume expansion of the wire and Y is Young's modulus of the wire then the energy density stored in the wire is

A. $\frac{1}{2}\gamma^2T^2Y$

B. $\frac{1}{3}\gamma^2T^2Y^3$

C. $\frac{1}{18}\frac{\gamma^2T^2}{T}$

D. $\frac{1}{18}\gamma^2T^2Y$

Answer: D

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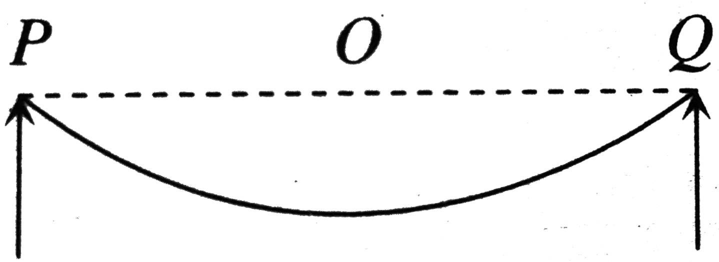

14.

Span of bridge is 2.4 km. At $30^\circ C$ a cable along the span sags by 0.5

km. Taking $\alpha = 12 \times 10^{-6} / {}^\circ C$, change in length of cable for a change in temperature from $10^\circ C$ to $42^\circ C$ is

A. 9.9 m

B. 0.099 m

C. 0.99 m

D. 0.4 km

Answer: C

Watch Video Solution

15. The specific heat of a substance varies with temperature $t(.^\circ C)$ as

$c = 0.20 + 0.14t + 0.023t^2 (cal / g^\circ / C)$

The heat required to raise the temperature of 2 g of substance from $5^\circ C$ to $15^\circ C$ will be

A. 24 cal

B. 56 cal

C. 82 cal

D. 100 cal

Answer: C

Watch Video Solution

16. Work done in converting one gram of ice at $-10^{\circ} C$ into steam at $100^{\circ} C$ is

A. 3045 J

B. 6056 J

C. 721 J

D. 6 J

Answer: A

Watch Video Solution

17. 50 g of copper is heated to increase its temperature by $10^{\circ} C$. If the same quantity of heat is given to $10g$ of water, the rise in its temperature is (specific heat of copper $= 420 J / kg^{\circ} / C$)

A. $5^{\circ} C$

B. $6^{\circ} C$

C. $7^{\circ} C$

D. $8^{\circ} C$

Answer: A

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18. Two liquid A and B are at $32^\circ C$ and $24^\circ C$. When mixed in equal masses the temperature of the mixture is found to be $28^\circ C$. Their specific heats are in the ratio of

A. $3:2$

B. $2:3$

C. $1:1$

D. $4:3$

Answer: C

Watch Video Solution

19. A beaker contains 200 g of water. The heat capacity of the beaker is equal to that of 20 g of water. The initial temperature of water in the beaker is $20^\circ C$ .If 440 g of hot water at $92^\circ C$ is poured in it, the final temperature (neglecting radiation loss) will be nearest to

A. $58^{\circ} C$

B. $68^{\circ} C$

C. $73^{\circ} C$

D. $78^{\circ} C$

Answer: B

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20. A liquid of mass m and specific heat c is heated to a temperature 2T. Another liquid of mass m/2 and specific heat 2 c is heated to a temperature T. If these two liquids are mixed, the resulting temperature of the mixture is

A. $(2/3)T$

B. $(8/5)T$

C. $(3/5)T$

D. $(3/2)T$

Answer: D

Watch Video Solution

21. Three liquids with masses m_1, m_2, m_3 are throughly mixed. If their specific heats are c_1, c_2, c_3 and their temperature T_1, T_2, T_3, respectively, then the temperature of the mixture is

A. $\dfrac{c_1T_1 + c_2T_2 + c_3T_3}{m_1c_1 + m_2c_2 + m_3c_3}$

B. $\dfrac{m_1c_1T_1 + m_2c_2t_2 + m_3c_3T_3}{m_1c_1 + m_2c_2 + m_3c_3}$

C. $\dfrac{m_1c_1T_1 + m_2c_2T_2 + m_3c_3T_3}{m_1T_1 + m_2T_2 + m_3T_3}$

D. $\dfrac{m_1T_1 + m_2T_2 + m_3T_3}{c_1T_1 + c_2T_2 + c_3T_3}$

Answer: B

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22. In a industrical process 10 kg of water per hour is to be heated from $20^\circ C \to 80^\circ C$. To do this, steam at $150^\circ C$ is passed from a boiler into a copper coilo immersed in water. The steam condenses in the coil and is returned to the boiler as water at $90^\circ C$, how many kg of steam is required per hour . ltb rgt (Specific heat of steam = $1 cal per g^\circ C$, latent heat of vaporisation = $540 cal g^{-1}$)

A. 1 g

B. 1 kg

C. 10 g

D. 10 kg

Answer: B

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23. A calorimeter contains 0.2 kg of water at $30^\circ C$. 0.1 kg of water at $60^\circ C$ is added to it, the mixture is well stirred and the resulting temperature if found to be $35^\circ C$. The thermal capacity of the calorimeter is

A. $6300J/K$

B. $1260J/K$

C. $4200J/K$

D. none of these

Answer: B

Watch Video Solution

24. Consider two rods of same length and different specific heats (S_1, S_2), conductivities (K_1, K_2) and area of cross-sections (A_1, A_2)

and both having temperature T_1 and T_2 at their ends. If rate of loss of heat due to conduction is equal, then :-

A. $K_1A_1 = K_2A_2$

B. $K_2A_1 = K_1A_2$

C. $\frac{K_1A_1}{S_1} = \frac{K_2A_2}{S_2}$

D. $\frac{K_2A_1}{S_2} = \frac{K_1A_2}{S_1}$

Answer: A

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25. A semicircular rods is joined at its end to a straight rod of the same material and the same cross-sectional area. The straight rod forms a diameter of the other rod. The junctions are maintained at different temperatures. Find the ratio of the heat transferred through a cross section of the straight rod in a given time.

A. $2 : \pi$

B. $1 : 2$

C. $\pi : 2$

D. $3 : 2$

Answer: A

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26. A heat flux of 4000 J/s is to be passed through a copper rod of length 10 cm and area of cross section $100 cm^2$. The thermal conductivity of copper is $400 W / m / ^\circ C$ The two ends of this rod must be kept at a temperature difference of

A. $1^\circ C$

B. $10^\circ C$

C. $100^\circ C$

D. $1000^{\circ} C$

Answer: C

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27. The coefficients of thermal conductivity of copper, mercury and glass are respectively K_c, K_m and K_g such that $K_c > K_m > K_g$. If the same quantity of heat is to flow per second per unit area of each and corresponding temperature gradients are X_c, X_m and X_g

A. $X_x = X_m = X_g$

B. $X_c > X_m > X_g$

C. $X_c < X_m < X_g$

D. $X_m < X_c < X_g$

Answer: C

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28. 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. Calculate the thickness of the shell if temperature difference between the outer and inner surfaces of the shell in steady state is T.

A. $\frac{2\pi R^2 KT}{P}$

B. $\frac{4\pi R^2 KT}{P}$

C. $\frac{\pi R^2 KT}{P}$

D. $\frac{\pi R^2 KT}{4P}$

Answer: B

Watch Video Solution

29. There are three thermometers one in contact with the skin of the man other in between the vest and the shirt and third in between the shirt and coat. The readings of the thermomenters are $30^\circ C$, $25^\circ C$ and $22^\circ C$, respectively. If the vest and the shirt are of the same thickness, the ratio of their thermal conductivities is

A. $9:25$

B. $25:9$

C. $5:3$

D. $3:5$

Answer: D

Watch Video Solution

30. Two rods are of same material and having same length and area. If heat ΔQ flows through them for 12 min when they are joined side by side. If now both the rods are joined in parallel, then the same amount of heat ΔQ will flow in

A. 24 s

B. 3 s

C. 1.5 s

D. 48 s

Answer: B

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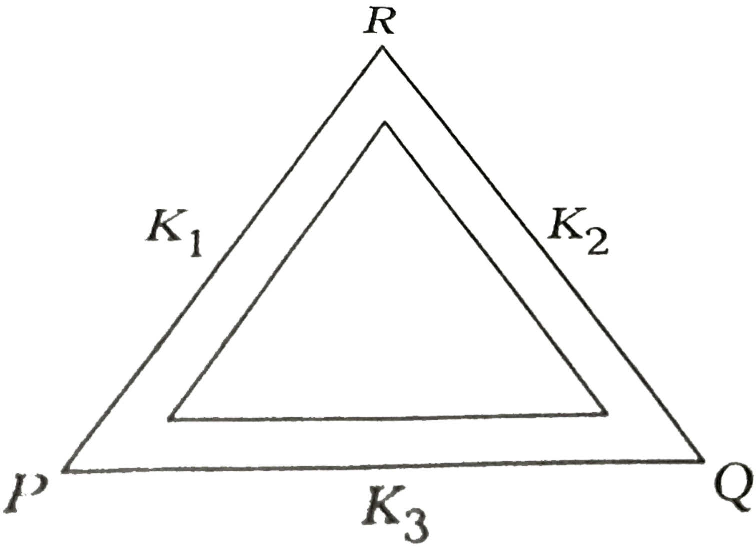
31. Three rods of same dimensions are arranged as shown in figure. They have thermal conductivities K1, K2 and K3 . The points P and Q are maintained at different temperatures, For the heat flow at the same rate alig PRQ and PQ which of the following option is correct?



A. $K_3 = \frac{1}{2}(K_1 + K_2)$

B. $K_3 = K_1 + K_2$

C. $K_3 = \frac{K_1 K_2}{K_1 + K_2}$

D. $K_3 = 2(K_1 + K_2)$

Answer: C

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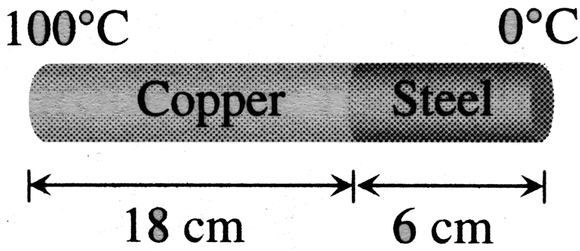

32.

The coefficient of thermal conductivity of copper is nine times that of steel. In the composite cylindrical bar shown in Fig. what will be the temperature at the junction of copper and steel ?

A. $75^{\circ} C$

B. $67^{\circ} C$

C. $33^{\circ} C$

D. $25^{\circ} C$

Answer: A

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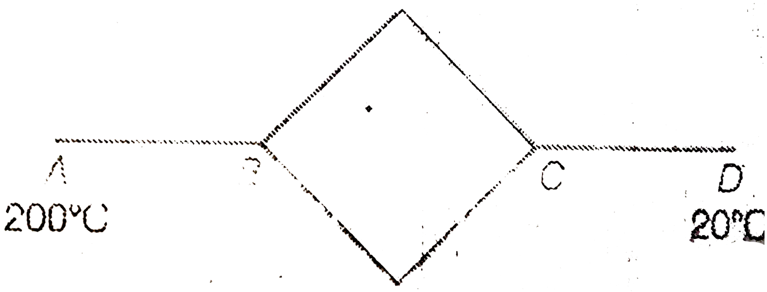
33. Six identical conducting rods are joined as shown figure. Points A and D are maintained at temperatures $200^\circ C$ and $20^\circ C$ respectively. The temperature junction B will be



A. $120^\circ C$

B. $100^\circ C$

C. $140^\circ C$

D. $80^\circ C$

Answer: C

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34. An ice box used for keeping eatables cool has a total wall area of $1m^2$ and a wall thichness of 5.0 cm. The thermal cunductivity of the ice box is $K = 0.01J/m^\circ C$. It is filled with large amount of ice at $0^\circ C$ along with eatables on a dfay when the temperature is $30^\circ C$ The latent heat of fusion of ice is $334 \times 10^3 J/kg$. The amount of ice melted in one day is (1 day $= 86, 000s$)

A. 776 g

B. 7760 g

C. 11520 g

D. 1552 g

Answer: D

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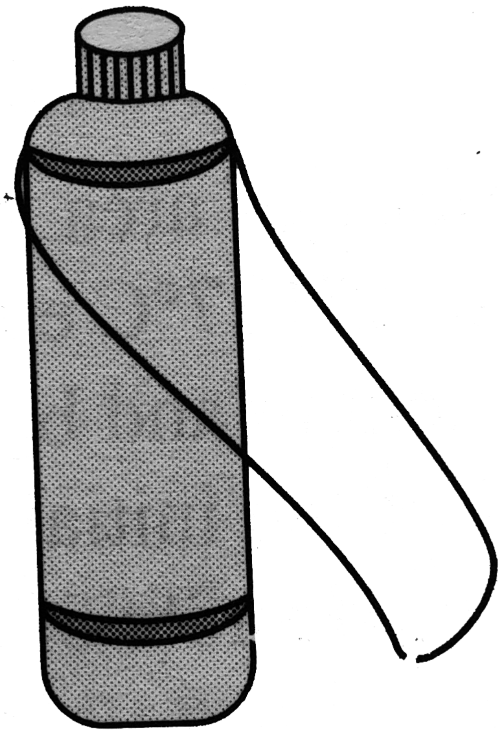

35.

The only possibility of heat flow in a thermos flask is through its cork which is $75cm^2$ in area and 5 cm thick its thermal conductivity is $0.0075cal/cm-s-^\circ C$. The outside temperature is $40^\circ C$ and latent heat of ice is $80cal/g$. Time taken by 500 g of ice at $0^\circ C$ in the flask to melt into water at $0^\circ C$ is `

A. 2.47 h

B. 4.27 h

C. 7.42 h

D. 4.72 h

Answer: A

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36. Certain substance emits only the wavelengths $\lambda_1, \lambda_2, \lambda_3$ and λ_4 when it is at a high temperature, it will absorb only the following wavelengths

A. λ_1

B. λ_2

C. λ_1 and λ_2

D. λ_1,λ_2,λ_3 and λ_4

Answer: D

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37.

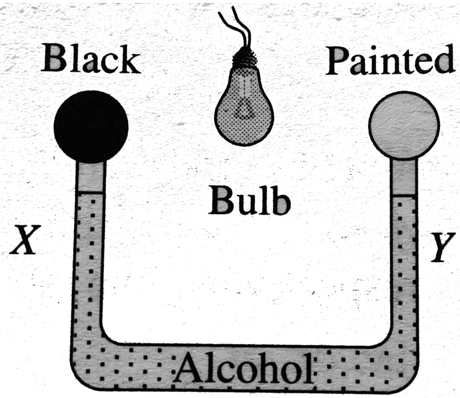

Fig. 1.79

Figure. Shows two air filled bulbs connected by a U-tube partly filled with alcohol. What happens to the levels of alcohol in the limbs X and Y when an electric bulb placed midway between the bulbs is lighted?

A. The level of alcohol in limb X falls while that in limb Y rises

B. The level of alcohol in limb X rises while that in limb Y falls

C. The level of alcohol falls in both limbs

D. There is no change in the levels of alcohol in either of the two limbs

Answer: A

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38. A black body at 200 K is found to emit maximum energy at a wavelength of $14\mu m$. When its temperature is raised to 1000 K, the wavelength at which maximum energy is emitted is

A. $14\mu m$.

B. $70\mu m$.

C. $2.8\mu m$

D. $2.8\mu m$.

Answer: C

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39. 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. $256/81$

B. $64/27$

C. $16/9$

D. $\frac{4}{3}$

Answer: A

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40. The wavelength of maximum energy released during an atomic axplosion was $2.93 \times 10^{-10} m$. Given that Wien's constant is $2.93 \times 10^{-3} m - K$, the maximum temperature attained must be of the order of

A. 10^{-7}K

B. $10^{7} K$

C. $10^{-13} K$

D. $5.86 \times 10^{7} K$

Answer: B

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41. The rectangular surface of area $8cm \times 4cm$ of a black body at temperature $127^{\circ} C$ emits energy E per section if length and breadth are reduced to half of the initial value and the temperature is raised to $327^\circ C$, the ratio of emission of energy becomes

A. $\frac{3}{8}E$

B. $\frac{81}{16}E$

C. $\frac{9}{16}E$

D. $\frac{81}{64}E$

Answer: D

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42. A solid copper cube of edges 1 cm is suspended in an evacuated enclosure. Its temperature is found to fall from $100^\circ C$ to $99^\circ C$ in 100 s. Another solid copper cube of edges 2 cm, with similar surface nature, is suspended in a similar manner. The time required for this cube to cool from $100^\circ C$ to $99^\circ C$ will be approximately

A. 25 s

B. 50 s

C. 200 s

D. 400 s

Answer: C

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43. A sphere, a cube and a thin circular pate are heated to the same temperature. If they are made of same material and have equal masses, determine which of these three object cools the fastest and which one cools the slowest?

A. Temperature of sphere drops to room temperature at last

B. Temperature of cube drops to room temperature at last

C. Temperature of thin circular plate drom to room temperature at last

D. Temperatures of all the three drop to room temperature at the same.

Answer: A

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44. A sphere and a cube of same material and same volume are heated up to same temperature and allowed to cool in the same sorroundings. The radio of the amounts of radiations emitted in equal time intervals will be

A. $1:1$

B. $\frac{4\pi}{3}:\frac{1}{86400}/^{\circ}C1$

C. $\left(\frac{\pi}{6}\right)^{1/3}:1$

D. $\frac{1}{2}\left(\frac{4\pi}{3}\right)^{2/3}:1$

Answer: C

Watch Video Solution

45. A substance cools from $75^{\circ}C$ to$70^{\circ}C$ in T_1 minute, from $70^{\circ}C$ to $65^{\circ}C$ in T_2 minute and from $65^{\circ}C$ to $60^{\circ}C$ in T_3 minute, then.

A. $T_1 = T_2 = T_3$

B. $T_1 > T_2 > T_3$

C. $T_1 < T_2 < T_3$

D. $T_1 > T_2 < T_3$

Answer: C

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46. A liquid takes 5 minutes to cool from $80^\circ C$ to$50^\circ C$. How much time will it take to cool from $60^\circ C$ to $30^\circ C$? The temperature of surroundings is $20^\circ C$.

A. 30 s

B. 60 s

C. 90 s

D. 48 s

Answer: D

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47. A body takes T minutes to cool from $62^\circ C$ to $61^\circ C$ when the surrounding temperature is $30^\circ C$. The time taken by the body to cool from $46^\circ C$ to $45^\circ C$ is

A. Greter than T minutes

B. Equal to T minutes

C. Less than T minutes

D. None of these

Answer: B

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48. The rates of cooling of two different liquids put in exactly similar calorimeters and kept in identical surroundings are the same if

A. The masses of the liquids are equal

B. Equal masses of the liquids at the same temperature are taken

C. Different volumes of the liquids at the same

D. Equal volumes of the liquids at the same temperature are taken

Answer: D

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49. Hot water cools from $60^{\circ} C$ to $50^{\circ} C$ in the first 10 min and to $42^{\circ} C$ in the next 10 min. The temperature of the surrounding is

A. $5^{\circ} C$

B. $10^{\circ} C$

C. $15^{\circ} C$

D. $20^{\circ} C$

Answer: B

Watch Video Solution

50. There are two thin spheres A and B of the same material and same thickness. They behave like black bodies, Radius of A is double that of B and Both have same temperature T. When A and B are kept in a room of temperature $T_0(<T)$, the ratio of their rates of cooling is (assume negligible heat exchange between A and B).

A. $2:1$

B. $1:1$

C. $4:1$

D. $8:1$

Answer: B

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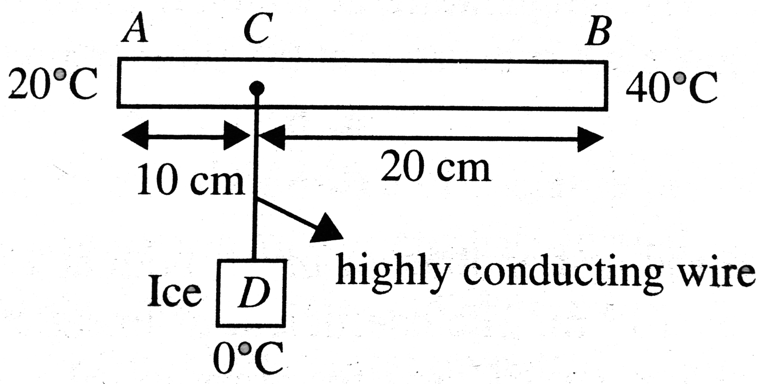
51.



As shown in Fig. AB is rod of length 30 cm and area of cross section $1.0 cm^2$ and thermal conductivity 336 SI units. The ends A and B are maintained at temperatures $20^\circ C$ and $40^\circ C$, respectively .A point C of this rod is connected to a box D, containing ice at $0^\circ C$ through a highly conducting wire of negligible heat capacity. The rate at which ice melts in the box is (assume latent heat of fusion for ice $L_f = 80 cal/g$)

A. $84 mg/s$

B. $84 g/s$

C. $20 mg/s$

D. $40 mg/s$

Answer: D

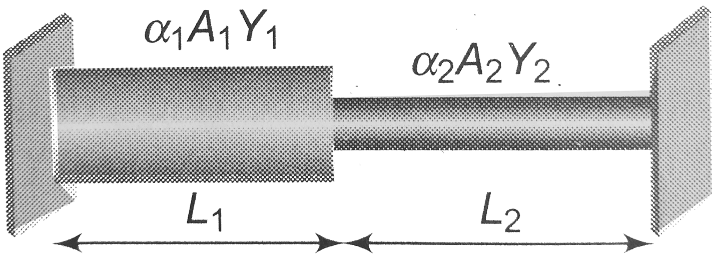
Watch Video Solution

52. Two rods are joined between fixed supports as shown in the figure. Condition for no change in the length of individual rods with the increase of temperature will be

($\alpha_1, \alpha_2 =$ linear expansion coefficient

$A_1, A_2 =$ Area of rods

$Y_1, Y_2 =$ Young modulus)



A. $\frac{A_1}{A_2} = \frac{\alpha_1 y_1}{\alpha_2 y_2}$

B. $\frac{A_1}{A_2} = \frac{L_1 \alpha_1 y_1}{L_2 \alpha_2 y_2}$

C. $\frac{A_1}{A_2} = \frac{L_2 \alpha_2 y_2}{L_1 \alpha_1 y_1}$

D. $\frac{A_1}{A_2} = \frac{\alpha_2 y_2}{\alpha_1 y_1}$

Answer: D

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53. A rod of length l and cross sectional area A has a variable conductivity given by $K = \alpha T$, where α is a positive constant T is temperatures in Kelvin. Two ends of the rod are maintained at temperatures T_1 and $T_2 (T_1 > T_2)$. Heat current flowing through the rod will be

A. $\frac{A\alpha T_1^2 - T_2^2}{l}$

B. $\frac{A\alpha T_1^2 + T_2^2}{l}$

C. $\frac{A\alpha T_1^2 + T_2^2}{3l}$

D. $\frac{A\alpha T_1^2 - T_2^2}{2l}$

Answer: D

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54. A black body emits radiation at the rate P when its temperature is T. At this temperature the wavelength at which the radiation has maximum intensity is λ_0, If at another temperature T' the power radiated is P' and wavelength at maximum intensity is $\frac{\lambda_0}{2}$ then

A. $P'T' = 32PT$

B. $P'T' = 16PT$

C. $P'T' = 8PT$

D. $P'T' = 4PT$

Answer: A

Watch Video Solution

55. A solid metallic sphere of diameter 20 cm and mass 10 kg is heated to a temperature of $327^\circ C$ and suspended in a box in which a constant temperature of $27^\circ C$ is maintained. Find the rate at which the temperature of the Sphere will fall with time. Stefan's constant $= 5.67 \times 10^{-8} W/m^2/K^4$ and specific heat of metal $= 420 J/kg/^\circ C$.

A. $0.055^\circ C/s$

B. $0.066^\circ C/s$

C. $0.044^\circ C/s$

D. $0.03^\circ C/s$

Answer: B

Watch Video Solution

56. The coefficient of linear expansion of an in homogeneous rod change linearly from α_1 to α_2 from one end to the other end of the rod. The effective coefficient of linear expansion of rod is

A. $\alpha_1 + \alpha_2$

B. $\frac{\alpha_1 + \alpha_2}{2}$

C. $\sqrt{\alpha_1 \alpha_2}$

D. $\alpha_1 - \alpha_2$

Answer: B

Watch Video Solution

57. A wire is made by attaching two segments together end to end. One segment is made of aluminium and the other is steel. The effective coefficient of linear expansion of the two segment wire is $19 \times 10^{-6} / {}^\circ C$. The fraction length of aluminium is (linear coefficient of thermal expansion of aluminium and steel are $23 \times 10^{-6} . ^{\circ} C$ and $12 \times 10^{-6} / ^{\circ} C$,

A. $\frac{5}{11}$

B. $\frac{6}{11}$

C. $\frac{7}{11}$

D. $\frac{8}{11}$

Answer: C

Watch Video Solution

58. Heat is required to change 1 kg of ice at $-20^{\circ} C$ into steam. Q_1 is the heat needed to warm the ice from $-20^{\circ} C$ to $0^{\circ} C$, Q_2 is the heat needed to melt the ice, Q_3 is the heat needed to warm the water from $0^{\circ} C$ to $100^{\circ} C$ and Q_4 is the heat needed to vapourize the water. Then

A. $Q_4 > Q_3 > Q_2 > Q_1$

B. $Q_4 > Q_3 > Q_1 > Q_2$

C. $Q_4 > Q_2 > Q_3 > Q_1$

D. $Q_4 > Q_2 > Q_1 > Q_3$

Answer: A

Watch Video Solution

59. A block of wood is floating in water at $0^\circ C$. The temperature of water is slowly raised from $0^\circ C$ to $10^\circ C$. How will the precentage of volume of block above water level change with rise in temperature?

A. increase

B. decrease

C. first increase and then decrease

D. first decrease and then increase

Answer: C

Watch Video Solution

60. An incandescent lamp consumint $P = 54W$ is immersed into a transparent calorimeter containing $V = 10^3 cm^3$ of water in 420 s the water is heated by $4^\circ C$. The percentage of the energy consumed by the lamp that passes out of the calorimeter in the form of radiant energy is

A. $81.5\ \%$

B. $26\ \%$

C. $40.5\ \%$

D. $51.5\ \%$

Answer: B

Watch Video Solution

61. A thread of liquid is in a uniform capillary tube of length L. As measured by a ruler. The temperature of the tube and thread of liquid is raised by ΔT. If γ be the coefficient of volume expansion of the liquid and α be the coefficient of linear expansion of the material of the tube, then the increase ΔL in the length of the thread, again measured by the ruler will be

A. $\Delta L = L(\gamma - \alpha)\Delta T$

B. $\Delta L = L(\gamma - 2\alpha)\Delta T$

C. $\Delta L = L(\gamma - 3\alpha)\Delta T$

D. $\Delta L = L\gamma\Delta T$

Answer: B

Watch Video Solution

62. A brass wire 1.8 m long at 27^{C} is held taut with little tension between two rigid supports. If the wire is cooled to a temperature of $-39^{\circ}C$, what is the tension developed in the wire, if its diameter is 2.0 mm ? Co-efficient of linear expansion of brass $= 2.0 \times 10^{-5} K^{-1}$, Young's modulus of brass $= 0.91 \times 10^{11}$ Pa.

A. 3400N

B. 34kN

C. 0.34kN

D. 6800N

Answer: C

Watch Video Solution

63. A mass m of lead shot is placed at the bottom of a vertical cardboard cylinder that is 1.5 m long and closed at both ends. The cylinder is suddenly inverted so that the shot falls 1.5 m If this procces is repeated quickely 100 times, auuming no heat is dissipated or lost, the temperature of the shot will increase by (specific heat of lead $= 0.03 cal / g^\circ C$)

A. 0

B. $5^\circ C$

C. $7.3^\circ C$

D. $11.3^\circ C$

Answer: D

Watch Video Solution

64. An iron rocket fragment initially at $-100^\circ C$ enters the earth's atmosphere almost horizontally and quickly fuses completely in atmospheric friction. Specific heat of iron is $0.11 kcal / kg^\circ C$. Its melting point is $1535^\circ C$ and the latent heat of fusion is $3 kcals / kg$.

The minimum velocity with which the fragmento must have entered the atmosphere is

A. $0.45km/s$

B. $1.32km/s$

C. $2.32km/s$

D. zero

Answer: B

Watch Video Solution

65. A liquid of density $0.85g/cm^3$ flows through a calorimeter at the rate of $8.0cm^2/s$. Heat is added by means of a 250 W electric heating coil and a temperature difference of $15^\circ C$ is established in steady state conditions between the inflow and the outflow points of the liquid. The specific heat for the liquid will be

A. $0.6kcal / kgK$

B. $0.3kcal / kgK$

C. $0.5kcal / kgK$

D. $0.4kcal / kgK$

Answer: A

Watch Video Solution

66. An iron ball has a diameter of $6cm$ and is $0.010mm$ too large to pass through a hole in a brass plate when the ball and plate are at a temperature of $30^\circ C$. At what temperature, the same for ball and plate, will the ball just pass through the hole?

Take the values of (prop) from Table 20.2.

A. $23.8^\circ C$

B. $53.8^\circ C$

C. $42.5^{\circ} C$

D. $63.5^{\circ} C$

Answer: B

Watch Video Solution

67. A flask of mercury is sealed off at $20^{\circ} C$ and is completely filled with mercury. If the bulk modulus for mercury is 250 Mpa and the coefficient of volume expansion of mercury is $1.82 \times 10^{-4} /^{\circ} C$ and the expansion of glass is ignored, the pressure of mercury within flask at $100^{\circ} C$ will be

A. 100MPa

B. 72MPa

C. 36MPa

D. 24MPa

Answer: C

Watch Video Solution

68. The densities of wood and benzene at $0^{\circ} C$ are $880 kgm^{-3}$ and $900 kgm^{-3}$ respectively. The coefficients of volume expansion are $1.2 \times 10^{-3} C^{-1}$ for wood and $1.5 \times 10^{-3} C^{-1}$ for benzene. At what temperature will a piece of wood just sink in benzene?

A. $53^{\circ} C$

B. $63^{\circ} C$

C. $73^{\circ} C$

D. $83^{\circ} C$

Answer: D

Watch Video Solution

69. An iron rod and another of brass, both at $27^\circ C$ differ in length by 10^{-3}m. The coefficient of linear expansion for iron is $1.1 \times 10^{-5} / ^\circ C$ and for brass is $1.9 \times 10^{-5} / ^\circ C$. The temperature at which both these rods will have the same length is

A. $0^\circ C$

B. $152^\circ C$

C. $175^\circ C$

D. Data is insufficient

Answer: A

Watch Video Solution

70. An ordinary refrigerator is thermally equivalent to a box of corkboard 90 mm thick and 5.6m^2 in inner surface area. When the door is closed, the inside wall is kept, on the average, $22.2^\circ C$ below the temperature of the outside wall. If the motor of the refrigerator runs 15% of the time while the door is closed, at what rate must heat be taken from the interior whicle the motor is running?

The thermal conductivity of corkboard is $k = 0.05W/mK$.

A. 400 W

B. 500 W

C. 300 W

D. 250 W

Answer: B

Watch Video Solution

71. A bullet of mass 5 g moving at a speed of 200 m/s strikes a rigidly fixed wooden plank of thickness 0.2m normally and passes through it losing half of its kinetic energy. If it again strikes an identical rigidly fixed wooden plank and passes through it, assuming the same resistance in the two planks the ratio of the thermal energies produced in the two planks is

A. $1:1$

B. $1:2$

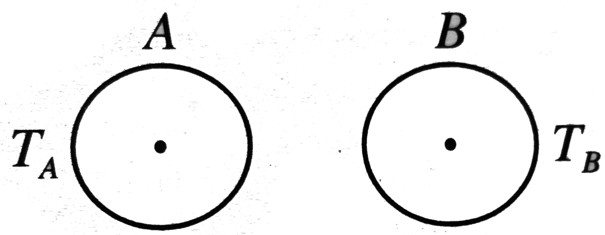
C. $2:1$

D. $4:1$

Answer: A

Watch Video Solution

72.



A and B are tqo isolated spheres kept in close proximity so that they can exchange energy by radiation. The two spheres have identical physical dimensions but the surface of A behaves like a perfactly black body while the surface of B reflects $20\ \%$ of all the radiations it receives. They are isolated from all other sources of radiation.

A. (a)If they are in thermal equilibrium and exchange equal amounts of radiation per second then they will be at same absolute temperature, $T_A = T_B$.

B. (b)If they are in thermal equilibrium and exchange equal amounts of radiation per second then $T_A = (0.8)^{1/4} T_B$.

C. (c)If they are not in thermal equilibrium and are each at $t = 0$ at the same temperature $T_A = T_B = T$, then the sphere A will lose thermal energy and B will gain thermal energy.

D. (d)If they are not in thrmal equilibrium and are each at $t = 0$ at the same temperature $T_A = T_B = T$, Then the sphere A will gain thermal energy and B will lose thermal energy.

Answer: A

Watch Video Solution

73. A thermally isulated piece of metal is heated under atmospheric pressure by an electric current so that it receives electric energy at a constant power P. This leads to an increase of absolute temperature T of the metal with time t as follows:

$T(t) = T_0[1 + a(t - t_0)]^{1/4}$. Here, a, t_0 and T_0 are constants. The heat capacity $C_p(T)$ of the metal is

A. $\frac{4P}{aT_0}$

B. $\frac{4PT}{aT_0^4}$

C. $\frac{2PT}{aT_0^4}$

D. $\frac{2P}{aT_0}$

Answer: B

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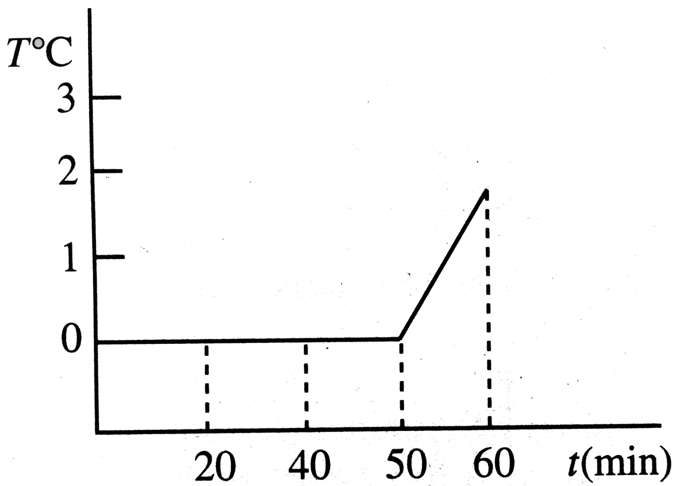

74.

A cooking vessel on a slow burner contains 5 kg of water and an unknown mass of ice in equilibrium at $0^{\circ} C$ at time $t = 0$. The temperature of the mixture is measured at various times and the result is plotted as shown in Fig. During the first 50 min the mixture remains at $0^{\circ} C$. From 50 min to 60 min, the temperature increases to $2^{\circ} C$ Neglecting the heat capacity of the vessel, the initial mass of the ice is

A. $\frac{10}{7} kg$

B. $\frac{5}{7} kg$

C. $\frac{5}{4} kg$

D. $\frac{5}{8} kg$

Answer: B

Watch Video Solution

75. A glass cylinder contains $m_0 = 100 g$ of mercury at a temperature of $t_0 = 0^{\circ} C$. When temperature becomes $t_1 = 20^{\circ} C$ the cylinder contains $m_1 = 99.7g$ of mercury The coefficient of volume expansion of mercury $\gamma_{He} = 18 \times (10^{-5} /^{\circ} C$ Assume that the temperature of the mercury is equal to that of the cylinder. The corfficient of linear expansion of glass α is

A. $10^{-5} /^{\circ} C$

B. $2 \times 10^{-5} /^{\circ} C$

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

D. $6 \times 10^{-5} /^{\circ} C$

Answer: A

Watch Video Solution

76. Power radiated by a black body is P_0 and the wavelength corresponding to maximum energy is around λ_0, On changing the temperature of the black body, it was observed that the power radiated becames $\frac{256}{81}P_0$. The shift in wavelength corresponding to the maximum energy will be

A. $+\frac{\lambda_0}{4}$

B. $+\frac{\lambda_0}{2}$

C. $-\frac{\lambda_0}{4}$

D. $-\frac{\lambda_0}{2}$

Answer: C

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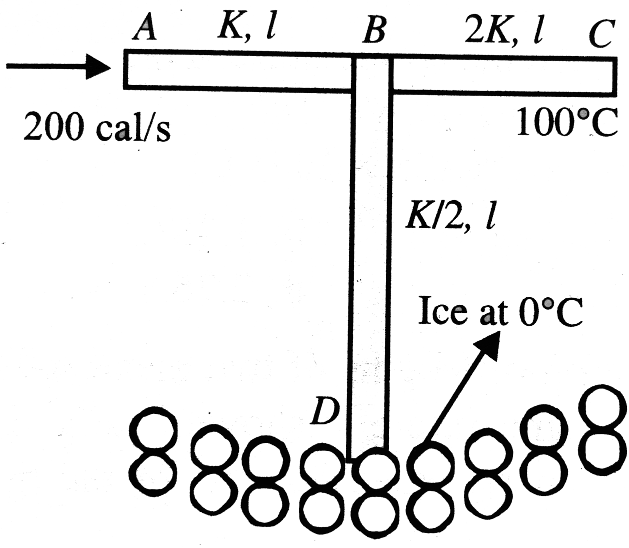

77.

Three rods AB, BC and BD of same length l and cross section A are arranged as shown. The end D is immersed in ice whose mass is 440 g and is at $0^\circ C$. The end C is maintained at $100^\circ C$. Heat is supplied at constant rate of 200 cal/s. Thermal conductivities of AB, BC and BD are K, 2K and $K/2$, respectively Time after which whole ice will melt is ($K = 100 cal/m - s^\circ C A = 10 cm^2, l = 1 cm$)

A. 400 s

B. 600 s

C. 700 s

D. 800 s

Answer: D

Watch Video Solution

78. The length of s steel rod exceeds that of a brass rod by 5 cm. If the difference in their lengths remains same at all temperature, then the length of brass rod will be: (α for iron and brass are $12 \times 10^{-6} / ^\circ C$ and $18 \times 10^{-6} / ^\circ C$, respectively)

A. 15 cm

B. 5 cm

C. 10 cm

D. 2 cm

Answer: C

Watch Video Solution

79. A container of capacity 700 mL is filled with two immiscible liquids of volume 200 mL and 500 mL with respective volume expansivities as $1.4 \times 10^{-5} / ^{\circ} C$ and $2.1 \times 10^{-5} / ^{\circ} C$. During the heating of the vessel, it is observed that neither any liquid overflows nor any empty space is created. The volume expansivity of the container is

A. $1.9 \times 10^{-5} / ^{\circ} C$

B. $1.9 \times 10^{-6} / ^{\circ} C$

C. $1.6 \times 10^{-5} / ^{\circ} C$

D. $1.6 \times 10^{-6} / ^{\circ} C$

Answer: A

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80. The coefficient of apparent expansion of a liquid when determined using two different vessle A and B are γ_1 and γ_2, respectily. If the coefficient of linerar expansion of vesel A is α. Find the coefficient of linear expension of the vessel B.

A. $\dfrac{(\gamma_1 - \gamma_2)}{3} - \alpha_1$

B. $\dfrac{(\gamma_2 - \gamma_1)}{3} + \alpha_1$

C. $\dfrac{(\gamma_2 - \gamma_1)}{3} - \alpha_1$

D. $\dfrac{(\gamma_1 - \gamma_2)}{3} + \alpha_1$

Answer: B

Watch Video Solution

81. A glass vessel is filled up to 3/5th of its volume by mercury. If the volume expansivities of glass and mercury be $9 \times 10^{-6} / {}^\circ C$ and

$18 \times 10^{-5} / ^\circ C$ respectively, then the coefficient of apparent expansion of mercury is

A. $17.1 \times 10^{-5} / ^\circ C$

B. $9.9 \times 10^{-5} / ^\circ C$

C. $17.46 \times 10^{-5} / ^\circ C$

D. $16.5 \times 10^{-5} / ^\circ C$

Answer: D

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82. A thin circular metal disc of radius 500.0 mm is set rotating about a central axis normal to its plane. Upon raising its temperature gradually, the radius increases to 507.5 mm. The percentage change in the rotational kinetic energy will be

A. 1.5%

B. -1.5%

C. 3%

D. -3%

Answer: D

Watch Video Solution

83. A platinum sphere floats in mercury. Find the percentage change in the fraction of volume of sphere immersed in mercury whenthe temperature is raised by $80^{\circ}C$ (volume expansivity of mercury is $182 \times \times 10^{-6} / ^{\circ}C$ and linear expansivity of platinum $9 \times 10^{-6} / ^{\circ}C$)

A. 1.24%

B. `1.45%

C. 2.48%

D. 2.76%

Answer: A

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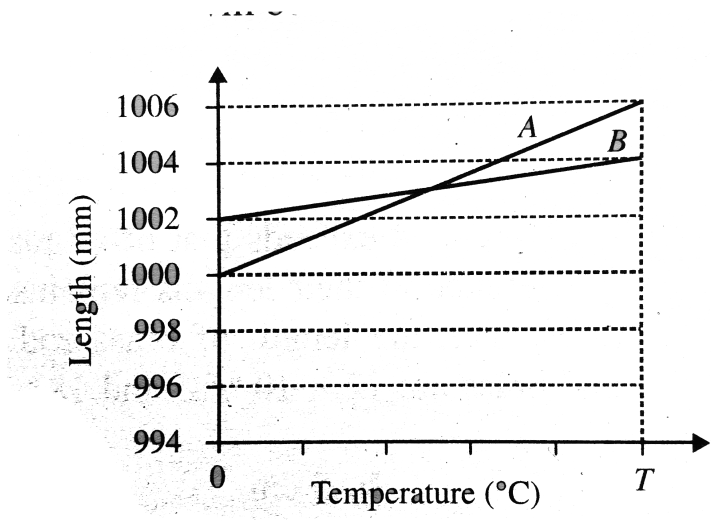

84.

The variation of length of two metal rods A and B with change in temperature is shown in Fig. the coefficient of linear expansion α_A for the metal A and the temperature T will be

A. $\alpha_A = 3 \times 10^{-6} / {}^\circ C, 500^\circ C$

B. $\alpha_A = 3 \times 10^{-6} / ^\circ C, 222.22^\circ C$

C. $\alpha_A = 27 \times 10^{-6} / ^\circ C, 500^\circ C$

D. $\alpha_A = 27 \times 10^{-6} / ^\circ C, 222.22^\circ C$

Answer: D

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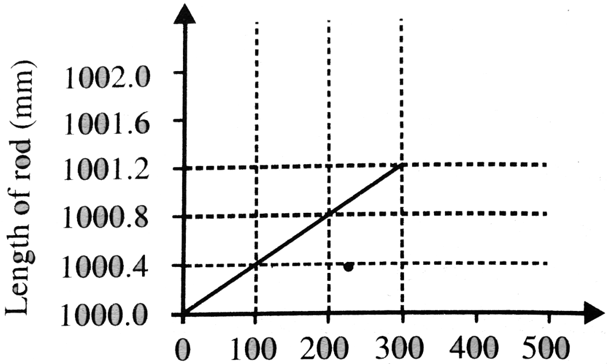
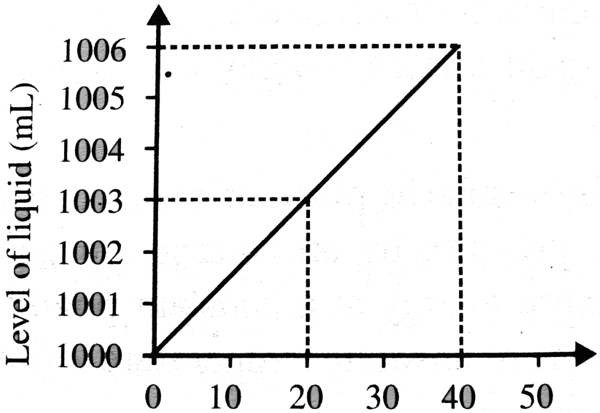


(a) Temperature (°C)



(b) Temperature (°C)

85.

The graph of elongation of rod of a substance A with temperature rise is shown if Fig. A liquid B contained in a cylindrical cessel made up of substance A, graduated in millilitres at $0^{\circ} C$ is heated gradually. The readings of the liquid level in the vessel corresponding to different temperatures are shown in the figure. the real volume expansivity of liquid is

A. $2.7 \times 10^{-5} / {}^{\circ} C$

B. $15.4 \times 10^{-5} / {}^{\circ} C$

C. $16.2 \times 10^{-5} / {}^{\circ} C$

D. $151.2 \times 10^{-5} / {}^{\circ} C$

Answer: C

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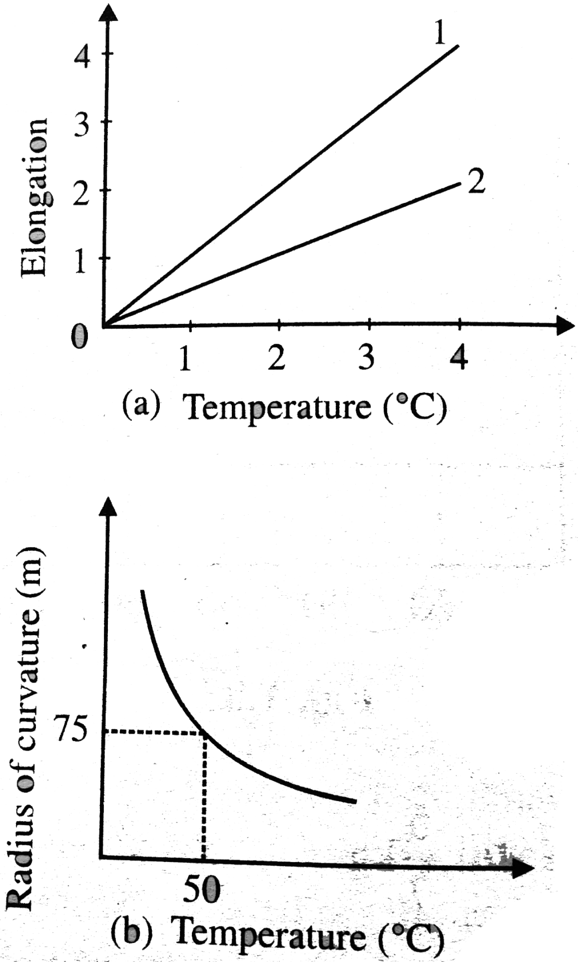

86.

Figure. Shows the graphs of elongation versus temperature for two different metals. If these metals are employed to form a straight bimetallic strip of thickness 6 cm and heated, it bends in the form of an arc, the radius of cuvature chaging with temperature approximately as shown in the figure. The linear expansivities of the two metals are

A. $24 \times 10^{-6} / {}^{\circ} C$ and $12 \times 10^{-6} / {}^{\circ} C$

B. $20 \times 10^{-6} / {}^{\circ} C$ and $10 \times 10^{-6} / {}^{\circ} C$

C. $18 \times 10^{-6} / {}^{\circ} C$ and 9xx10^(-6)//^@C`

D. $16 \times 10^{-6} / {}^{\circ} C$ and $8 \times 10^{-6} / {}^{\circ} C$

Answer: D

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87. Water at $0^{\circ} C$ contained in a closed vessel, is abruptly opened in an evacuated chamber. If the specific latent heats of fusion and vapourization at $0^{\circ} C$ are in the ratio $\lambda : 1$ the fraction of water eveporated will be

A. $\lambda / 1$

B. $\lambda / (\lambda + 1)$

C. $(1 - \lambda) / \lambda$

D. $(\lambda - 1) / (\lambda + 1)$

Answer: B

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88. A system receives heat continuously at the rate of 10 W. The temperature of the system becomes constant at $70^\circ C$ when the temperature of the surroundings is $30^\circ C$. After the heater is switched off, the system cools from $50^\circ C$ to $49.9^\circ C$ in 1 min. The heat capacity of the system is

A. $1000 J /^\circ C$

B. $1500 J /^\circ C$

C. $3000 J /^\circ C$

D. none of these

Answer: C

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89. In a motor the electrical power input is 500 W and the mechanical power output is 0.54 horse power. Heat developed in the motor in 1 h is (assuming that all the electric energy which is not converted to mechanical energy is converted to heat) is

A. $4.18 \times 10^4 cal$

B. $3.6 \times 10^5 cal$

C. $8.6 \times 10^4 cal$

D. $1.28 \times 10^5 cal$

Answer: C

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90. The molar heat capacity of a certain substance varies with temperature according to the given equation

$C = 27.2 + (4 \times 10^{-3})T$

The heat necessary to change the temperature of 2 mol of the substance from 300 K to 700 K is

A. $3.46 \times 10^4 J$

B. $2.33 \times 10^3 J$

C. $3.46 \times 10^3 J$

D. $2.33 \times 10^4 J$

Answer: D

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91. The corfficient of linear expansion for a certain metal varies with temperature as $\alpha(T)$. If L_0 is the initial elgnth of the metal and the temperature of metal is changed from T_0 to $T(T_0 > T)$, then

A. $L = L_0 \int_{T_0}^{T} \alpha(T) dT$

B. $L = L_0 \left[1 + \int_{T0}^{T} \alpha(T) dT\right]$

C. $L = L_0 \left[1 - \int_{T_0}^{T} \alpha(T) dT\right]$

D. $L > L_0$

Answer: B

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92. A piece of metal floats on mercury. The coefficient of volume expansion of metal and mercury are γ_1 and γ_2, respectively. if the temperature of both mercury and metal are increased by an amount

ΔT, by what factor does the fraction of the volume of the metal submerged in mercury changes ?

A. $\dfrac{1+\gamma_2\Delta T}{1+\gamma_1\Delta T}$

B. $1+\gamma_2\Delta T$

C. $1+\gamma_1\Delta T$

D. $\dfrac{1+\gamma_2\Delta T}{1-\gamma_1\Delta T}$

Answer: A

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93. A uniform metallic disc of radius r and mass m is spinning with angular speed ω_0 about an axis passing through its centre and perpendicular to plane. If its temperature is increased (slightly) by ΔT its new angular speed is (The coefficient of linear expansion of the metal is α)

A. $\omega_0[1+2a(\theta_2-\theta_1)]$

B. $\omega_0[1+a(\theta_2-\theta_1)]$

C. $\dfrac{\omega_0}{[1+2\alpha(\theta_2-\theta_2)]}$

D. none of these

Answer: C

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94. Calculate the compressional force required to prevent the metallic rod of length l cm and cross sectional area Acm^2 when heated through $t^\circ C$ from expanding lengthwise. Young's modulus of elasticity of the metal is E and mean coefficient of linear expansion is α per degree celsius.

A. $EA\alpha t$

B. $EA\alpha t/((1+\alpha t)$

C. $EA\alpha t / (1 - at)$

D. $El\alpha t$

Answer: B

Watch Video Solution

95. The coefficient of linear expansion of glass is α_g per $.^\circ C$ and the cubical expansion of mercury is γ_m per $.^\circ C$. The volume of the bulb of a mercury thermometer at $0^\circ C$ is V_0 and cross section of the capillary is A_0. What is the length of mercury column in capillary at $T^\circ C$, if the mercury just fills the bulb at $0^\circ C$?

A. $\dfrac{V_0 T(\gamma_m + 3\alpha_g)}{A_0(1 + 2\alpha_g T)}$

B. $\dfrac{V_0 T(\gamma_m - 3\alpha_g)}{A_0(1 + 2\alpha_g T)}$

C. $\dfrac{V_0 T(\gamma_m + 2\alpha_g)}{A_0(1 + 3\alpha_g T)}$

D. $\dfrac{V_0 T(\gamma_m - 2\alpha_g)}{A_0(1 + 3\alpha_g T)}$

Answer: B

Watch Video Solution

96. A 10 kW drilling machine is used to drill a bore in a small aluminium block of mass 8.0 kg. 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 $= 0.91 J g^{-1} K^{-1}$.

A. $103^{\circ} C$

B. $130^{\circ} C$

C. $105^{\circ} C$

D. $30^{\circ} C$

Answer: A

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97. A ball of thremal capacity $10 cal / ^\circ C$ is heated to the temperature of furnace it is then transferred into a vessel containing water. The water equivalent of vessel and the constents is 200 g. The temperature of the vessel and its contents rises from $10^\circ C$ to $40^\circ C$. What is the temperature of furnace?

A. $640^\circ C$

B. $64^\circ C$

C. $600^\circ C$

D. $100^\circ C$

Answer: A

Watch Video Solution

98. Two tanks A and B contain water at $30^\circ C$ and $80^\circ C$ respectively calculate the amount of water that must be taken from each tank respectively to prepare 40 kg of water at $50^\circ C$

A. 24 kg, 16 kg

B. 16 kg, 24kg

C. 20 kg, 20kg

D. 30 kg, 10 kg

Answer: A

Watch Video Solution

99. It takes 10 min for an electric kettle to heat a certain quantity of water from $0^\circ C$ to $100^\circ C$. It takes 54 min to convert this water $100^\circ C$ into steam Then latent heat of steam is

A. 80 cal/g

B. 540 cal/kg

C. 540 cal/g

D. 80 cal/kg

Answer: C

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100. Ice at $0^\circ C$ is added to 200 g of water initially at $70^\circ C$ in a vacuum flask. When 50 g of ice has been added and has all melted the temperature of the flask and contents is $40^\circ C$. When a further 80 g of ice has been added and has all melted the temperature of the whole becomes $10^\circ C$. Find the latent heat of fusion of ice.

A. $80cal/g$

B. $90cal/g$

C. $70 cal / g$

D. $540 cal / g$

Answer: B

Watch Video Solution

101. The loss of weight of a solid when immersed in a liquid at $0^{\circ} C$ is W_0 and at $t^{\circ} C$ is $'W'$. If cubical coefficient of expansion of the solid and the liquid are γ_s and γ_1 then $W =$

A. $W_0[1 + (\gamma_S - \gamma_L)t]$

B. $W_0[1 - (\gamma_S - \gamma_L)t]$

C. $W_0[(\gamma_S - \gamma_L)t]$

D. $W_0 t / (\gamma_S - gamme_L)$

Answer: A

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102. A pendulum clock having copper rod keeps correct time at $20^{\circ} C$. It gains 15 seconds per day if cooled to $0^{\circ} C$. Calculate the coefficient of linear expansion of copper.

A. $1.7 \times 10^{-4} / ^{\circ} C$

B. $1.7 \times 10^{-5} / ^{\circ} C$

C. $3.4 \times 10^{-4} / ^{\circ} C$

D. $3.4 \times 10^{-5} / ^{\circ} C$

Answer: B

Watch Video Solution

103. A glass flask is filled up to a mark with 50 cc of mercury at $18^{\circ} C$. If the flask and contents are heated to $38^{\circ} C$, how much mercury will be above the mark (α for glass is $9 \times 10^{-6} / {}^\circ C$ and coeffiecient of real expansion of mercury is $180 \times 10^{-6} / {}^\circ C$)?

A. 0.85 cc

B. 0.46 cc

C. 0.153 cc

D. 0.05 cc

Answer: C

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104. A flask of volume 10^3 cc is completely filled with mercury at $0^\circ C$ The coefficient of cubical expansion of mercury is $180 \times 10^{-6} / {}^\circ C$ and heat of glass is $40 \times 10^{-6} / {}^\circ C$. If the flask in now placed in boiling water at $100^\circ C$ how much mercury will overflow?

A. 7 cc

B. 14 cc

C. 21 cc

D. 28cc

Answer: D

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105. An aluminium measuring rod, which is correct at $5^\circ C$ measures the length of line as 80 cm at $45^\circ C$. If thermal coefficient of linear expansion of aluminium is $2.50 \times 10^{-5} per.^\circ C$. The correct length of the line is

A. 80.08 cm

B. 79.92 cm

C. 81.12 cm

D. 79.62 cm

Answer: A

Watch Video Solution

106. One end of a copper rod of uniform cross section and length 1.5 m is kept in contact with ice and the other end with water at $100^{\circ} C$. At what point along its length should a temperature of $200^{\circ} C$ be maintained so that in the steady state, the mass of ice melting be equal to that of the steam produced in same interval of time. Assume that the whole system is insulated from surroundings:

$[L_{\text{ice}} = 80 cal / g, L_{\text{steam}} = 540 cal / g]$

A. 8.59 cm from ice and

B. 10.34 cm from water end

C. 10.34 cm from ice end

D. 8.76 cm from water end

Answer: B

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107. A liquid takes 5 minutes to cool from $80^\circ C$ to$50^\circ C$. How much time will it take to cool from $60^\circ C$ to $30^\circ C$? The temperature of surroundings is $20^\circ C$.

A. 5 min

B. 9 min

C. 4 min

D. 12 min

Answer: B

Watch Video Solution

108. A one litre flask contains some mercury. It is found that at different temperatures the volume of air inside the flask remains tha same. What is the volume of mercury in the flask? Given the cofficients of linear expansion of glass is $9 \times 10^{-6} / ^{\circ} C$ and the coefficient of volume expansion of mercury is $1.8 \times 10^{-4} / ^{\circ} C$

A. 50 cc

B. 100 cc

C. 150 cc

D. 200 cc

Answer: C

Watch Video Solution

109. 250 g of water and equal volume of alcohol of mass 200 g are replaced successively in the same colorimeter and cool from $606^{\circ} C$

to $55^\circ C$ in 130 s and 67 s, respectively. If the water equivalent of the calorimeter is 10 g, then the specific heat of alcohol in $cal / g^\circ C$ is

A. 1.3

B. 0.67

C. 0.62

D. 0.985

Answer: C

Watch Video Solution

110. A 2 g bullet moving with a velocity of 200 m/s is brought to a sudden stoppage by an obstacle. The total heat produced goes to the bullet. If the specific heat of the bullet is $0.03 cal / g^\circ C$, the rise in its temperature will be

A. $158.0^\circ C$

B. $15.80^\circ C$

C. $1.58^\circ C$

D. $0.1580^\circ C$

Answer: A

Watch Video Solution

111. $10gm$ of ice at $-20^\circ C$ is dropped into a calorimeter containing $10gm$ of water at $10^\circ C$, the specific heat of water is twice that of ice. When equilibrium is reached the calorimeter will contain:

A. 20 g of water

B. 20 g of ice

C. 10 g ice and 10 g of water

D. 5 g ice and 15 g of water

Answer: C

Watch Video Solution

112. A steel ball of mass 0.1 kg falls freely from a height of 10 m and bounces to a height of 5.4 m from the ground. If the dissipated energy in this process is absorbed by the ball, the rise in its temperature is (specific heat of steel $= 460K/kg^{\circ}/C, g = 10m/s^2$)

A. $0.01^{\circ}C$

B. $0.1^{\circ}C$

C. $1^{\circ}C$

D. $1.1^{\circ}C$

Answer: B

Watch Video Solution

113. The earth receives its surface radiation from the sun at the rate of 1400 W/m^2. The distance of the centre of the sun from the surface of the earth is 1.5×10^{11} m and the radius of the sun is 7.0×10^8 m. Treating sun as a black body, it follows from the above data that its surface temeperature is

A. 5801K

B. $10^6 K$

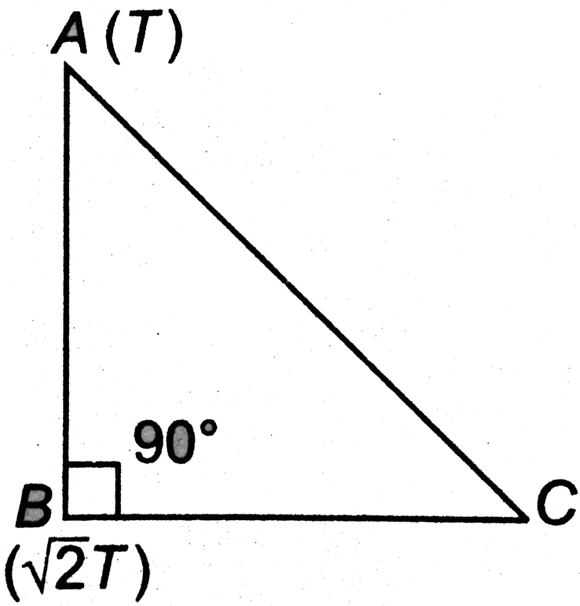
C. $50.1K$

D. $5801^\circ C$

Answer: A

Watch Video Solution

114. Three rods of identical cross-sectional area and made from the same metal form the sides of an isosceles triangle ABC right angled at B as shown in the figure. The points A and B are maintained at temperature T and $(\sqrt{2})T$ respectively in the steady state. Assuming that only heat conduction takes place, temperature of point C will be



A. $\dfrac{3T}{\sqrt{2}+1}$

B. $\dfrac{T}{\sqrt{2}+1}$

C. $\dfrac{T}{3\left(\sqrt{2}-1\right)}$

D. $\dfrac{T}{\sqrt{2}-1}$

Answer: A

Watch Video Solution

115. The coefficient of linear expansion of crystal in one direction is α_1 and that in every direction perpendicular to it is α_2. The coefficient of cubical expansion is

A. $\alpha_1 + \alpha_2$

B. $2\alpha_1 + \alpha_2$

C. $\alpha_1 + 2\alpha_2$

D. none of these

Answer: C

Watch Video Solution

116. A uniform metal rod is used as a bar pendulum. If the room temperature rises by $10^{\circ} C$, and the coefficient of linear expansion of the metal of the rod is $2 \times 10^{-6} per^{\circ} C$, the period of the pendulum will have percentage increase of

A. (a)-2×10^{-3}

B. (b)-1×10^{-3}

C. (c)2×10^{-3}

D. (d)1×10^{-3}

Answer: D

Watch Video Solution

117. An iron rod of length 50 cm is joined at an end to aluminium rod of length 100 cm. All measurements refer to $20^0 C$. Find the length of the composite system at $100^o C$ and its average coefficient of linear expansion. The coefficient of linear expansion of iron and aluminium are $12X10^{-6} C^{-1}$ and $24X10^{-6} C^{-1}$ respectively.

A. $36 \times 10^{-6} / {}^\circ C$

B. $12 \times 10^{-6} / {}^\circ C$

C. $20 \times 10^{-6} / {}^\circ C$

D. $48 \times 10^{-6} / {}^\circ C$

Answer: C

Watch Video Solution

118. The coefficient of apparent expansion of mercury in a glass vessel is $153 \times 10^{-6} / {}^\circ C$ and in a steel vessel is $114 \times 10^{-6} / {}^\circ C$. If α for steel is $12 \times 10^{-6} / ^{\circ} C$, then that of glass is

A. $9 \times 10^{-6} / ^{\circ} C$

B. $6 \times 10^{-6} / ^{\circ} C$

C. $36 \times 10^{-6} / ^{\circ} C$

D. $27 \times \left(10^{-6} / ^{\circ} C\right.$

Answer: A

Watch Video Solution

119. A vessel is partly filled with a liquid. Coefficients of cubical expansion of material of the vessel and liquid are γ_v unoccupied by the liquid will necessarily

A. (a)remain unchanged if $\gamma_v = \gamma_L$

B. (b)increase if $\gamma_v = \gamma_L$

C. (c)decrease if $\gamma_v = \gamma_L$

D. (d)none of the above

Answer: B

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120. An electrically heated coil is immersed in a calorimeter containing 360 g of water at $10^\circ C$. The coil consumes energy at the rate of 90 W. The water equivalent of calorimeter and coil is 40 g. The temperature of water after 10 min is

A. $4.214^\circ C$

B. $42.14^\circ C$

C. $30^\circ C$

D. none of these

Answer: B

Watch Video Solution

Watch Video Solution

121. Which one of the following would raise the temperature of 20 g of water at $30^\circ C$ most when mixed with?

(Specific heat of water is $1cal/g-.^\circ C$)

A. 20 g of water at $40^\circ C$

B. 40 g of water at $35^\circ C$

C. 10 g of water at $50^\circ C$

D. 4 g of water at $80^\circ C$

Answer: D

Watch Video Solution

122. A kettle with 2 litre water at $27^\circ C$ is heated by operating coil heater of power 1 kW. The heat is lost to the atmosphere at constant rate $160 J / s$, when its lid is open. In how much time will water heated to $77^{\circ} C$ with the lid open ? (specific heat of water = $4.2 kJ /^{\circ} C . kg$)

A. 8 min 20 s

B. 6 min 2 s

C. 14 min

D. 7 min

Answer: A

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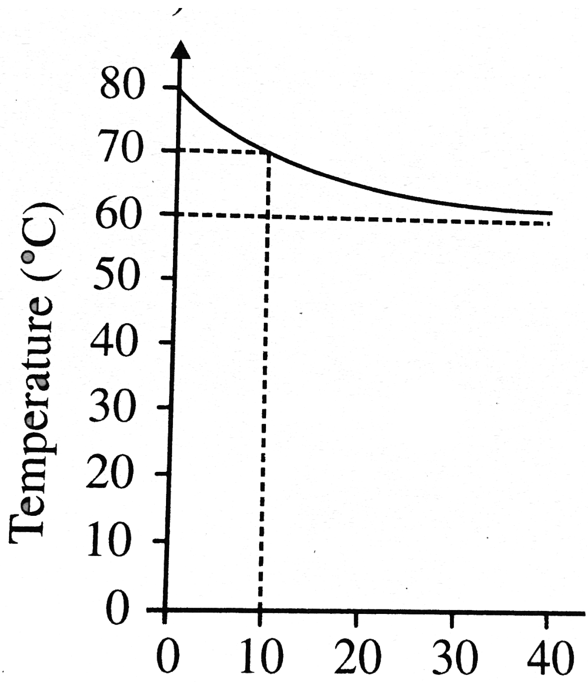

123.

A vessel contains M grams of water at a certain temperature and water at certain other temperature is passed into it at a constant rate of mg/s. The variation of temeprature of the mixture with time is shown in Fig. The values of M and m are, respectively (the heat exhanged after a long time is 800 cal)

A. (a)40 and 2

B. (b)40 and 4

C. (c)20 and 4

D. (d)20 and 2

Answer: B

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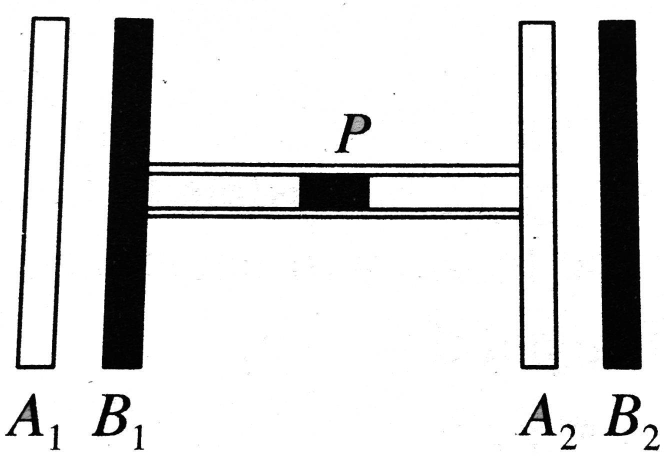

124.

Two plates identical in size, one of black and rough surface (B_1) and the other smooth and polished (A_2) are interconnected by a thin horizontal pipe with a mercury pellet at the centre. Two more plates

A_1 (identical to A_2) and B_2 (identical B_1) are heated to the same temperature and placed closed to the plates B_1, and A_2 shown in Fig. The mercury pellet

A. moves to the right

B. moves to the left

C. remains stationary

D. starts oscillating left and right

Answer: C

Watch Video Solution

125. Two spheres of different material one with double the radius and one fourth wall thickness of the other are filled with ice. If the time taken for complete melting of ice in the larger radius one is 25 minutes and that for smaller sphere is 16 minutes, the ratio of thermal conductivities of material of larger sphere to smaller sphere is

A. $4:5$

B. $5:4$

C. $8:25$

D. $25:8$

Answer: C

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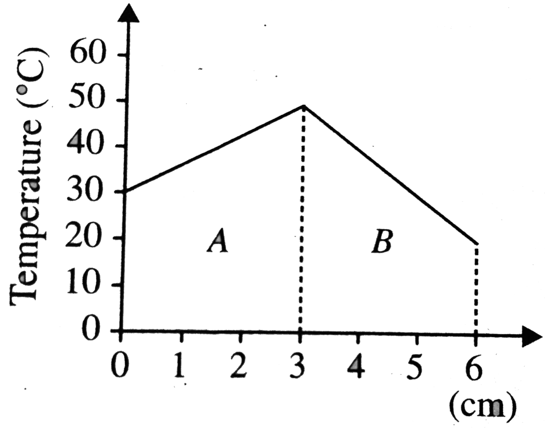

126.

The temperature across two different slabs A and B are shown I the steady state (as shown Fig) The ratio of thermal conductivities of A and B is

A. $2:3$

B. $3:2$

C. $1:1$

D. $5:3$

Answer: B

Watch Video Solution

127. An earthenware vessel loses 1 g of water per second due to evaporation. The water equivalent of the vessel is 0.5 kg and the vessel contains 9.5 kg of water find the time required for the water in the vessel to cool to $28^\circ C$ from $30^\circ C$. Neglect radiation losses. Latent heat of vapourization of water in this range of temperature is $540 cal/g$.

A. 38.6 min

B. 30.5 min

C. 34.5 min

D. 41.2 min

Answer: A

Watch Video Solution

128. 5g of water at $30^\circ C$ and 5 g of ice at $-29^\circ C$ are mixed together in a calorimeter. Find the final temperature of mixture. Water equivalent of calorimeter is negligible, specific heat of ice = $0.5 cal/g.^\circ C$ and latent heat of ice $= 80 cal/g$.

A. $0^\circ C$

B. $10^\circ C$

C. $-30^\circ C$

D. $> 10^\circ C$

Answer: A

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129. A body cools in 7 min from $60^\circ C$ to $40^\circ C$ What will be its temperature after the next 7 min? The temperature of surroundings is $10^\circ C$.

A. $28^{\circ} C$

B. $25^{\circ} C$

C. $30^{\circ} C$

D. $22^{\circ} C$

Answer: A

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130. A room at $20^{\circ} C$ is heated by a heater of resistence 20 ohm connected to 200 VV mains. The temperature is uniform throughout the room and the heati s transmitted through a glass window of area $1m^2$ and thickness 0.2 cm. Calculate the temperature outside. Thermal conductivity of glass is $0.2cal / mC^{\circ}$ s and mechanical equivalent of heat is $4.2J / cal.$

A. $13.69^{\circ} C$

B. $15.24^\circ C$

C. $17.85^\circ C$

D. $19.96^\circ C$

Answer: B

Watch Video Solution

131. A body cools from $50^\circ C$ to $49.9^\circ C$ in 5 s. How long will it take to cool from $40^\circ C$ to $39.9^\circ C$? Assume the temperature of surroundings to be $30^\circ C$ and Newton's law of cooling to be valid:

A. 2.5 s

B. 10 s

C. 20 s

D. 5 s

Answer: B

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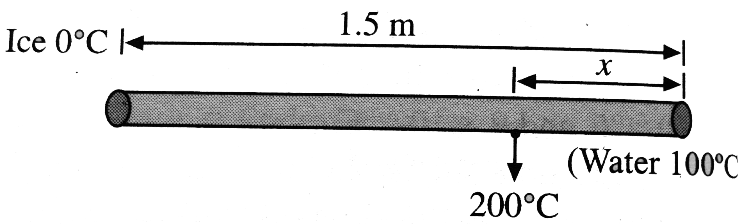

132.

One end of a copper rod of uniform cross section and of length 1.5 m is kept in contact with ice and the other end with water at $100^{\circ}C$. At what point along its length should a temperature of $200^{\circ}C$ be maintained so that in dteady state, the mass of ice melting be equal to that of the steam produced in same interval of time? Assume that the whole system is insulated from surroundings. Latent heat of fusion of ice and vapourization of water are $80cal/g$ and $540cal/g$, respectively

A. 10.34 cm from the end at $100^\circ C$

B. 10.34 mm from the end at $100^\circ C$

C. 1.034 cm from the end at $100^\circ C$

D. 1.034 m from the end at $100^\circ C$

Answer: A

Watch Video Solution

133. When the temperature of a black body increases, it is observed that the wavelength corresponding to maximum energy changes from $0.26\mu m$ to $0.13\mu m$. The ratio of the emissive powers of the body at the respective temperatures is

A. $\frac{16}{1}$

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

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

D. $\frac{1}{16}$

Answer: D

Watch Video Solution

134. The temperature of a room heated by heater is $20^\circ C$ when outside temperature is $-20^\circ C$ and it is $10^\circ C$ when the outside temperature is $-40^\circ C$. The temperature of the heater is

A. (a)$80^\circ C$

B. (b)$100^\circ C$

C. (c)$40^\circ C$

D. (d)$60^\circ C$

Answer: D

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135. The radiation emitted by a star A is 10000 times that of the sun. If the surface temperature of the sun and star A are $6000K$ and $2000K$ respectively. The ratio of the radii of the star A and the sun is:

A. $300:1$

B. $600:1$

C. $900:1$

D. $1200:1$

Answer: C

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136. A planet radiates heat at a rate proportional to the fourth power of its surface temperature T. If such a steady temperature of the planet is due to an exactly equal amount of heat received from the sun then which of the following statement is true?

A. The planets surface temperature vaires inversely as the distance of the sun.

B. The planet's surface temperature varies directly as the square of its distance from the sun.

C. The planet's surface temperature varies inversely as the square root of its distance from the sun.

D. The planet's surface temperature is proporional to the fourth power of distance from the sun.

Answer: C

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137. A planet is at an average distance d from the sun and its average surface temeperature is T. Assume that the planet receives energy only from the sun and loses energy only through radiation from the surface. Neglect atmospheric effects. If $T \propto d^{-n}$, the value of n is

A. 2

B. 1

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

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

Answer: C

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138. A blackbody is at a temperature of 2880K. The energy of radiation emitted by this object with wavelength between 499nm and 500nm is U_1, between 999nm and 1000nm is U_2 and between 1499 nm and 1500 nm is U_3. The Wien constant $b = 2.88 \times 10^6 nmK$. Then

A. $U_1 = 0$

B. $U_2 = 0$

C. $U_1 = U_2$

D. $U_2 > U_1$

Answer: D

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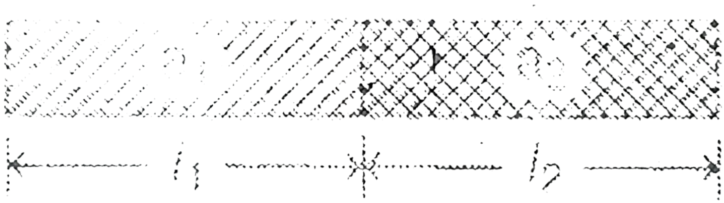
139. Two rods having lengths l_1 and l_2, made of material with linear expansion coefficients α_1 and α_2 were soldered together. The equivalent coefficeints linear expansion for the composite rod is



A. $\dfrac{l_1\alpha_2 + l_2\alpha_1}{l_1 + l_2}$

B. $\dfrac{l_1\alpha_1 + l_2\alpha_2}{\alpha_1 + \alpha_2}$

C. $\dfrac{l_1\alpha_1 + l_2\alpha_2}{l_1 + l_2}$

D. $\dfrac{l_2\alpha_1 + l_1\alpha_2}{\alpha_1 + \alpha_2}$

Answer: C

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140.

In the given figure, a rod is free at one end and other end is fixed. When we change the temperature of rod by $\Delta\theta$, then strain produced in the rod will be

A. $\alpha\Delta\theta$

B. $\frac{1}{2}\alpha\Delta\theta$

C. zero

D. information incomplete

Answer: C

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141. A bar measured with a vernier caliper is found to be 180 mm long. The temperature during the measurement is $10^\circ C$. The measurement error will be if the scale of the vernier caliper has been graduated at a temeprature of $20^\circ C$. ($\alpha = 1.1 \times 10^{-5} .^\circ C^{-1}$. Assume that the length of the bar does not change.)

A. (a)$1.98 \times 10^{-1} mm$

B. (b)$1.98 \times 10^{-2} mm$

C. (c)$1.98 \times 10^{-3} mm$

D. (d)$1.98 \times x 10^{-4} mm$

Answer: B

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142. A closed cubical box is made of perfectly insulating material and the only way for heat to enter or leave the box is through two solid cylindrical metal plugs, each of cross sectional area $12cm^2$ and length 8cm fixed in the opposite walls of the box. The outer surface of one plug is kept at a temperature of $100^\circ C$. while the outer surface of the plug is maintained at a temperature of $4^\circ C$. The thermal conductivity of the material of the plug is $2.0Wm^{-1}C^{-1}$. A source of energy generating 13W is enclosed inside the box. Find the equilibrium temperature of the inner surface of the box assuming that it is the same at all points on the inner surface.

A. $62^\circ C$

B. $46^\circ C$

C. $76^\circ C$

D. $52^\circ C$

Answer: C

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143. Two models of a windowpane are made. In one model, two identical glass panes of thickness 3 mm are separated with an air gap of 3 mm. This composite system is fixed in the window of a room The other model consist of a single glass pane of thickness 3 mm, the temperature difference being the same as for the first model. the ratio of the heat flow fot the double pane to that for the single pane is

$(K_{\text{glass}} = 2.5 \times 10^{-4} cal / s. m.^{\circ} C$ and $K_{\text{air}} = 6.2 \times 10^{-6} cal / s. m.^{\circ} C)$.

A. $1/20$

B. $1/70$

C. $1/100$

D. $1/50$

Answer: D

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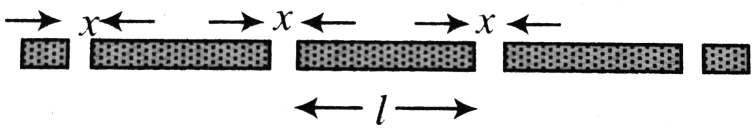

144.

The gap between any two rails each of length l laid on a railway trach equals x at $27^{\circ}C$ When the temperature rises to $40^{\circ}C$ the gap closes up. The coefficient of linear expansion of the material of the rail is α. The length of a rail at $27^{\circ}C$ will be

A. $\frac{x}{26\alpha}$

B. $\frac{x}{13\alpha}$

C. $\frac{2x}{13\alpha}$

D. none of these

Answer: B

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145. 1 g of steam at $100^\circ C$ and an equal mass of ice at $0^\circ C$ are mixed. The temperature of the mixture in steady state will be (latent heat of steam $= 540 cal / g$, latent heat of ice $= 80 cal / g$,specific heat of water $= 1 cal / g^\circ C$)

A. $50^\circ C$

B. $100^\circ C$

C. $67^\circ C$

D. None of these

Answer: B

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146. Water at $0^\circ C$ was heated until it started to boil and then until it all changed to steam. The time required to heat water from $0^\circ C$ to $100^\circ C$ is 5 min and the time to change boiling water to steam is 28 minutes. If the flame supplied heat at a constant rate, the specific latent heat of vaporization of water (neglecting heat losses, container etc. is (in J/g). (specific heat of water s $= 4.2J/g$)

A. 540

B. 2268

C. 2352

D. 2356

Answer: C

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147. A tap supplies water at $15^{\circ}C$ and another tap connected to geyser supplies water at $95^{\circ}C$. How much hot water must be taken so as to get 60 kg of water at $35^{\circ}C$?

A. 15 kg

B. 5 kg

C. 10 kg

D. 20 kg

Answer: A

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148. The remaining volume of a glass vessel is constant at all temperature if $\frac{1}{x}$ of its volume is filled with mercury. The coefficient of volume expansion of mercury is 7 times that of glass. The value of x should be

A. 5

B. 7

C. 6

D. 8

Answer: B

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Multiple Correct

1. Due to thermal expansion with rise in temperature:

A. (a)metallic scale reading becames lesser that true value

B. (b)pendulum clock becomes fast

C. (c)a floating body sinks a little more

D. (d)the weight of a body in a liquid increases

Answer: A::C::D

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2. During heat exchange, temperature of a solid mass does not change. In this process, heat

A. in not being supplied to the mass

B. is not being taken out from the mass

C. may have been supplied to the mass

D. may have been taken out from the mass

Answer: C::D

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3. A metallic circular disc having a circular hole at its centre rotates about an axis passing through its centre and perpendicular to its plane. When the disc is heated:

A. its speed will decrease

B. its diameter will decrease

C. its moment of inertial will increase

D. its speed will increase

Answer: A::C

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4. A polished metallic piece and a black painted wooden piece are kept in open in bright sun for a long time.

A. the wooden piece will absorb less heat than the metallic piece

B. the wooden piece will have a lower temperature than the metallic piece

C. if touched, the metallic piece will be felt hotter than the wooden piece

D. when the two pieces are removed from the open to a cold room, the wooden piece will lose heat at a faster rate than the metallic piece

Answer: C::D

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5. 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 increae by a factor of 16

D. the total emitted energy will increase by a factor of 2

Answer: A::C

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6. During the melting of a slab of ice at 273K at atmospheric pressure,

A. positive work is done by the ice water system on the atmosphere

B. positive work is done on the ice water system by the atmosphere

C. the internal energy of the ice water system increases

D. the internal energy of the ice water system decreases.

Answer: B::C

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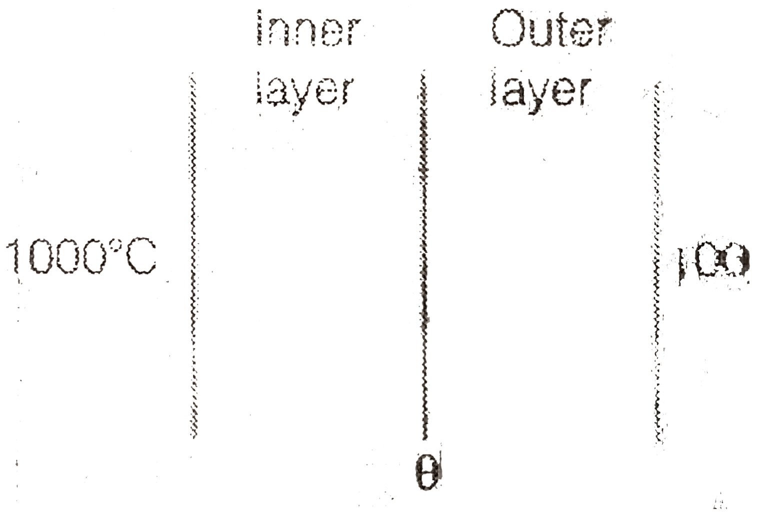
7. The temperature drop through a two layer furnace wall is $900^\circ C$. Each layer is of equal area of cross section. Which of the following actions will result in lowering temperature θ of the interface ?



A. By increasing the thermal conductivity of outer layer

B. By increasing the thermal conductivity of inner layer

C. By increasing thickness of outer layer

D. By increasing thickness of inner layer

Answer: A::D

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8. The ends of a metal rod are kept at temperatures θ_1 and θ_2 with $\theta_2 > \theta_1$. The rate of flow of heat along the rod is directly proportional to

A. the length of the rod

B. the diameter of the rod

C. the cross sectional area of the rod

D. the temperature difference $(\theta_2 - \theta_1)$ between the ends of the rod

Answer: C::D

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9. Choose the correct statements from the following:

A. (a)A temperature change which increases the length of a steel rod by 0.1% will increase its volume by nearly 0.3%

B. (b)The specific heat of a solid is different when the solid is heated at (i) constant pressure and (ii) the constant volume

C. (c)the thermal conductivity of air being less than that for wool, we prefer wool to air for thermal insulation

D. (d)When the distance between two fixed points is measured with a steel tape, the observed reding will be less on a hot day than on a cold day

Answer: A::B::D

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10. Choose the correct statements from the following:

A. Good reflectors are good emitters of thermal radiation

B. Burns caused by water at $100^\circ C$ are more severe than those caused by steam at $100^\circ C$

C. If the earth did not have atmosphere, it would become intolerably cold

D. It is impossible to construct a heat engine of 100% efficiency

Answer: C::D

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11. When the temperature of a copper coin is raised by $80^\circ C$, its diameter increases by 0.2%.

A. percentage rise in the area of a face is 0.4%

B. percentage rise in the thickness is 0.4%

C. percentage rise in the volume is 0.6%

D. corfficient of linear expansion of copper is $0.25 \times 10^{-4} / ^\circ C$

Answer: A::C::D

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12. A vessel is partly filled with liquid. When the vessel is cooled to a lower temperature, the space in the vessel unoccupied by the liquid remains constant. Then the volume of the liquid (V_L) volume of the vessel (V_V) the coefficient of cubical expansion of the material of the vessel (γ_v) and of the liquid (γ_L) are related as

A. $\gamma_L > \gamma_V$

B. $\gamma_L < \gamma_V$

C. $\frac{\gamma_V}{\gamma_L} = \frac{V_V}{V_L}$

D. $\frac{\gamma_V}{\gamma_L} = \frac{V_L}{V_V}$

Answer: A::D

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13. Two identical objects A and B are at temperatures T_A and T_B. Respectively. Both objects are placed in a room with perfectly absorbing walls maintained at a temperature $T(T_A > T > T_B)$. The objects A and B attain the temperature T eventually. Select the correct statements from the following:

A. A only emits radiation while B only obsorbs it until both attain the temperature T

B. A loses more heat by radiation than it absorbs, while B absorbs more radiation than it emits, until they attain the temperature T

C. Both A and B only absorb radiation, but do not emit it, until they attain the temperature T

D. Each object continuous to emit and absorb radiation even after attaining the temperature T.

Answer: B::D

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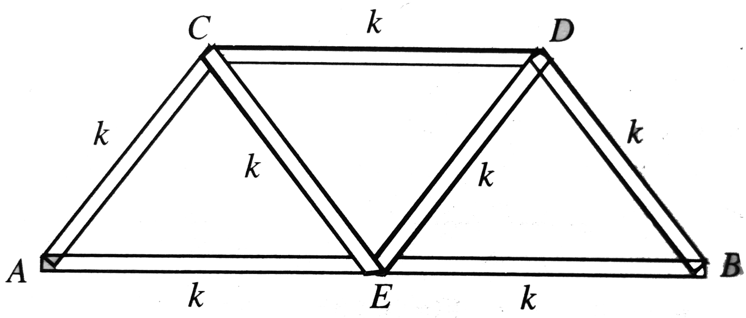

14.

Seven identical rods of material of thermal conductivity k are connected as shown in Fig. All the rods are of identical length l and cross sectional area A If the one end A is kept at $100^{\circ} C$ and the other end is kept at $0^{\circ} C$ what would be the temperatures of the junctions C, D and $E(\theta_C,\theta) D$ and θ_E) in the steady state?

A. $\theta_C > \theta_E > \theta_D$

B. $\theta_E = 50^{\circ} C$ and $\theta_D = 37.5^{\circ} C$

C. $\theta_E = 50^{\circ} C$,$\theta_C = 62.5^{\circ} C$ and $\theta_D = 37.5^{\circ} C$

D. $\theta_E = 50^{\circ} C$,$\theta_C = 60^{\circ} C$ and $\theta_D = 40^{\circ} C$

Answer: A::C

Watch Video Solution

15. A clock is calibrated at a temperature of $20^\circ C$ Assume that the penduum is a thin brass rod of negligible mass with a heavy bob attached to the end $\left(\alpha_{\text{brass}} = 19 \times 10^{-6} / K\right)$

A. On a hot day at $30^\circ C$ the clock gains 8.2 s

B. On a hot day at $30^\circ C$ the clock loses 8.2 s

C. On a cold day at $10^\circ C$ the clock gains 8.2 s

D. On a cold day at $10^\circ C$ the clock loses 8.2 s

Answer: B::C

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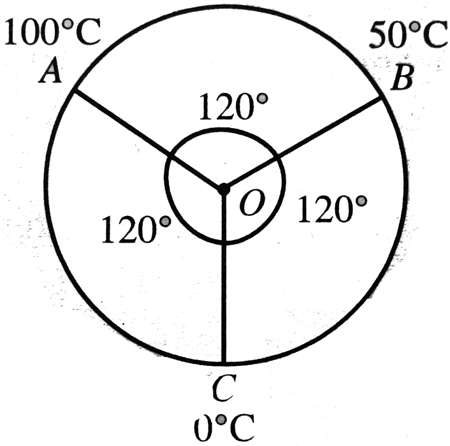
16.



A circular ring (centre O) of radius a, and of uniform cross section is made up of three different metallic rods AB, BC and CA (joined together at the points A, B and C in pairs) of thermal conductivityies α_1,α_2 and α_3 respectively (see diagram). The junction A, B and C are maintained at the temperatures $100^\circ C$,$50^\circ C$ and $0^\circ C$, respectively. All the rods are of equal lengths and cross sections. Under steady state conditions, assume that no heat is lost from the sides of the rods. Let Q_1,Q_2 and Q_3 be the rates of transmission of heat along the three rods AB, BC and CA. Then

A. $Q_1 = Q_2 = Q_3$ and all are transmitted in the clockwise sense

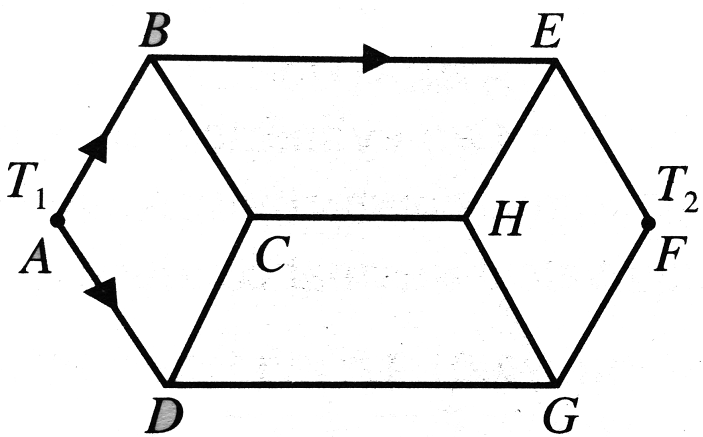
B. Q_1 and Q_2 flow in clockwise sense and Q_3 in the anticlockwise sense.

C. $Q_1 : Q_2 : Q_3 : : \alpha_1 : \alpha_2 : 2\alpha_3$

D. $\frac{Q_1}{\alpha_1} + \frac{Q_2}{\alpha_2} = \frac{Q_3}{\alpha_3}$

Answer: B::C::D

Watch Video Solution



17.

Eleven identical rods are arranged as shown in Fig. Each rod has length l, cross sectional area A and thermal conductivity of material

k. Ends A and F are maintained at temperatures T_1 and $T_2(<T_1)$, respectively. If lateral surface of each rod is thermally insulated, the rate of heat transfer $\left(\frac{dQ}{dt}\right)$ in each rod is

A. $\left(\frac{dQ}{dt}\right)_{AB}=\left(\frac{dQ}{dt}\right)_{CD}$

B. $\left(\frac{dQ}{dt}\right)_{BE}=\frac{2}{7}\frac{(T_1-T_2)KA}{l}$

C. $\left(\frac{dQ}{dt}\right)_{CH}\neq\left(\frac{dQ}{dt}\right)_{DG}$

D. $\left(\frac{dQ}{dt}\right)_{BC}=\left(\frac{dQ}{dt}\right)_{DC}$

Answer: B::C::D

Watch Video Solution

18. A solid sphere and a hollow sphere of the same material and of equal radii are heated to the same temperature.

A. in the beginning both will emit equal amount of radiation per unit time

B. In the beginning both will absorb equal amount of radiation per unit time

C. Both spheres will have same rate of fall of temeperature $\left(\frac{dT}{dt}\right)$

D. Both sphere will have equal temperatures at any moment.

Answer: A::B

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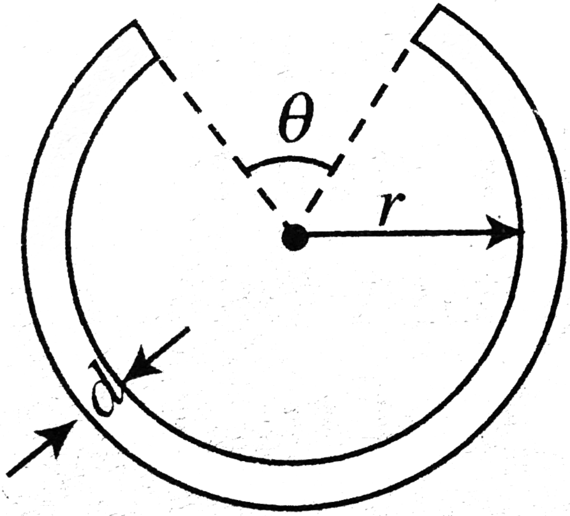

19.

A thin cylindrical metal rod is bent into a ring with a small gap as shown in figure. On heating the system

A. θ decreases, r and d increase

B. θ increase

C. d and r increase

D. θ is constant

Answer: C::D

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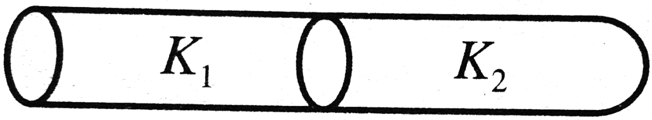

20.

Statement I: Two solid cylindrical rods of identical size and different thermal conductivity K_1 and K_2 are connected in series. Then the equivalent thermal conductivity of two rods system is less than that value of thermal conductivity of either rod.

Statement II: For two cylindrical rods of identical size and different thermal conductivity K_1 and K_2 connected in series, the equivalent thermal conductivity K is given by $\frac{2}{K}=\frac{1}{K_1}+\frac{1}{K_2}$

A. (a)Statement I is true, Statement II is true and Statement II is the correct explanation for statement I.

B. (b)Statement I is true, statement II is true and statement II NOT the correct explanation for Statement I

C. (c)Statement I is true, Statement II is false.

D. (d)Statement I is false, statement II is true.

Answer: D

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21. Statement I: As the temperature of the black body increases, the wavelength at which the spectral intensity (E_λ) is maximum decreases.

Statement II: The wavelength at which the spectral intensity will be maximum for a black body is proportional to the fourth power of its absolute temperature.

A. Statement I is true, Statement II is true and Statement II is the correct explanation for statement I.

B. Statement I is true, statement II is true and statement II NOT the correct explanation for Statement I

C. Statement I is true, Statement II is false.

D. Statement I is false, statement II is true.

Answer: C

Watch Video Solution

22. Statement I: The thermal resistance of a multiple later is equal to the sum of the thermal resistance of the individual laminas.

Statement II: Heat transferred is directly proportional to the temperature gradient in each layer.

A. (a)Statement I is true, Statement II is true and Statement II is the correct explanation for statement I.

B. (b)Statement I is true, statement II is true and statement II NOT the correct explanation for Statement I

C. (c)Statement I is true, Statement II is false.

D. (d)Statement I is false, statement II is true.

Answer: D

Watch Video Solution

23. In natural convection, the fluid motion is caused due to density difference produced by temperature gradient.

Statement II: In forced convection, the fluid is forced to flow along the solid surface by means of fans or pumps.

A. (a)Statement I is true, Statement II is true and Statement II is the correct explanation for statement I.

B. (b)Statement I is true, statement II is true and statement II NOT the correct explanation for Statement I

C. (c)Statement I is true, Statement II is false.

D. (d)Statement I is false, statement II is true.

Answer: B

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24. Statement I: The bulb of one thermometer is spherical while that of the other is cylindrical . Both have equal amounts of mercury. The response of the cylindrical bulb thermometer will be quicker.

Statement II: Heat conduction in a body is directly proportional to cross-sectional area.

A. Statement I is true, Statement II is true and Statement II is the correct explanation for statement I.

B. Statement I is true, statement II is true and statement II NOT the correct explanation for Statement I

C. Statement I is true, Statement II is false.

D. Statement I is false, statement II is true.

Answer: A

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25. Statement I: The expanded length l of a rod of original length l_0 is not correctly given by (assuming α to be constant with T) $l = l_0(1 + \alpha \Delta T)$ if $\alpha \Delta T$ is large.

Statement II: It is given by $l = l_0 e^{\alpha \Delta T}$, which cannot be treated as being approximately equal to $l = l_0(1 + \alpha \Delta T)$ for large value a ΔT.

A. Statement I is true, Statement II is true and Statement II is the correct explanation for statement I.

B. Statement I is true, statement II is true and statement II NOT the correct explanation for Statement I

C. Statement I is true, Statement II is false.

D. Statement I is false, statement II is true.

Answer: A

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Comprehension

1. A body cools in a surrounding of constant temperature $30^{\circ} C$ Its heat capacity is $2J/^{\circ} C$. Initial temperature of cooling is valid. The body of mass 1 kg cools to $38^{\circ} C$ in 10 min

When the body temperature has reached $38^\circ C$, it is heated again so that it reaches $40^\circ C$ in 10 min. The heat required from a heater by the body is

A. $36^\circ C$

B. $36.4^\circ C$

C. $37^\circ C$

D. $37.5^\circ C$

Answer: B

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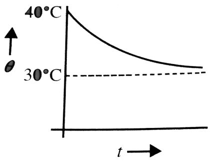
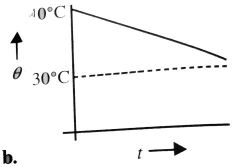
2. A body cools in a surrounding of constant temperature $30^\circ C$ Its heat capacity is $2J/^\circ C$. Initial temeprature of cooling is valid. The body cools to $38^\circ C$ in 10 min

The temperature of the body In $.^\circ C$ denoted by θ. The veriation of θ versus time t is best denoted as

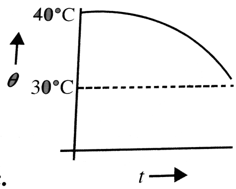
A. a.



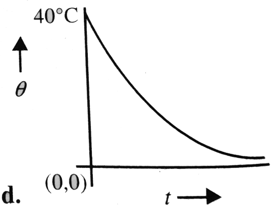
B. b.



C. c.



D. d.



Answer: A

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3. A body cools in a surrounding of constant temperature $30^\circ C$ Its heat capacity is $2J/^\circ C$. Initial temperature of cooling is valid. The body of mass 1 kg cools to $38^\circ C$ in 10 min

When the body temperature has reached $38^\circ C$, it is heated again so that it reaches $40^\circ C$ in 10 min. The heat required from a heater by the body is

A. 3.6 J

B. 0.364 J

C. 8 J

D. 4 J

Answer: C

Watch Video Solution

4. The internal energy of a solid also increases when heat is transferred to it from its surroundings. A 5 kg solid bar is heated at atmospheric pressure. Its temperature increases from $20^\circ C$ to $70^\circ C$. The linear expansion coefficient of solid bar is $1 \times 10^{-3} / ^\circ C$. The density of solid bar is $50 kg / m^3$. The specific heat capacity of solid bar is $200 J / kg C^\circ$. The atmospheric pressure is $1 \times 10^5 N / m^2$.

The work done by the solid bar due to thermal expansion, under atmospheric pressure is

A. 500 J

B. 1000 J

C. 1500 J

D. 2000 J

Answer: C

Watch Video Solution

5. The internal energy of a solid also increases when heat is transferred to it from its surroundings. A 5 kg solid bar is heated at atmospheric pressure. Its temperature increases from $20^\circ C$ to $70^\circ C$. The linear expansion coefficient of solid bar is $1 \times 10^{-3} / ^\circ C$. The density of solid bar is $50 kg / m^3$. The specific heat capacity of solid bar is $200 J / kg C^\circ$. The atmospheric pressure is $1 \times 10 N / m^2$.

The heat transferred to the solid bar is

A. 49000 J

B. 50000 J

C. 50500 J

D. 51000 J

Answer: B

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6. The internal energy of a solid also increases when heat is transferred to it from its surroundings. A 5 kg solid bar is heated at atmospheric pressure. Its temperature increases from $20^{\circ} C$ to $70^{\circ} C$. The linear expansion coefficient of solid bar is $1 \times 10^{-3} / ^{\circ} C$. The density of solid bar is $50 Kg / m^3$. The specific heat capacity of solid bar is $200 J / kgC^{\circ}$. The atmospheric pressure is $1 \times 10 N / m^2$.

The increase in the internal energy of the sold bar is

A. 49500 J

B. 48500 J

C. 49000 J

D. 50000 J

Answer: B

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7. A wire of length 1 m and radius 10^{-3}m is carrying a heavy current and is assumed to radiate as a black body. At equilibrium, its temperature is 900 K while that of surrounding is 300 K. The resistivity of the material of the wire at 300 K is $\pi^{\circ} \times 10^{-8}$ ohm m and its temperature coefficient of resistance is $7.8 \times 10^{-3} / C$ (stefan's constant$\sigma = 5.68 \times 10^{-8} W / m^2 K^4$).

Q. The resistivity of wire at 900 K is nearly

A. $2.4 \times 10^7 ohmm$

B. $2.4 \times 10^{-7} ohmm$

C. $1.2 \times 10^{-7} ohmm$

D. $1.2 \times 10^{-7} ohmm$

Answer: B

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8. A wire of length 1 m and radius 10^{-3}m is carrying a heavy current and is assumed to radiate as a black body. At equilibrium, its temperature is 900 K while that of surrounding is 300 K. The resistivity of the material of the wire at 300 K is $\pi^{\circ} \times 10^{-8}$ ohm m and its temperature coefficient of resistance is $7.8 \times 10^{-3} / C$ (stefan's constant$\sigma = 5.68 \times 10^{-8} W / m^2 K^2$.

Heat radiated per second by the wire is nearly

A. 23 W

B. 230 W

C. 2300 W

D. 23000 W

Answer: B

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9. A wire of length 1 m and radius 10^{-3}m is carrying a heavy current and is assumed to radiate as a black body. At equilibrium, its temperature is 900 K while that of surrounding is 300 K. The resistivity of the material of the wire at 300 K is $\pi^{\circ} \times 10^{-8}$ ohm m and its temperature coefficient of resistance is $7.8 \times 10^{-3} / C$ (stefan's constant$\sigma = 5.68 \times 10^{-8} W / m^2 K^2$.

The current in the wire is nearly

A. (a)0.555 A

B. (b)5.5 A

C. (c)55 A

D. (d)550 A

Answer: C

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10. Assume that the thermal conductivity of copper is twice that of aluminium and four times that of brass. Three metal rods made of copper, aluminium and brass are each 15 cm long and 2 cm in diameter. These rods are placed end to end, with aluminium between the other two. The free ends of the copper and brass rods are maintained at $100^\circ C$ and $0^\circ C$ respectively. The system is allowed to reach the steady state condition. Assume there is no loss of heat anywhere.

When steady state condition is reached everywhere, which of the following statement is true?

A. No heat is transmitted across the copper aluminium or aluminium brass junctions.

B. More heat is transmitted across the copper aluminium junction than across the aluminium brass junction.

C. More heat is tranmitted across the aluminium brass junction than the copper aluminium junction.

D. Equal amount of heat is transmitted at the copper aluminium and aluminium brass junctions.

Answer: D

Watch Video Solution

11. Assume that the thermal conductivity of copper is twice that of aluminium and four times that of brass. Three metal rods made of copper, aluminium and brass are each 15 cm long and 2 cm in diameter. These rods are placed end to end, with aluminium between the other two. The free ends of the copper and brass rods are maintained at $100^{\circ} C$ and $0^{\circ} C$ respectively. The system is allowed to reach the steady state condition. Assume there is no loss of heat anywhere.

When steady state condition is reached everywhere, which of the following statement is true?

A. $86^{\circ} C$

B. $18.8^{\circ} C$

C. $57^{\circ} C$

D. $73^{\circ} C$

Answer: A

Watch Video Solution

12. Assume that the thermal conductivity of copper is twice that of aluminium and four times that of brass. Three metal rods made of copper, aluminium and brass are each 15 cm long and 2 cm in diameter. These rods are placed end to end, with aluminium between the other two. The free ends of the copper and brass rods are maintained at $100^{\circ} C$ and $0^{\circ} C$ respectively. The system is allowed to reach the steady state condition. Assume there is no loss of heat anywhere.

When steady state condition is reached everywhere, which of the following statement is true?

A. $57^\circ C$

B. $35^\circ C$

C. $18.8^\circ C$

D. $28.5^\circ C$

Answer: A

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13. A thin copper rod of uniform cross section A square metres and of length L metres has a spherical metal sphere of radius r metre at Its one end symmetrically attached to the copper rod. The thermal conductivity of copper is K and the emissivity of the spherical surface of the sphere is ε.The free end of the copper rod is maintained at the temperature T kelvin by supplying thermal energy from a P watt source. Steady state conditions are allowed to be established while the rod is properly insulated against heat loss from its lateral surface. Surroundings are at $0^\circ C$ Stefan's constant $= \sigma W / m^2 K^4$.

After the steady state conditions are reached,the temperature of the spherical end of the rod, T_S is

A. A.$T_S = T - \frac{PL}{KA}$

B. B.$T_S = 0^\circ C$

C. C.$T_S = \frac{PL}{KA}$

D. D.$T_S = T - \frac{P(L+r)}{KA}$

Answer: D

Watch Video Solution

14. A thin copper rod of uniform cross section A square metres and of length L metres has a spherical metal sphere of radius r metre at tis one end symmetrically attached to the copper rod. The thermal conductivity of copper is K and the emissivity of the spherical surface of the sphere is ε.The free end of the copper rod is maintained at the temperature T kelving by supplying thermal energy from a P watt source. Steady state conditions are allowed ot be established while the rod is properly insulated aginst heat loss from its lateral surface. Surroundings are at $0^{\circ} C$ Stefan's constant $= \sigma W / m^2 K^4$.

The net power that will be radiated out, P_S from the sphere after steady state condition are reached is

A. $P_S = P$

B. $P_S = \frac{PA}{4\pi r^2}$

C. $P_S = 0$

D. $P_S = \sigma \varepsilon T_S^4$

Answer: A

Watch Video Solution

15. A thin copper rod of uniform cross section A square metres and of length L metres has a spherical metal sphere of radius r metre at tis one end symmetrically attached to the copper rod. The thermal conductivity of copper is K and the emissivity of the spherical surface of the sphere is ε.The free end of the copper rod is maintained at the temperature T kelving by supplying thermal energy from a P watt source. Steady state conditions are allowed ot be established while the rod is properly insulated aginst heat loss from its lateral surface. Surroundings are at $0^{\circ} C$ Stefan's constant $= \sigma W / m^2 K^4$.

If the metal sphere attached at the end of the copper rod is made of brass, whose thermal conductivity is $K_b < K$, then which of the following statements is true?

A. The temperature of the sphere will, under steady state conditions, continue to be T_B

B. The power that will be radiated out from the sphere will still be P_S.

C. It will take smaller time for steady state conditions to be reached

D. The rate of thermal energy transmitted across the copper rod, under steady state, will reduced.

Answer: B

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16. An immersion heater, in an insulated vessel of negligible heat capacity brings 100 g of water to the boiling point from $16^{\circ}C$ in 7 min. Then

Q. Power of heat is nearly

A. 8.4×10^{3}

B. 84 W

C. $8.4 \times 10^{3} \frac{cal}{s}$

D. 20 W

Answer: B

Watch Video Solution

17. An immersion heater, in an insulated vessel of negligible heat capacity brings 100 g of water to the boiling point from $16^\circ C$ in 7 min. Then

Q. The water is replaced by 200 g of alcohol, which is heated from $16^\circ C$ to the boiling point of $78^\circ C$ in 6 min 12 s whereas 30 g are vapourized in 5 min 6 s. The specific heat of alcohol is

A. $0.6 J / kg^\circ C$

B. $0.6 cal / g^\circ C$

C. $0.6 cal / kg^\circ C$

D. $6 J / kg^\circ C$

Answer: B

Watch Video Solution

18. An immersion heater, in an insulated vessel of negligible heat capacity brings 100 g of water to the boiling point from $16^{\circ}C$ in 7 min. Then

Q. Power of heat is nearly

A. $854J/Kg$

B. $854 \times 10^{3}J/kg$

C. $204cal/g$

D. $204cal/kg$

Answer: B

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19. A body of area $0.8 \times 10^{-2} m^2$ and mass $5 \times 10^{-4} kg$ directly faces the sun on a clear day. The body has an emissivity of 0.8 and specific heat of $0.8 cal / kg$ K. The surroundings are at $27^\circ C$. (solar constant $= 1.4 kW / m^2$).

The temperature that the body would reach if it lost all its heat by radiation is

A. A.$0.36^\circ C / s$

B. B.$3.6 K / s$

C. C.$36^\circ C / s$

D. D.$72 K / s$

Answer: B

Watch Video Solution

20. A body of area $0.8 \times 10^{-2} m^2$ and mass $5 \times 10^{-4} kg$ directly faces the sun on a clear day. The body has an emissivity of 0.8 and specific heat of $0.8 ca / kg$ K. The surroundings are at $27^\circ C$. (solar constant $= 1.4 kW / m^2$).

The maximum attainable temperature of the body is

A. $396K$

B. $396^\circ C$

C. $85^\circ C$

D. $85K$

Answer: A

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21. A body of area $0.8 \times 10^{-2} m^2$ and mass $5 \times 10^{-4} kg$ directly faces the sun on a clear day. The body has an emissivity of 0.8 and specific heat of $0.8cal / kg$ K. The surroundings are at $27^\circ C$. (solar constant $= 1.4kW / m^2$).

The temperature that the body would reach if it lost all its heat by radiation is

A. 396 K

B. $296^\circ C$

C. $85^\circ C$

D. $85K$

Answer: C

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22. A copper collar is to fit tightly about a steel shaft that has a diameter of 6 cm at $20^\circ C$. The inside diameter of the copper collar at the temperature is $5.98cm$

Q. To what temperature must the copper collar be raised to that it will just slip on the steel shaft, assuming the steel shaft remains at $20^\circ C$? $(\alpha_{\text{copper}} = 17 \times 10^{-6} / K)$

A. $324^\circ C$

B. $21.7^\circ C$

C. $217^\circ C$

D. $32.4^\circ C$

Answer: C

Watch Video Solution

23. A copper collar is to fit tightly about a steel shaft that has a diameter of 6 cm at $20^\circ C$. The inside diameter of the copper collar at the temperature is $5.98 cm$

Q. The tensile stress in the copper collar when its temperature returns to $20^\circ C$ is $(T = 11 \times 10^{10} N / m^2)$

A. $1.34 \times 10^5 N/m^2$

B. $3.68 \times 10^{-12} N/m^2$

C. $3.68 \times 10^8 N/m^2$

D. $1.34 \times 10^{-12} N/m^2$

Answer: C

Watch Video Solution

24. A copper collar is to fit tightly about a steel shaft that has a diameter of 6 cm at $20^\circ C$. The inside diameter of the copper collar at the temperature is $5.98cm$

If the breaking stress of copper is $230N/m^2$, at what temperature will the copper collar break as it cools?

A. $20^\circ C$

B. $47^\circ C$

C. $94^{\circ} C$

D. $217^{\circ} C$

Answer: C

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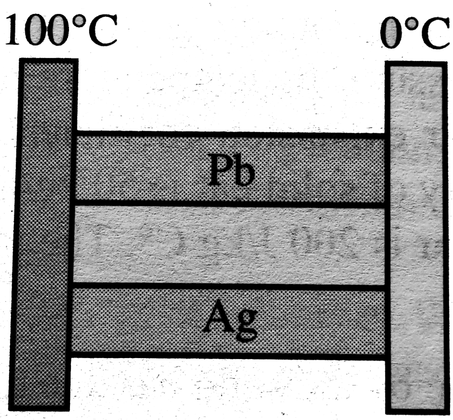

25.

Two insulated metal bars each of length 5 cm and rectangular cross section with sides 2 cm and 3 cm are wedged between two walls, one held at $100^{\circ} C$ and the other at $0^{\circ} C$. The bars are made of lead and silver. $K_{pb} = 350 W / mK, K_{Ag} = 425 W / mK.$

Thermal corrent through lead bar is

A. 210 W

B. 420 W

C. 510 W

D. 930 W

Answer: B

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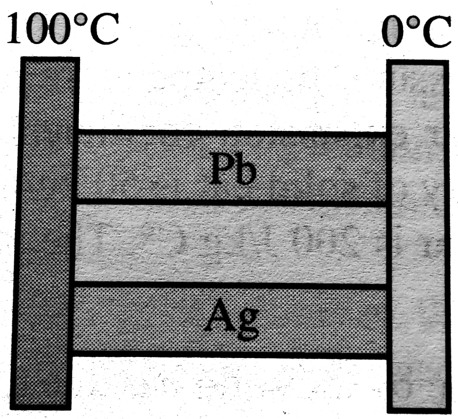
26.



Two insulated metal bars each of length 5 cm and rectangular cross section with sides 2 cm and 3 cm are wedged between two walls, one held at $100^\circ C$ and the other at $0^\circ C$. The bars are made of lead and silver. $K_{pb} = 350W/mK, K_{Ag} = 425W/mK.$

Total thermal current through the two bar system is

A. 210 W

B. 420 W

C. 510 W

D. 930 W

Answer: D

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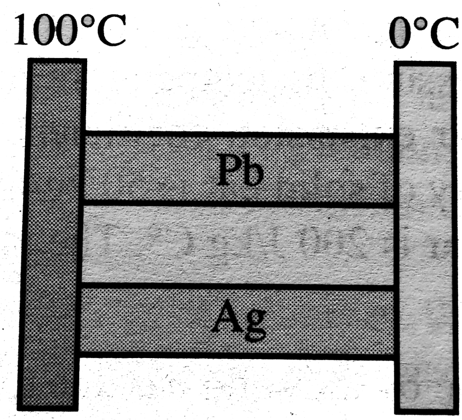
27.



Two insulated metal bars each of length 5 cm and rectangular cross section with sides 2 cm and 3 cm are wedged between two walls, one held at $100^{\circ} C$ and the other at $0^{\circ} C$. The bars are made of lead and silver. $K_{pb} = 350 W / mK, K_{Ag} = 425 W / mK.$

Equevalent thermal resistence of the two bar system is

A. $0.1 \frac{K}{W}$

B. $0.23\frac{K}{W}$

C. $0.19\frac{W}{W}$

D. $0.42\frac{K}{W}$

Answer: A

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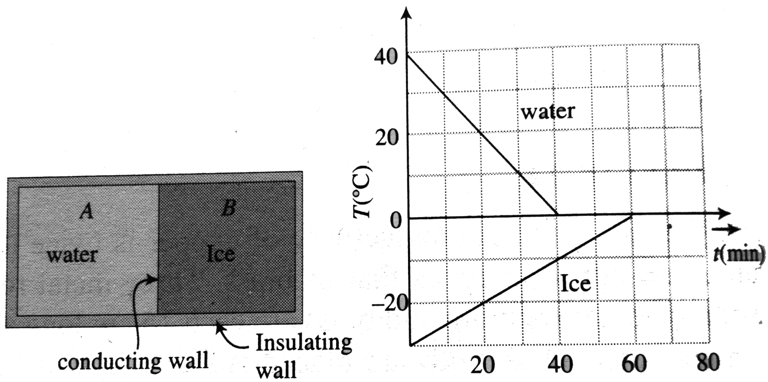

28.

A 0.60 kg sample of water and a sample of ice are placed in two compartmetnts A and B separated by a conducting wall, in a thermally insulated container. The rate of heat transfer from the water to the ice through the conducting wall is constant P, until thermal equilibrium is reached. The temperature T of the liquid water and the ice are given in graph as functions of time t. Temperature of the compartments remain homogeneous during whole heat transfer process. Given specific heat of ice $= 2100 J / kg - K$, specific heat of water $= 4200 J / kg - K$, and latent heat of fusion of ice $= 3.3 \times 10^5 J / kg$.

The value of rate P is?

A. The value of rate P is

B. 42.0 W

C. 36.0 W

D. 21.0 W

Answer: A

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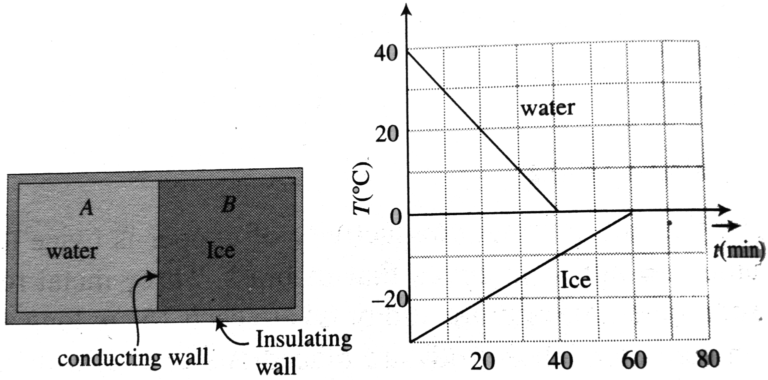

29.

A 0.60 kg sample of water and a sample of ice are placed in two compartmetnts A and B separated by a conducting wall, in a thermally insulated container. The rate of heat transfer from the water to the ice through the conducting wall is constant P, until thermal equilibrium is reached. The temperature T of the liquid water and the ice are given in graph as functions of time t. Temperature of the compartments remain homogeneous during whole heat transfer process. Given specific heat of ice $= 2100 J / kg - K$, specific heat of water $= 4200 J / kg - K$, and latent heat of fusion of ice $= 3.3 \times 10^5 J / kg.$

Initial mass of the ice in the container equal to

A. 0.36 kg

B. 1.2 kg

C. 2.4 kg

D. 3.6 kg

Answer: C

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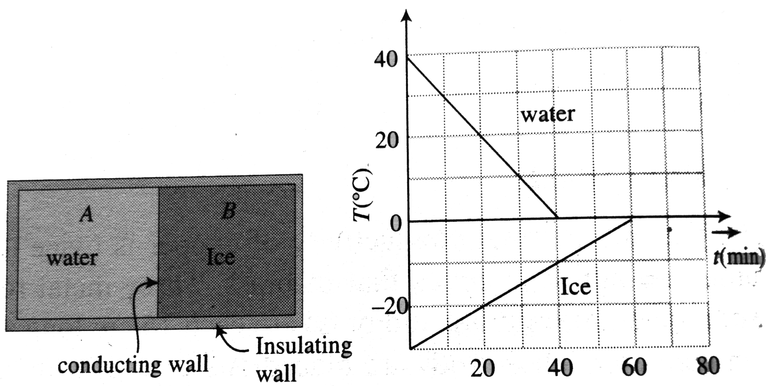

30.

A 0.60 kg sample of water and a sample of ice are placed in two compartmetnts A and B separated by a conducting wall, in a thermally insulated container. The rate of heat transfer from the water to the ice through the conducting wall is constant P, until thermal equilibrium is reached. The temperature T of the liquid water and the ice are given in graph as functions of time t. Temperature of the compartments remain homogeneous during whole heat transfer process. Given specific heat of ice $= 2100 J / kg - K$, specific heat of water $= 4200 J / kg - K$, and latent heat of fusion of ice $= 3.3 \times 10^5 J / kg.$

The mass of the ice formed due to conversion from the water till thermal equilibrium is reached is equal to

A. 0.12 kg

B. 0.15 kg

C. 0.25 kg

D. 0.40 kg

Answer: B

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Integer

1. 2 kg of ice at $-15^{\circ} C$ is mixed with 2.5 kg of water at $25^{\circ} C$ in an insulating container. If the specific heat capacities of ice and water are $0.5 cal / g^{\circ} C$ and $1 cal / g^{\circ} C$, find the amount of water present in the container? (in kg nearest integer)

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2. Four cylindrical rods of same material with length and radius (l,r), (2l,r),(l/2,r) and (l,2r) are connected between two reservoirs at $0^{\circ} C$ and $100^{\circ} C$. Find the ratio of the maximum to minimum rate of conduction in them.

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3. In two experiments with a countinous flow calorimeter to determine the specific heat capacity of a liquid,an input power of 16 W produced a rise of 10 K in the liquid. When the power was doubled, the same temperature rise was achieved by making the rate of flow of liquid three times faster. Find the power lost (in W) to the surrounding in each case.

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4. 2kg of ice at $-20^{\circ}C$ is mixed with 5kg of water at $20^{\circ}C$ 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 heats of water & ice are $1 kcal / kg /^{\circ} C$ and 0.5 $kcal / kg /^{\circ} C$ while the latent heat of fusion of ice is $80 kcal / kg$

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5. A clock with a metal pendulum beating seconds keeps correct time at $0^{\circ} C$. If it loses 12.5 s a day at $25^{\circ} C$, the coefficient of linear expansion of metal of pendulum is

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6. A body is cooled in 2 min n a room at temperature of $30^{\circ} C$ from $75^{\circ} C$ to $65^{\circ} C$. If the same body I s cooled from $55^{\circ} C$ to $45^{\circ} C$ in the same room, find the time taken (in minute).

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7. 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) $\frac{1}{4}$

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8. Two vessels connected at the bottom by a thin pipe with a sliding plug contain liquid at $20^\circ C$ and $80^\circ C$ respectively. The coefficient of cubic expansion of liquid is $10^{-3}K^{-1}$. The raio of height of liquid columns in the vessel (H_{20} / H_{80}) is nearest which interger ?

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Solved Example

1. A colorimeter contains $400g$ of water at a temperature of $5^\circ C$. Then, $200g$ of water at a temperature of $+10^\circ C$ and $400g$ of ice at a temperature of $-60^\circ C$ are added. What is the final temperature of the contents of calorimeter?

Specific heat capacity of water -1000 cal $/ kg / K$

Specific latent heat of fusion of ice $= 80 \times 1000$ cal $/ kg$

Relative specific heat of ice $= 0.5$

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2. In an insulated vessel, $250g$ of ice at $0^{\circ} C$ is added to $600g$ of water at $18.0^{\circ} C$.a. What is the final temperature of the system? B. How much ice remains when the system reaches equilibrium?

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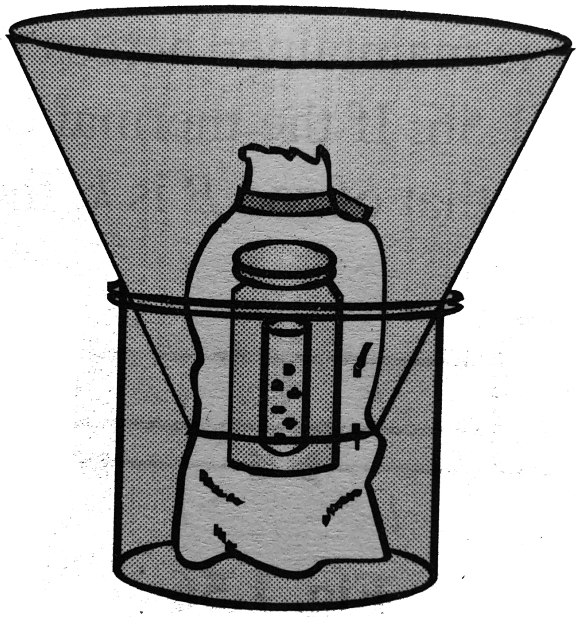
3. A solar cooker consists of a curved reflecting surface that concentrates sunlight onto the object to Earth's surface at the location is $6W / m^2$. The cooker face the sun and has a face diameter of $0.600m$. Assume 40.0% of the incident energy is tranferred to

$0.500 L$ of water in an open container, initially at $20.0^{\circ} C$. Over what time interval does the water completely boil away? (Ignore the heat capacity of the container.)



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4. An iron wire AB of length $3m$ at $0^{\circ} C$ is stretched between the oppsote walls of a brass casing at $0^{\circ} C$. The diameter of the wire is

$0.6mm$. What extra tension will be set up in the wire when the temperature of the system is rasied to $40^\circ C$?

Given $a_{\text{brass}} = 18 \times 10^{-6} / k$

$a_{\text{iron}} = 12 \times 10^{-6} / K$

$Y_{iron} = 21 \times 10^{10} N / m^2$

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5. A composite rod is made by joining a copper rod, end to end, with a second rod of different material but of the same area of cross section. At $25^\circ C$, the composite rod is $1m$ long and the copper rod is $30cm$ long. At $125^\circ C$ the length of the composte rod increases by $1.91mm$. When the composite rod is prevented from expanding by bolding it between two rigid walls, it is found that the constituent reds have remained unchanged in length in splite of rise of temperature. Find yong's modulus and the coefficient of linear expansion of the second red (Y of copper $= 1.3 \times 10^{10} N / m^2$ and a of copper $= 17 \times 10^{-6} / K$).

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6. How should $1kg$ of water at $50^{\circ}C$ be divided in two parts such that if one part is turned into ice at $0^{\circ}C$. It would release sufficient amount of heat to vapourize the other part. Given that latent heat of fusion of ice is $3.36 \times 10^5 J / Kg$. Latent heat of vapurization of water is $22.5 \times 10^5 J / kg$ and specific heat of water is $4200 J / kgK$.

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7. A layer of ice of $0^{\circ}C$ of thickness x_1 is floating on a pond. If the atmospheric temperature is $-7^{\circ}C$. Show that the time taken for thickness of the layer of ice to increase from x_1 to x_2 is given by

$$t = \frac{pL}{2kT}\left(x\frac{2}{2} - x_1^2\right)$$

where p is the density of ice, k its thermal conductivity and L is the latent heat of fusion of ice.

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8. A cylindrical rod of heat capacity $120J/K$ in a room temperature $27^{\circ}C$ is heated internally by heater of power $250W$, The steady state temperature attained by the rod is $37^{\circ}C$. Fin the following:

(a) The initial rate of increse in temperature

(b) The steady state rate of emission of radiant heat.

If the heater is switched off, find

(c) The initial rate of decrease is temperature

(d) The rate of decrease in temperature of the cylinder when its temperature falls to $31^{\circ}C$ and

(e) The maximum amount of heat lost by the cylinder

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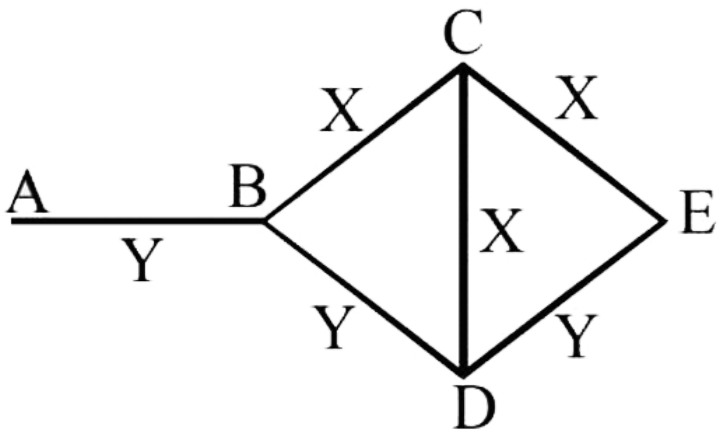
9. Three rods of material X and three rods of material Y are connected as shown in the figure. All the rods are of identical length and cross-sectional area. If the end A is maintained at $60^{\circ}C$ and the junction E at $10^{\circ} C$. Calculate the temperature of the junction B, C and D. The thermal conductivity of X is $0.92 cal / \sec - cm^{\circ} C$ and that of Y is $0.46 cal / \sec - cm -^{\circ} C$.



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10. A cubical block of co-efficient of linear expansion α_s is submerged partially inside a liquid of co-efficient of volume expansion γ_l. On increasing the temperature of the system by ΔT, the height of the cube inside the liquid remains unchanged. Find the relation between α_s and γ_l.

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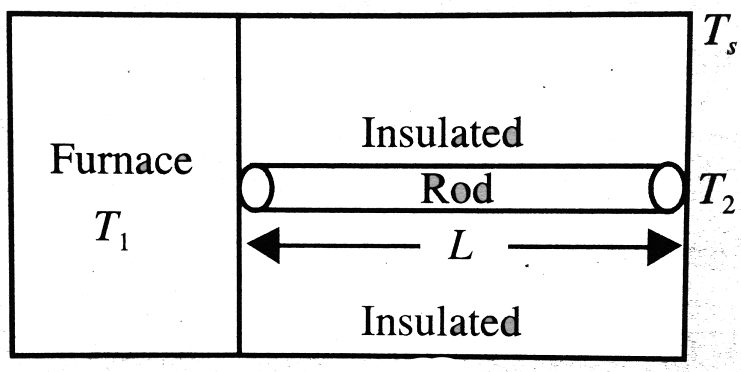
11. One end of a rod of length L and crosssectional area A is kept in a furnace at temperature T_1. The other end of the rod is kept at a temperature T_2. The thermal conductivity of the matrieal of the rod is K and emissivity of the rod is e. It is gives that $T_! = T_s + \Delta T$, where $\Delta T < \, < T_s, T_s$ is the temperature of the surroundings. If $\Delta T \propto (T_1 - T_2)$ find the proportional constant, consider that heat is lost only by rediation at the end where the temperature of the rod is T_1.



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12. A metal of mass 1 kg at constant atmospheric pressure and at initial temperature $20^\circ C$ is given a heat of 20000J. Find the following

(a) change in temperature,

(b) work done and

(c) change in internal energy.

(Given, specific heat $= 400J/kg-^\circ C$, coefficient of cubical expansion, $\gamma = 9 \times 10^{-5}/^\circ C$, density $\rho = 9000kg/m^3$, atmospheric pressure $= 10^5N/m^2$)

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13. In a 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.)

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

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

$s_{ice} = 2100 J / kg. K = 0.5 cal / g. K$

and $s_{\text{water}} = 4200 J / kg. K = 1 cal / g. K$.

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