PHYSICS

BOOKS - DISHA PUBLICATION PHYSICS (HINGLISH)

THERMAL PROPERTIES OF MATTER

Jee Main 5 Years At A Glance

1. The value closest to the thermal velocity of a helium atom at room temperature (300 K) in $ms^{-1}is: \left[k_B = 1.4 \times 10^{-23} j/k, m_{He} = 7 \times 10^{-27} kg\right]$

A. 1.3×10^4

B. 1.3×10^5

C. 1.3×10^2

D. 1.3×10^3

Answer: D

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2. A body takes 10 minutes to cool from $60^\circ C$ to $50^\circ C$. The temperature of surroundings is constant at 25°C. Then, the temperature of the body after next 10 minutes will be approximately

A. $43^\circ C$

B. $47^\circ C$

C. $41^\circ C$

D. $45^\circ C$

Answer: A

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3. A steel of length 5 m and area of cross-section 40 cm^2 is prevented from expanding along its length while the temperature rises by $10^\circ C$. If coefficient of linear expansion and Young's modulus of steel are

$1.2 \times 10^{-5} K^{-1}$ and $2 \times 10^{11} Nm^{-2}$ respectively,

the force developed in the rail is approximately:

A. $2 \times 10^{7} N$

B. $1 \times 10^{5} N$

C. $2 \times 10^{9} N$

D. $3 \times 10^{-5} N$

Answer: B

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4. An external pressure P is applied on a cube at $0^{\circ} C$ so that it is equally compressed from all sides.

K is the bulk modulus of the material of the cube and α is its coefficient of linear expansion. Suppose we want to bring the cube to its original size by heating. The temperature should be raised by

A. $\frac{3\alpha}{PK}$

B. $3PK\alpha$

C. $\frac{P}{3\alpha K}$

D. $\frac{P}{\alpha K}$

Answer: C

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5. A copper ball of mass 100 gm is at a temperature T. It is dropped in a copper calorimeter of mass 100 gm, filled with 170 gm of water at room temperature. Subsequently, the temperature of the system is found to be $75^\circ C$. T is given by : (Given : room temperature = $30^\circ C$, specific heat of copper $= 0.1 cal/gm^\circ C$)

A. $1250^\circ C$

B. $825^\circ C$

C. $800^\circ C$

D. $885^\circ C$

Answer: D

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6. An experiment takes 10 minutes to raise the temperature of water in a container from $0^\circ C \text{to} 100^\circ C$ and another 55 minutes to convert it totally into steam by a heater supplying heat at a uniform rate. Neglecting the specific heat of the container and taking specific heat of water to be $1 cal/g^\circ C$, the heat of vapourization according to this experiment will come out to be:-

A. 560 cal/g

B. 550 cal/g

C. 540 cal/g

D. 530 cal/g

Answer: B

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7. Hot water cools from $60^\circ C$ to $50^\circ C$ in the first 10 minutes and to $45^\circ C$ in the next 10 minutes. The temperature of the surroundings is:

A. $25^\circ C$

B. $10^\circ C$

C. $15^\circ C$

D. $20^\circ C$

Answer: B

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8. Three rods of Copper, Brass and Steel are welded together to from a Y shaped structure. Area of cross-section of each rod $= 4cm^2$. End of copper rod is maintained at $100^\circ C$ where as ends of brass and steel are kept at $0^\circ C$. Lengths of the copper, brass

and steel rods are 46, 13 and 12 cm respectively. The rods are thermally insulated from surroundings excepts at ends. Thermal conductivities of copper, brass and steel are 0.92, 0.26 and 0.12 CGS units respectively. Rate of heat flow through copper rod is :

A. 1.2 cal/s

B. 2.4 cal/s

C. 4.8 cal/s

D. 6.0 cal/s

Answer: C

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Exercise 1 Concept Builder Topicwise

1. Two indentical recrangular strips. One of copper and the other of steel, are rivetted together to from o bimetallic strip $(\alpha_c opper > \alpha_s teel)$. On hearing. This strip will

A. remain straight

B. bend with copper on convex side

C. bend with steel on comvex side

D. get twisted

Answer: B

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2. A liquid with coefficient of volume expansion γ is filled in a container of a material having coefficient of linear expansion α . If the liquid overflows on heating, then

A. $\gamma = 3\alpha$

B. $\gamma > 3\alpha$

C. $\gamma < 3\alpha$

D. $\gamma = 3\alpha^3$

Answer: B

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3. Four identical rods of same material are joined end to end to form a square. If the temperature difference between the ends of a diagonal is $100^\circ C$, then the temperature difference between the ends of other diagonal will be

A. $0^\circ C$

B. $\frac{100}{l}^\circ C$

C. $\frac{100}{2l}^\circ C$

D. $100^\circ C$

Answer: A

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4. A cylindrical metal rod is shaped into a ring with a small gap as shown. On heating the system:

A. x decreases, r and d increase

B. x and r increase, d decreases

C. x, r and d all increase

D. x and r decreased, d remains constant

Answer: C

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5. When the temperature of a rod increases from t to $r + \Delta t$, its moment of inertia increases from I to $I + \Delta I$. If α is the value of $\Delta I / I$ is

A. $2\alpha\Delta t$

B. $\alpha\Delta T$

C. $\frac{\alpha\Delta t}{2}$

D. $\frac{\Delta t}{\alpha}$

Answer: A

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6. For the construction of a thermometer, one of the essential requirements is a thermometric substance which

A. remains liquid over the entire range of temperatures to be meaured.

B. has property that in variable with temperature

C. has a property that varies with temperature

D. obey Boyle's law

Answer: C

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7. Two substance of same size are made of same material but one is hollow and the other is solid. They are heated to same temperature, then

A. both spheres will expand equally

B. hollow sphere will expand more than the solid one

C. solid sphere will expand more than the hollow one

D. None of these

Answer: A

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8. Consider two identical iron spheres, one which lie on a thermally insulating plate, while the other hangs from an insulatory thread. Equal amount of

heat is supplied to the two spheres

A. temperature of A will be greater than B

B. temperature of B will be greater than A

C. their temperature will be equal

D. can't be predicted

Answer: B

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9. The reading of Centigrade thermometer coincides with that of Fahrenheit thermometer in a liquid. The

temperature of the liquid is

A. $-40^\circ C$

B. $313^\circ C$

C. $0^\circ C$

D. $100^\circ C$

Answer: A

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10. 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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11. A breaker is filled with water at $4^\circ C$. at one time the temperature is increased by few degrees above $4^\circ C$ and at another time it is decreased by a few degrees below $4^\circ C$. One shall observe that

A. the level remains constant in each case

B. in first case water flows while in second case its level comes down

C. in second case water over flows while in first case its comes down

D. water overflows in both the cases

Answer: D

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12. A pendulum clock loses 12s a day if the temperature is $40^\circ C$ and gains 4s 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:

A. $30^\circ C, \alpha = 1.85 \times 10^{-3}/^\circ C$

B. $55^\circ C, \alpha = 1.85 \times 10^{-2}/^\circ C$

C. $25^\circ C, \alpha = 1.85 \times 10^{-5}/^\circ C$

D. $60^\circ C, \alpha = 1.85 \times 10^{-4}/^\circ C$

Answer: C

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13. The apparent coefficient of expansion of liquid, when heated in a copper vessel is C and when heated in a silver vessel is S. If A is the linear coefficient of expansion of Copper, linear expansion coefficient of silver is

A. $\frac{C+S-3A}{3}$

B. $\frac{C+3A-S}{3}$

C. $\frac{S+3A-C}{3}$

D. $\frac{C+S+3A}{3}$

Answer: B

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14. The coefficient of linear expansion for a certain metal varies with temperature as $\alpha(T)$. If L_0 is the initial length 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. $L = L_0 \left[1 + \int_{T_0}^{T} \alpha(T) dT\right]$

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

D. $L > L_0$

Answer: B

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15. The table gives the initial length L, change in temperature ΔT and change in length ΔL of four rods. The rod, which has greatest coefficient of expansion?

A. a

B. b

C. c

D. d

Answer: C

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16. A piece of metal weight 45 g is air and 25 g in a liquid of density $1.5 \times 10^3 kg - m^{-3}$ Kept at 30°. When the temperature of the liquid is raised to $40^\circ C$, the metal piece weight 27g. The density of

liquid at $40^\circ C$ is $1.25 \times 10^3 kg - m^{-3}$. The coefficient of linear expansion of metal is

A. $1.3 \times 10^{-3} / ^\circ C$

B. $5.2 \times 10^{-3} / ^\circ C$

C. $2.6 \times 10^{-3} / ^\circ C$

D. $0.26 \times 10^{-3} / ^\circ C$

Answer: C

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17. If the cold junction of thermocouple is kept at $0^\circ C$ and the hot junction is kept at $T^\circ C$, then the

relation between neutral temperature (T_n) and temperature of inversion (T_i) is

A. $T_n = 2T_i$

B. $T_n = T_i - T$

C. $T_n = T_i + T$

D. $T_n = T_i / 2$

Answer: D

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18. On a temperature scale Y, water freezes at -160° Y and boils at -50° Y . On this Y scale , a

temperature of 340 K is

A. $-73.7^\circ Y$

B. $-233.7^\circ Y$

C. $-86.3^\circ Y$

D. $-106.3^\circ Y$

Answer: C

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19. On a new scale of temperature (which is linear) and called the W scale. The freezing and boiling points of water are $39^\circ W$ and $239^\circ W$ respectively.

What will be the temperature on the new scale, corresponding to a temperature of $39^\circ C$ on the Celsius scale?

A. $78^\circ W$

B. $117^\circ W$

C. $200^\circ W$

D. $139^\circ W$

Answer: B

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20. A centigrade and a Fehrenheit thermometer are dipped in boiling water. The water temperature is lowered until the Fehrenheit thermometer registers $140^\circ F$. What is the fall in temperature as register by the centigrade thermometer

A. 80°

B. 60°

C. 40°

D. 30°

Answer: C

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21. A metallic bar is heated from $0^{\circ}C$ to $100^{\circ}C$. The coefficient of linear expansion is $10^{-5}K^{-1}$. What will be the percentage increase in length

A. $0.01\ \%$

B. $0.1\ \%$

C. $1\ \%$

D. $10\ \%$

Answer: B

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22. A long cylindrical metal vessel of volume V and coefficient of linear expansion α contains a liquid. The level of liquid has not changed on heating. The coefficient of volume expansion of the liquid is.

A. $\frac{V-\alpha}{V}$

B. $\frac{V+\alpha}{V}$

C. $\frac{V}{V-\alpha}$

D. 3α

Answer: D

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23. A block of wood is floating on water at $0^\circ C$ with a certain volume V outside the water-level. The temperature of water is slowly raised from $0^\circ C$ to $20^\circ C$. How will the volume V change with rise in temperature ?

A. V will remain unchanged

B. V will go decreasing from beginning to the end

C. V will decrease till the temperature of water reaches $4^\circ C$ and then it will go on increasing

D. V will increase till the temperature of water reaches $4^\circ C$ and then it will go on decreasing

Answer: D

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24. A crystal has a coefficient of expansion 13×10^{-7} in one direction and 231×10^{-7} in every direction at right angles to it. Then the cubical coefficient of expansion is

A. 462×10^{-7}

B. 244×10^{-7}

C. 475×10^{-7}

D. 257×10^{-7}

Answer: C

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25. The coefficient of apparent expansion of mercury in a glass vessel is $153 \times 10^{-6} / {}^{\circ}C$ and in a steel vessel is $144 \times 10^{-6} / {}^{\circ}C$. 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. $27 \times 10^{-6} / {}^{\circ}C$

Answer: A

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26. A metal ball immersed in alcohol weighs w_1 and$0^\circ C$ andw_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

A. $W_1 > W_2$

B. $W_1 = W_2$

C. $W_1 < W_2$

D. $W_1 = (W_2/2)$

Answer: C

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27. A metal cube of length of 10.0 mm at $0^\circ C$ is heated to $200^\circ C$. Given: its coefficient of linear expansion is $2 \times 10^{-5} K^{-1}$. The percent change of its volume is

A. 0.1

B. 0.2

C. 0.4

D. 1.2

Answer: D

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28. A pendulum clock is 5 sec. Slow at a temperature $30^\circ C$ and 10 sec. fast at a temperature of $15^\circ C$, At what temperature does it give the correct time-

A. $18^\circ C$

B. $20^\circ C$

C. $22^\circ C$

D. $25^\circ C$

Answer: C

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29. If there is no heat loss, the heat released by the condensation of x gram of steam at $100^\circ C$ into water at $100^\circ C$ can be used to convert y gram of ice at $0^\circ C$ into water at $100^\circ C$. Then the ratio of y:x is nearly [Given $L_l = 80cal/gm$ and $L_v = 540cal/gm$]

A. $1:1$

B. $1:1$

C. $1:3$

D. $3:1$

Answer: C

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30. Which one of the following graphs best represents the ways in which the total power P radiated by a black body depends upon the thermodynamic temperature T of the body?

A. 

B. 

C. 

D. 

Answer: C

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31. The coefficient of thermal conductivity of copper, mercury and glass are respectively K_c, K_m and K_g that $K_c > K_m > K_g$. If the same quantity of heat is to flow per second per unit of each and

corresponding temperature gradients are X_c, X_m and X_g, then

A. $X_c = X_m = X_g$

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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32. If l is the length, A is the area of cross-section and K the thermal conductivity, then the thermal

resistance of the block is given by

A. Kl/A

B. l/KA

C. AK/l

D. A/Kl

Answer: B

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

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

B. the cube cools down faster than the sphere

C. the sphere cools down faster than the cube

D. whichever is having more mass will cool down faster

Answer: B

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34. Consider a compound slab consisting of two different material having equal thickness and

thermal conductivities K and $2K$ respectively. The equivalent thermal conductivity of the slab is

A. $\frac{4}{3}K$

B. $\frac{2}{3}K$

C. $\sqrt{3}K$

D. 3K

Answer: A

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35. The rate of heat flow through the cross-section of the rod shown in figure is ($T_2 > T_1$ and thermal

conductivity of the material of the rod is K)

A. $\frac{K\pi r_1 r_2(T_2 - T_1)}{L}$

B. $\frac{K\pi(r_1 + r_2)^2(T_2 - T_1)}{4L}$

C. $\frac{K\pi(r_1 + r_1)^2(T_2 - T_1)}{L}$

D. $\frac{K\pi(r_1 + r_1)^2(T_2 - T_1)}{2L}$

Answer: A

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36. If at temperature T, the emissive power and absorption power of a body for wave length are e_λ

and a_λ respectively, then-

A. $e_\lambda = a_\lambda$

B. $e_\lambda > a_\lambda$

C. $e_\lambda < a_\lambda$

D. there will not be any difinite relation between e_λ and a_λ

Answer: A

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37. 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 $100^\circ C$

A. the temperature of the system becomes $169^\circ C$.

B. half of the ice is melted and the temperature of the system remains $0^\circ C$.

C. the temperature remains $100^\circ C$ and 53g of steam condenses.

D. the temperature remains $100^{\circ}C$ and the entire steam condenses.

Answer: C

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38. Assuming the sun to have a spherical outer surface of radius r radiating like a black body at temperature $t^{\circ}C$. The power received by a unit surface (normal to the incident rays) at a distance R from the centre of the sun is

where σ is the Stefan's constant.

A. $\frac{r^2\sigma(t+273)^4}{4\pi R^2}$

B. $\frac{16\pi^2 r^2\sigma t^4}{R^2}$

C. $\frac{r^2\sigma(t+273)^4}{R^2}$

D. $\frac{4\pi r^2\sigma t^4}{R^2}$

Answer: C

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39. The emissive power of a black body at $T = 300K$ is $100Wa/m^2$ consider a body B of area $A = 10m^2$ coefficient of reflectivity $r = 0.3$ and coefficient of

transmission $t = 0.5$ its temperature is 300 K. then which of the followin is correct:

A. the emissive power of B is $20W/m^2$

B. the emissive power of B is $200W/m^2$

C. the power emitted by B is 200 Watts

D. the emissivity of B is 0.2

Answer: B

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40. The plots of intensity versus wavelength for three black bodies at temperatures T_1, T_2 and T_3

respectively are as shown. Their temperature are such that

A. $T_1 > T_2 > T_3$

B. $T_1 > T_3 > T_2$

C. $T_2 > T_3 > T_1$

D. $T_3 > T_2 > T_1$

Answer: B

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41. A lead bullet strikes against a steel plate with a velocity $200ms^{-1}$. If the impact is perfectly inelastic and the heat produced is equally shared between the bullet and the target, thent he rise in temperature of the bullet is (specific heat capacity of lead $= 125Jkg^{-1}K^{-1}$)

A. $80^{\circ}C$

B. $60^{\circ}C$

C. $160^{\circ}C$

D. $40^{\circ}C$

Answer: A

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42. A piece of ice falls from a hight h so that it melts completely. Only one quarter of the heat produced is absorbed by the ice and all energy of ice gets converted into heat during its fall. The value of h is : (Latent heat of ice is $3.4 \times 10^5 j/kg$ and $g = 10N/kg$)

A. 34km

B. 544km

C. 136km

D. 68km

Answer: C

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43. 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 it is $23^\circ C$. What should be the temperature when A and C are mixed?

A. $18.2^\circ C$

B. $22^\circ C$

C. $20.2^\circ C$

D. $25.2^\circ C$

Answer: C

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44. Which of the following circular rods (given radius r and length l) each made of the same material and whose ends are maintained at the same temperature will conduct most heat?

A. $r = 2r_0, l = 2l_0$

B. $r = 2r_0, l = l_0$

C. $r = r_0, l = 2l_0$

D. $r = r_0, l = l_0$

Answer: B

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45. 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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46. Steam at $100^\circ C$ is passed into $1.1kg$ of water contained in a calorimeter of water equivalent $0.02kg$ at $15^\circ C$ till the temperature of the calorimeter and its content rises to $80^\circ C$. What is

the mass of steam condensed? Latent heat of steam = $536 cal / g$.

A. 0.13

B. 0.065

C. 0.26

D. 0.135

Answer: A

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47. A body of mass 5 kg falls from a height of 20 metres on the ground and it rebounds to a height of

0.2 m. If the loss in potential energy is used up by the body, then what will be the temperature rise? $\left(\text{specific heat of material} = 0.09 \text{ cal gm}^{-1\circ}\text{C}^{-1}\right)$

A. $0^\circ C$

B. $4^\circ C$

C. $8^\circ C$

D. None of these

Answer: D

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48. Two identical vessels are filled with equal amounts of ice. The vessels are made from different materials. If the ice melts in the two vessels in times t_1 and t_2 respectively, then their thermal conductivities are in the ratio

A. $t_2 : t_1$

B. $t_2^2 : t_1^2$

C. $t_1 : t_2$

D. $t_1^2 : t_2^2$

Answer: A

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49. A cylindrical rod of aluminium is of length 20 cm and radius 2 cm. The two ends are maintained at temperatures of $0^{\circ}C$ and $50^{\circ}C$ the coefficient of thermal conductivity is $\frac{0.5 \ \text{cal}}{cm \times \text{sec} \times {}^{\circ}C}$. Then the thermal resistance of the rod in $\frac{\text{cal}}{\text{sec} \times {}^{\circ}C}$ is

A. 318

B. 31.8

C. 3.18

D. 0.318

Answer: D

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50. Solar radiation emitted by sun resembles that emitted by a body at a temperature of $6000K$ Maximum intensity is emitted at a wavelength of about $4800A^{\circ}$ If the sun was cooled down from $6000K$ to $3000K$ then the peak intensity would occure at a wavelenght of .

A. 4800 Å

B. 9600 Å

C. 2400 Å

D. 19200 Å

Answer: B

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51. A metal ball of surface area $200cm^2$ and temperature $527^\circ C$ is surrounded by a vessel at $27^\circ C$. If the emissivity of the metal is 0.4, then the rate of loss of heat from the ball is $\left(\sigma = 5.67 \times 10^{-8} J/m^2 - s - k^4\right)$

A. 108 joule

B. 168 joule

C. 182 joule

D. 192 joule

Answer: C

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52. Two rods of same length and transfer a given amount of heat 12 second, when they are joined as shown in figure (i). But when they are joined as shown in figure (ii), they they will transfer same heat in same conditions in

A. 24s

B. 13s

C. 15s

D. 48s

Answer: D

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53. Two cylinders P and Q have the same length and diameter and are made of different materials having thermal conductivities in the ratio 2 : 3. These two cylinders are combined to make a cylinder. One end

of P is kept at $100^{\circ}C$ and another end of Q at $0^{\circ}C$.

The temperature at the interface of P and Q is

A. $40^{\circ}C$

B. $50^{\circ}C$

C. $60^{\circ}C$

D. $70^{\circ}C$

Answer: A

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54. Three very large plates of same area are kept parallel and close to each other. They are considered

as ideal black surface and have very high thermal conductivity The first and third plates are maintained at temperatures $2T$ and $3T$ respectively Find the temperature of the middle (i.e second) plate under steady state .

A. $\left(\frac{65}{2}\right)^{1/4}$ T

B. $\left(\frac{97}{4}\right)^{1/4}$ T

C. $\left(\frac{97}{2}\right)^{1/4}$ T

D. $(97)^{1/4}$T

Answer: C

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

A. R_1^2 / R_2^2

B. R_1 / R_2

C. R_2 / R_1

D. R_2^2 / R_1^2

Answer: A

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56. Two vessels of different materials are similar in size in every respect. The same quantity of ice filled in them gets melted in 20 min and 35 min, respectively. The ratio of coefficients of thermal conduction of the metals is

A. $4:7$

B. $7:4$

C. $25:16$

D. $16:25$

Answer: B

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57. Which of the following graphs correctly represents the relation between In (E) and In (T), where E is the amount of radiation emitted per unit time from a unit area of the body and T is the absolute temperature ?

A. 

B. 

C. 

D. 

Answer: C

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58. A mass of 50g of water in a closed vessel, with surroundings at a constant temperature takes 2 minutes to cool from $30^{\circ}C$ to $25^{\circ}C$. A mass of 100g of another liquid in an identical vessel with identical surroundings takes the same time to cool from 30°C to $25^{\circ}C$. The specific heat of the liquid is: (The water equivalent of the vessel is 30g.)

A. 2.0 kcal/kg

B. 7 kcal/kg

C. 3kcal/kg

D. 0.5 kcal/kg

Answer: D

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59. A block of steel heated to $100^{\circ} C$ is left in a room to cool. Which of the curves shown in fig., represents the correct behaviour as per Newton's law of

cooling?

A. A

B. B

C. C

D. None of these

Answer: A

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60. A body cools from $50.0^\circ C$ to $48^\circ C$ in 5s. How long will it take to cool from $40.0^\circ C$ to $39^\circ C$?

Assume the temperature of surroundings to be $30.0^{\circ}C$ and Newton's law of cooling to be valid.

A. 2.5s

B. 10s

C. 20s

D. 5s

Answer: B

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61. A body initially at $80^{\circ}C$ cools to $64^{\circ}C$ in 5 minutes and to $52^{\circ}C$ in 10 minutes. What will be its

temperature in 15 minutes and what is the temperature of its surroundings?

A. $42.7^\circ C$

B. $35^\circ C$

C. $47^\circ C$

D. $40^\circ C$

Answer: A

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62. Consider two hot bodies B_1 and B_2 which have temperature $100^\circ \mathrm{C}$ and $80^\circ \mathrm{C}$ respectively at t = 0.

The temperature of surroundings is 40° C. The ratio of the respective rates of cooling R_1 and R_2 of these two bodies at $t = 0$ will be

A. $R_1 : R_2 = 3:2$

B. $R_1 : R_2 = 5:4$

C. $R_1 : R_2 = 2:3$

D. $R_1 : R_2 = 4:5$

Answer: A

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63. A body cools in a surrounding of constant temperature $30^\circ C$ Its heat capacity is $2J/^\circ C$. Initial temeprature of cooling is $40^\circ C$ and assuming newtons law of cooling is valid. The body cools to $38^\circ C$ in 10 min

In further 10 min it will cools from $38^\circ C$ to _____

A. $36^\circ C$

B. $36.4^\circ C$

C. $37^\circ C$

D. $37.5^\circ C$

Answer: B

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64. According to 'Newton's Law of cooling', the rate of cooling of a body is proportional to the

A. temperature of the body

B. temperature of the surrounding

C. fourth power of the temperature of the body

D. difference of the temperature of the body and the surroundings

Answer: D

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65. If a body cools down from $80^\circ C$to $60^\circ C$ in 10 min when the temperature of the surrounding of the is $30^\circ C$. Then, the temperature of the body after next 10 min will be

A. $50^\circ C$

B. $48^\circ C$

C. $30^\circ C$

D. None of these

Answer: B

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66. A body cools from $50^\circ C$ to $40^\circ C$ in 5 min. The surroundings temperature is $20^\circ C$. In what further times (in minutes) will it cool to $30^\circ C$?

A. 5

B. $15/2$

C. $25/3$

D. 10

Answer: C

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

A. two

B. three

C. four

D. one

Answer: D

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68. State Newton's law of cooling and draw the graph showing cooling of hot water with temperature.

A. 

B. 

C. 

D. None of these

Answer: B

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69. A hot body, obeying Newton's law of cooling is cooling down from its peak value $80^\circ C$ to an ambient temperature of $30^\circ C$. It takes 5 minutes in cooling down from $80^\circ C$ to $40^\circ C$. How much time will it take to cool down from $62^\circ C$ to $32^\circ C$? (Given In 2 = 0.693, In 5 = 1.609)

A. 3.75 minutes

B. 8.6 minutes

C. 9.6 minutes

D. 6.5 minutes

Answer: B

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Exercise 2 Concept Applicator

1. A metallic rod l cm long, A square cm in cross-section is heated through $t^{\circ}\mathrm{C}$. If Young's modulus of elasticity of the metal is E and the mean coefficient of linear expansion is α per degree celsius, then the compressional force required to prevent the rod from expanding along its length is

A. $EA\alpha t$

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

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

D. $El\alpha t$

Answer: A

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2. A glass sinker has a mass M in air, When weighed in a liquid at temperature t_1, the apparent mass is M_1 and when weighed in the same liquid at temperature t_2, the apparent mass is M_2. If the coefficient of cubical expansion of the glass is γ_g, then the real coefficient of expansion of the liquid is :

A. $\gamma_g + \left(\frac{M_2 - M_1}{M - M_2}\right) \cdot \frac{1}{(t_2 - t_1)}$

B. $\gamma_g - \left(\frac{M_2 - M_1}{M - M_2}\right) \cdot \frac{1}{(t_2 - t_1)}$

C. $\gamma_g - \left(\frac{M - M_2}{M_2 - M_1}\right) \cdot \frac{1}{(t_2 - t_1)}$

D. $\gamma_g + \left(\frac{M_2 - M_1}{M_2 + M_1}\right) \cdot \frac{1}{(t_2 - t_1)}$

Answer: A

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3. Two marks on a glass rod $10cm$ apart are found to increase their distance by $0.08mm$ when the rod is heated from $0^\circ C \text{to} 100^\circ C$. A flask made of the same

glass as that of rod measures a volume of $100 at 0^{\circ} C$.

The volume it measures at $100^{\circ} C$ in (cc) is.

A. 1002.4

B. 1004.2

C. 1006.4

D. 1008.2

Answer: A

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4. If a bar is made of copper whose coefficient of linear expansion is one and a half times that of iron,

the ratio of force developed in the copper bar to the iron bar of identical lengths and cross-sections, when heated through the same temperature range (Young's modulus of copper may be taken to be equal to that of iron) is

A. $3/2$

B. $2/3$

C. $9/4$

D. $4/9$

Answer: A

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5. Two vertical glass tubes filled with a liquid are connected by a capillary tube as shown in the figure. The tube on the left is put in an ice bath at $0^\circ C$ while the one on the right is kept at $30^\circ C$ in a water bath. The difference in the levels of the liquid in the two tubes is 4.0 cm while the height of the liquid column at $0^\circ C$ is 120 cm. The coefficient of volume expansion of the liquid is

A. $22 \times 10^{-4} / ^\circ C$

B. $1.1 \times 10^{-4} / ^\circ C$

C. $11 \times 10^{-4} / ^\circ C$

D. $2.2 \times 10^{-4} / {}^{\circ}C$

Answer: C

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6. The maximum energy is the thermal radiation from a hot source occurs at a wavelength of $11 \times 10^{-5} cm$. According to Wien's law, the temperature of this source (on Kelvin scale) will be n times the temperature of another source (on Kelvin scale) for which the wavelength at maximum energy is $5.5 \times 10^{-5} cm$. The value of n is:

A. 2

B. 4

C. $1/2$

D. 1

Answer: C

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7. 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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8. The radiant energy from the Sun incident normally at the surface of earth is $20kcal/m^2$ min What

would have been the radiant energy incident normally on the earth if the sun had a temperature twice of the present one ? .

A. 160k cal/m^2 min

B. 40k cal/m^2 min

C. 320k cal/m^2 min

D. 80k cal/m^2 min

Answer: C

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9. 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 loss half the maximum heat it can lose.

A. $\ln 2 / k$

B. $k / ln2$

C. $k \ln 2$

D. None of these

Answer: A

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10. 1 g of water in liquid phase has volume $1cm^3$ and in vapour phase 1671 cm^3 at atmospheric pressure and the latent heat of vaporization of water is 2256 J/g, the change in the internal energy in joules for 1 g of water of 373K when it changes from liquid phase to vapour phase at the same temperature is:

A. 2256

B. 167

C. 2089

D. 1

Answer: C

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11. Two rods of the same length and areas of cross-section A_1 and A_2 have their ends at the same temperature. K_1 and K_2 are the thermal conductivities of the two rods. The rate of flow of heat is same in both the rods if-

A. $\frac{A_1}{A_2} = \frac{K_1}{K_2}$

B. $\frac{A_1}{A_2} = \frac{K_2}{K_1}$

C. $A_1 A_2 = K_1 K_2$

D. $A_1K_1^2 = A_2K_2^2$

Answer: B

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12. Two straight metallic strips each of thickness t and length l are rivetted together. Their coefficients of linear expansions are$\alpha_1 \text{and} \alpha_2$. If they are heated through temperature ΔT, the bimetallic strip will bend to form an arc of radius

A. $t/\{\alpha_1 + \alpha_2)\Delta T\}$

B. $t/\{(\alpha_2 - \alpha_1)\Delta T\}$

C. $t(\alpha_1 - \alpha_2)\Delta T$

D. $t(\alpha_2 - \alpha_1)\Delta T$

Answer: B

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13. The temperature of the two outer surfaces of a composite slab consisting of two materials having coefficient of thermal conductivity K and 2K and thickness x and 4x respectively are T_2 and $T_1(T_2 > T_1)$. The rate of heat transfer through the slab, in a steady state is

$\left(\frac{A(T_2 - T_1)K}{x}\right) f$ with f equal to

A. 1

B. $1/2$

C. $2/3$

D. $1/3$

Answer: D

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14. A glass flask of volume 1 litre is fully filled with mercury at $0^\circ C$. Both the flask and mercury are now heated to $100^\circ C$. If the coefficient of volume expansion of mercury is $1.82 \times 10^{-4} / ^\circ C$, volume coefficient of linear expansion of glass is $10 \times 10^{-6} / ^\circ C$, the amount of mercury which overflows is

A. 15.2 ml

B. 17.2 ml

C. 19.2 ml

D. 21.2 ml

Answer: A

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15. 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.

A. $\frac{W_0 - W_1}{(W_0 - W_2)(t_2 - t_1)} + \frac{\beta(W_0 - W_1)}{W_0 - W_2}$

B. $\frac{W_2 - W_0}{t_2 - t_1}\beta$

C. $\frac{W_1 - W_0}{t_2 - t_1}\beta$

D. $\frac{W_0}{(t_2 - t_1)}\beta + \frac{W_2 - W_1}{(W_0 - W)}\beta$

Answer: A

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16. In a thermocouple, the temperature of the cold junction and the neutral temperature are $-40^\circ C$ and $275^\circ C$ respectively. If the cold junction temperature is increased by $60^\circ C$, the neutral temperature and temperature of inversion respectively become

A. $275^\circ C, 530^\circ C$

B. $355^\circ C, 530^\circ C$

C. $375^\circ C, 590^\circ C$

D. $355^\circ C, 590^\circ C$

Answer: A

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17. Two identical rods of copper and iron are coated with wax uniformly. When one end of each is kept at temperature of boiling water, the length upto which wax melts are 8.4 cm and 4.2 cm respectively. If

thermal conductivity of copper is 0.92, then thermal conductivity of iron is

A. 0.23

B. 0.46

C. 0.115

D. 0.69

Answer: A

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18. The top of an insulated cylindrical container is covered by a disc having emissivity 0.6 and

conductivity 0.167 $WK^{-1}m^{-1}$ and thickness 1 cm. The temperature is maintained by circulating oil as shown in figure. Find the radiation loss to the surrounding in $Jm^{-2}s^{-1}$ if temperature of the upper surface of the disc is $27^{\circ}C$ and temperature of the surrounding is $27^{\circ}C$.

A. $595Jm^{-2}s^{-1}$

B. $545Jm^{-2}s^{-1}$

C. $495Jm^{-2}s^{-1}$

D. None of these

Answer: A

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19. The two ends of a rod of length L and a uniform cross-sectional area A are kept at two temperature T_1 and T_2 $(T_1 > T_2)$. The rate of heat transfer. $\frac{dQ}{dt}$, through the rod in a steady state is given by

A. $\frac{dQ}{dt} = \frac{k(T_1 - T_2)}{LA}$

B. $\frac{dQ}{dt} = kLA(T_1 - T_2)$

C. $\frac{dQ}{dt} = \frac{kA(T_1 - T_2)}{L}$

D. $\frac{dQ}{dt} = \frac{kL(T_1 - T_2)}{A}$

Answer: C

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20. A body cools in a surrounding which is at a constant temperature of θ_0. Assume that it obeys Newton's law of cooling. Its temperature θ is plotted against time t. Tangents are drawn to the curve at the points $P(\theta = \theta_2)$ and $Q(\theta = \theta_1)$. These tangents meet the time axis at angle of ϕ_2 and ϕ_1, as shown, then

A. $\frac{\tan\phi_2}{\tan\phi_1} = \frac{\theta_1 - \theta_0}{\theta_2 - \theta_0}$

B. $\frac{\tan\phi_2}{\tan\phi_1} = \frac{\theta_2 - \theta_0}{\theta_1 - \theta_0}$

C. $\frac{\tan\phi_1}{\tan\phi_2} = \frac{\theta_1}{\theta_2}$

D. $\frac{\tan\phi_1}{\tan\phi_2} = \frac{\theta_2}{\theta_1}$

Answer: B

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21. 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 sec

B. 6 min 2 sec

C. 14 min

D. 7 min

Answer: A

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22. A metal bar of length l is well lagged with some non-conducting material to prevent losses of heat from its surface and the two ends are maintained at steady temperatures θ_1 and θ_2 with $\theta_1 > \theta_2$, then in

the steady state the temperature θ of s section of the bar at distance x from the hot end varies as shown in the graph

A. 

B. 

C. 

D. 

Answer: B

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23. A compressive force, F is applied at the two ends of a long thin steel rod. It is heated, simultaneously, such that its temeprature increass by ΔT. The net change in its length is zero. Let l be the length of the rod, A its area of cross-section, Y its Young's modulus, and α its coefficient of linear expansion. Then, F is equal to

A. $l^2 Y \alpha \Delta T$

B. $lAY\alpha\Delta T$

C. $AY\alpha\Delta T$

D. $\frac{AY}{\alpha\Delta T}$

Answer: C

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24. 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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25. A piece of ice (heat capacity $= 2100 Jkg^{-1}.^{\circ} C^{-1}$ and latent heat $= 3.36 \times 10^{5} Jkg^{-1}$) of mass m grams is at $-5.^{\circ} C$ at atmospheric pressure. It is given 420 J of heat so that the ice starts melting. Finally when the ice . Water mixture is in equilibrium, it is found that 1 gm

of ice has melted. Assuming there is no other heat exchange in the process, the value of m in gram is

A. 4

B. 8

C. 2

D. 5

Answer: B

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26. A large cylindrical rod of length L is made by joining two identical rods of copper and steel of

length $\left(\frac{L}{2}\right)$ each. The rods are completely insulated from the surroundings. If the free end of copper rod is maintained at $100^\circ C$ and that of steel at $0^\circ C$ then the temperature of junction is (Thermal conductivity of copper is 9 times that of steel)

A. $90^\circ C$

B. $50^\circ C$

C. $10^\circ C$

D. $67^\circ C$

Answer: A

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27. A partition wall has two layers A and B, in contact, each made of a different material. They have the same thickness but the thermal conductivity of layer A is twice that of layer B. If the steady state temperature difference across the wall is 60 K, then the corresponding difference across the layer A is

A. 10K

B. 20K

C. 30K

D. 40K

Answer: B

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28. Water of volume 4L in a closed container is heated with a coil of 2 kW. While water is heated, the container loses energy at a rate of 120 J/s. In how much time will the temperature of water rise from $27^{\circ}C$ to $77^{\circ}C$? (Specific heat of water is 4.2 kJ/kg and that of the container is negligible).

A. 5 min 15s

B. 3 min 7s

C. 11 min

D. 18 min

Answer: A

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