PHYSICS

BOOKS - MODERN PUBLISHERS PHYSICS (HINGLISH)

THERMAL PROPERTIES OF MATTER

Solved Example

1. A faulty thermometer reads $5^{\circ}C$ and $99^{\circ}C$ in ice and steam, respectively. If this thermometer reads $62^{\circ}C$, find the correct temperature in $^{\circ}C$.

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2. A thermometer with wrong calibration reads melting point of ice as-$8^\circ C$ and $50^\circ C$ in place of $40^\circ C$. Calculate the boiling point of water on this scale.

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3. A thermometer is taken from the melting ice into a warm liquid which results in rise in mercury level to 1/5th of the distance between the lower and the upper fixed points. Calculate the temperature of liquid in kelvins.

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4. Calculate the temperature at which the reading on Fahrenheit scale is equal to half the reading of Celsius scale.

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5. A faulty constant volume thermometer using helium gas records a pressure of 1.65×10^4 Pa at normal freezing point of water, and a pressure of 2.10×10^4 Pa at normal boiling point of water. Using these observations, determine the temperature of absolute zero on the Celsius scale.

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6. For what increase in temperature of a bras rod ,its length will increase by 0.5%

$\alpha_{\text{brass}} = 0.00002^\circ C^{-1}$

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7. Gaps are left while laying the railway lines in order to allow for expansion. The gap between steel rails of length 65 m is 3.56 cm at $15^\circ C$. Calculate the temperature at which the rails will just touch each other. Take, $O_{\text{steel}} = 1.1 \times 10^{-5} \circ C^{-1}$

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8. A blacksmith fixes iron ring on the rim of the wooden wheel of a bullock cart. The diameter of the rim and the ring are $5.243m$ and $5.231m$ respectively at $27^{\circ}C$. To what temperature should the ring be heated so as to fit the rim of the wheel ? Coefficient of linear expansion of iron =$1.20 \times 10^{-5}K^{-1}$

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9. The length of a brass rod at $20^{\circ}C$ is observed to be 0.8 m when measured by an iron scale, correct at $0^{\circ}C$. What will be the correct length of the rod at$0^{\circ}C$? Take,

$\alpha_{\text{iron}} = 1.2 \times 10^{-5}{}^{\circ}C^{-1}$

$\alpha_{\text{brass}} = 1.9 \times 10^{-5}{}^{\circ}C^{-1}$

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10. A clock with a brass pendulum keeps correct time at $30^\circ C$. How many seconds will it loose or gain if the temperature falls by $10^\circ C$? Take, $\alpha_{\text{brass}} = 0.000019^\circ C^{-1}$

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11. A metallic ball of radius 0.2 m is heated from 320 K to 522 K. What will be the increase in surface area of the ball? Given, coefficient of superficial expansion of the ball $= 3.4 \times 10^{-5} K^{-1}$

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12. When a glass block of volume $15,000 cm^3$ is heated from $20^\circ C$ to $40^\circ C$, its volume increases by $5 cm^3$. What is the coefficient of linear expansion of glass?

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13. A gasoline tank made of steel is filled completely with 60 litres of gasoline, both at a temperature of $12^\circ C$. How much gasoline will overflow when the temperature is increased to $25^\circ C$?

$\alpha_{\text{steel}} = 1.1 \times 10^{-5} {}^\circ C^{-1}$

$\gamma_{\text{gasoline}} = 9.5 \times 10^{-4} {}^\circ C^{-1}$

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14. A geyser heats 5kg/min water , from $25^{\circ} C$ to $80^{\circ} C$. Find the rate of consumption of the fuel if the geyser operates on a gas burner , Take Heat of cosumbustion $= 5 \times 10^{4} J / g$

sepcific heat of water $= 4.20 \times 10^{3} J / kg / K$

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15. A sphere of aluminium of 0.047 kg is placed for sufficient time in a vessel containing boiling water, so that the sphere is at 100° C. It is then immediately transferred to 0.14 kg copper calorimeter containing 0.25 kg of water at 20° C. The temperature of water rises and attains a steady state at 23° Calculate the specific heat capacity of aluminium. (Give specific heat of copper $= 0.386 \times 10^3 Jkg^{-1}K^{-1}$).

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16. A thermally isolated vessel is maintained inside at $0^\circ C$ and contains 200 g of water. When the air above the water is pumped out, some of the water freezes while rest of it evaporated at $0^\circ C$ itself. Determine the mass of water that freezed. Take, Latent heat of vapourisation of water at $0^\circ C = 2.19 \times 10^3 J/g$

Latent heat of fusion of ice =$3.36 \times 10^2 J/g$

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17. In a container containing 0.2 kg of water at $40^{\circ}C$, 0.2 kg of ice at $0^{\circ}C$ is mixed. Calculate the heat of fusion of ice if the resulting temperature is $5.5^{\circ}C$. Take, Specific heat of water = $4186Jkg^{-1}K^{-1}$

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18. Calculate the heat required to convert 3 kg of ice at $-12^{\circ}C$ kept in a calorimeter to steam at $100^{\circ}C$ at atmospheric pressure. Given,

specific heat capacity of ice = $2100Jkg^{-1}K^{-1}$

specific heat capicity of water = $4186Jkg^{-1}K^{-1}$

Latent heat of fusion of ice = $3.35 \times 10^{5}Jkg^{-1}$

and latent heat of steam = $2.256 \times 10^{6}Jkg^{-1}$.

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19. For a glass window of area $1500cm^2$ and thickness 0.5 cm, determine the rate of loss of heat if the temperature inside the window is $35^\circ C$ and outside is $-2^\circ C$. Take, coefficient of thermal conductivity of glass $= 2.2 \times 10^{-3} cals^{-1} cm^{-1} K^{-1}$

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20. When steam at $100^\circ C$ is passed into a metal cylinder, water at $100^\circ C$ is collected at the rate of 200 g/min. If the area and thickness of cylinder are $300cm^2$ and 20 mm, respectively, determine the temperature of the outer surface. Take, thermal conductivity of metal $= 0.424 cal s^{-1}$cm. Latent heat of steam $= 540 cal g^{-1}$

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21. One end of 0.5 m long metal rod is in steam at $100^{\circ}C$ and the other end is put in ice at $0^{\circ}C$. If ice melts at the rate of 10 g/min, calculate the thermal conductivity of the metal. Take, cross sectional area of $rod = 2\pi cm^2$. Latent ice of heat = 80 cal/g

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22. On the Dal lake of Kashmir, a layer of 2 cm thick ice is formed when the outside temperature is $-10^{\circ}C$. How much time it will take for the increase in thickness of ice by 0.5 mm? Take, Density of ice $= 1g / c^3$ m

Latent heat of ice = 80 cal/g

Thermal conductivity of ice = $0.008 cal s^{-1} cm^{-1} {}^{\circ}C^{-1}$

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23. A rectangular steel tank of thickness 2.5 cm is used to boil water by a constant temperature furnace. If the level of water inside the tank falls at a steady rate of 0.25 cm in 2 minutes due to vaporisation, find the temperature of the furnace.

Take, conductivity of steel $= 0.2 cal s^{-1} m^{-1} {}^{\circ}C^{-1}$

Latent heat of steam = 540 cal/g

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24. Three rods of equal length and equal area of cross section are connected end to end in series. The open end of the first rod (from left) is at a temperature of $300^\circ C$ and that of the last rod is at $20^\circ C$ in steady state. If the thermal conductivities of rods from left to right are in the ratio of 1: 3: 4, then find the temperatures of both the junctions.

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25. A 2m iron rod of uniform cross section has its one end in contact with ice at $0^\circ C$ and the other end with water at $100^\circ C$. Find a point along the length of the rod at which a temperature of $150^{\circ}C$ is maintained so that mass of ice melted is equal to mass of steam produced in the same time. Consider that the system is thermally isolated from the surroundings. Take, Latent heat of ice = 80 cal/g

Latent heat of vapourisation of water = 540 cal/g

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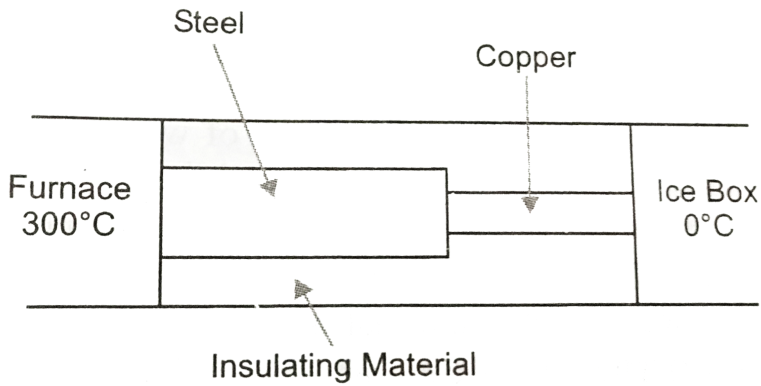
26. What is the temperature of steel-copper junction in the steady state of the system shown in fig. Length of the steel rod = 30.0 cm, length of the copper rod = 20.0 cm, temperature of the furnace = $300^{\circ}C$, temperature of cold end $= 0^{\circ}C$. The area of cross-section of the steel rod is twice that of the copper rod. thermal conductivity of steel $= 50.2 Js^{-1} m^{-1} . ^{\circ} C^{-1}$ and of copper $= 358 Js^{-1} m^{-1} . ^{\circ} C^{-1}$.



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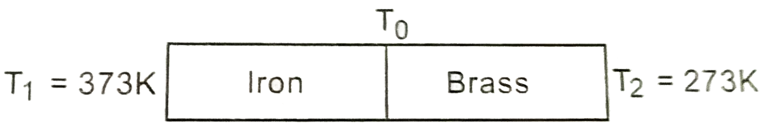
27. An iron bar ($L_1 = 0.1 m, A_1 = 0.02 m^2, K_1 = 79 W m^{-1} K^{-1}$) and a brass bar ($L_2 = 0.1 m, A_2 = 0.02 m^2, K_2 = 109 W m^{-1} K^{-1}$) are

soldered end to end as shown in fig. the free ends of iron bar and brass bar are maintained at 373 K and 273 K respectively. Obtain expressions for and hence compute (i) the temperature of the junction of the two bars, (ii) the equivalent thermal conductivity of the compound bar and (iii) the heat current through the compound bar.



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28. A hot body at $70^\circ C$ cools to 25° C in 15 min . Find its temperature after the next 10 mins. The temperature of the surroundings is $10^\circ C$.

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29. At what temperature, a perfect black body will radiate energy at the rate of $6.48W/cm^2$. Take, $\sigma = 5.67 \times 10^{-8} Wm^{-2}$K^(-4)`

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30. Due to voltage fluctuations, the temperature of an electric bulbs rises from 2000 K to 3000 K. Calculate the percentage rise in the electric power consumed.

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31. Calculate the energy radiation by the sun in 2 mins if it is considered to be perfect sphere of radius $6.8 \times 10^8 m$ and its surface temperature is approximately 6200 K. Take $\sigma = 5.67 \times 10^{-8} Jm^{-2} s^{-1} K^{-4}$

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32. A thin brass rectangular sheet of sides 15.0 cm and 10.0 cm is heated in a furnace to $500^\circ C$ and then taken out. Calculate the electric power that is needed to maintain the sheet at this temperature, given that the emissivity is 0.250. (Stefan-Boltzmann constant, $\sigma = 5.67 \times 10^{-8} Wm^{-2} K^{-4}$)

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33. A sphere of radius 15 cm is at a temperature of $215^\circ C$. Find the maximum amount of heat which may be lost per second by radiation when the sphere is placed in an enclosure at $25^\circ C$. Take, $\sigma = 5.67 \times 10^{-8} W m^{-2} K^4$

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34. Compare the rate of loss of heat by one degree from a cup of hot coffee when it is at $100^\circ C$ and at $40^\circ C$, in a room at $10^\circ C$. Consider the coffee to act as a black body.

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35. A hot body has a surface temperature of $1345^\circ C$. Calculate the wavelength at which it radiates maximum energy . Take .

Wein,s constant = 0.2898 cm K

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36. The sun radiates maximum energy at a wavelength of 4753 Å. If the temperature of the sun is 6076 K, determine the temperature of a star for which maximum energy is emitted at 9300 Å

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37. A heated filament of a bulb is radiating maximum energy at wavelength 3.14×10^{-5} cm. Determine the total amount of energy lost per second per unit area by the filament if the temperature of the surrounding air is $20^\circ C$. Take,

$b = 0.288 cmK$

$\sigma = 5.77 \times 10^{-5} ergs^{-1} cm^{-2} K^{-4}$

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Practice Problem

1. A Fahrenheit thermometer and a Celsius thermometer are put in a hot liquid in a cylinder. The reading on Celsius scale is $\frac{3}{2}$ times the reading on Fahrenheit scale. Calculate the temperature on Celsius, Fahrenheit and Kelvin Scale.

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2. A thermometer has wrong calibrations marked on it. The lower and upper fixed points on it are 4° and 96° . The temperature of a body measured by this thermometer is 60° . Calculate the correct temperature of the body on Celsius scale.

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3. A faulty thermometer reads melting point of ice as $-5^{\circ} C$ and it reads $70^{\circ} C$ instead of $60^{\circ} C$. What will be temperature of boiling point of water on this scale?

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4. The pressure recorded by a constant volume gas thermometer is 3.1×10^{4} Pa at melting point of sulphur and 1.8×10^{4} Pa at triple point of water. What will be melting point of sulphur?

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5. Small amount of mercury is poured in a glass container of 2 litres capacity. Calculate the volume of mercury in the container assuming that volume of air inside the container always remains same.

α for glass $= 9 \times 10^{-6} {}^{\circ}C^{-1}$

α for mercury $= 0.6 \times 10^{-4} {}^{\circ}C^{-1}$

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6. In a certain arrangement, two cylinders of brass and steel are laid side by side and there is a constant difference of length between them at any temperature. Calculate the lengths of these cylinders at $0^{\circ}C$ if there is a difference of 5 cm between their lengths at all temperatures.

$\alpha_{\text{brass}} = 0.0000019^{\circ} C^{-1}$

$\alpha_{\text{steel}} = 1.2 \times 10^{-6} C^{-1}$

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7. A clock with a steel pendulum gives accurate time at $30^{\circ} C$. Calculate the fractional loss or gain in time if temperature changes to $50^{\circ} C$. Coefficient of linear expansion of steel $= 12 \times 10^{-6 \circ} C^{-1}$

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8. A metallic sphere is heated from 225 K to 325 K. On heating, the volume increases by 2% of original value.

Find the coefficients of linear, superficial and cubical expansion of metal.

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9. Calculate the volume of ethane required to be burnt to convert 100 kg of water at $20^{\circ}C$ to steam at $100^{\circ}C$, assuming that only 40% of heat is useful. Heat of combustion of ethane is 371 kcal mol^{-1} . (One mole of gas occupies 22.4 litres at S.T.P. and latent heat of water is $2.25 \times 10^6 Jkg^{-1}$)

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10. 100 gm of water at $20^\circ C$ is converted into ice at $0^\circ C$ by a refrigerator in 2 hours. What will be the quantity of heat removed per minute? Specific heat of water = $1 cal g^{-1} C^{-1}$ and latent heat of ice $= 80 cal g^{-1}$

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11. On mixing 0.35 kg of ice at $0^\circ C$ with 0.8 kg of water at $45^\circ C$ in a container, the final temperature becomes $20^\circ C$. What will be the heat of fusion of ice? (Specific heat of water $= 4186 J kg^{-1} K^{-1}$)

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12. A room is to be maintained at a constant temperature of $30^{\circ} C$ and is heated by a heater of resistance 10Ω connected to 210 V mains supply. Heat is transmitted outside through a window of thickness 0.3 cm and area $2 m^{2}$ What will be temperature outside the window?

Thermal conductivity of glass $= 0.3 cal s^{-1} m^{-1} {}^{\circ} C^{-1}$

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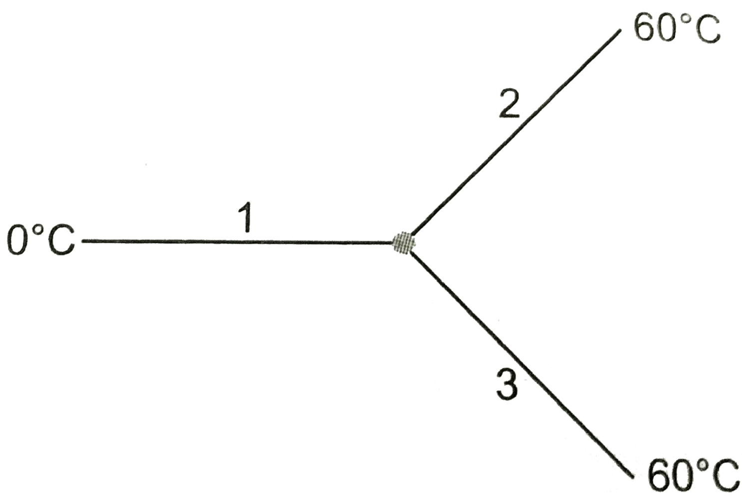
13. A rectangular steel tank of thickness 3 cm contains water. The water in the tank is boiled by a furnace. The level of water falls at a constant rate of 1.5 cm in 15 minutes. What will be the temperature of furnace if K for steel is $0.2 cal s^{-1} m^{-1} {}^{\circ} C^{-1}$?

14. Three rods made of same material and having same cross-section have been joined as shown in Fig. 7(e).18. Each rod is of the same length. The left and the right ends are kept at $0^\circ C$ and $60^\circ C$ respectively. What is the temperature of the junction of the three rods.



15. The temperature difference between two ends of a 2 m long bar A is $40^{\circ}C$ and that between a 3 m long bar B of same area is $60^{\circ}C$. If the rate of conduction of heat in two bars is same, calculate the ratio of coefficients of thermal conductivity of two bars.

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16. An ice layer of thickness 3 cm is formed on a lake. How much time will it take to increase the thickness of ice by 2 mm if temperature of air is $-30^{\circ}C$? Take, Density of ice $=1gcm^{-3}$, Latent heat of ice $=80calg^{-1}$, Conductivity of ice $=0.008cals^{-1}cm^{-1\circ}C^{-1}$

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17. A body cools from $70^{\circ}C$ to $60^{\circ}C$ in 10 minutes. Calculate the temperature of body after further 7 minutes if temperature of surroundings is $12^{\circ}C$.

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18. A pan filled with hot food cools from $50^{\circ}C$ to $40^{\circ}C$ in 2 minutes and to $30^{\circ}C$ in next 5 minutes. Calculate the temperature of surroundings.

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19. A body cools from $90^{\circ} C$ to $80^{\circ} C$ in 2 minutes. How long will it take to cool from $70^{\circ} C$ to $50^{\circ} C$ if temperature of surroundings is $16^{\circ} C$?

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20. An electric heater is made up of 10 thin polished tubes of a metal. Each tube is 0.5 m long and 2 cm in diameter. Hot water at $60^{\circ} C$ is constantly circulating through the tubes. What will be the heat radiated in 2 hours by the heater in a room where room temperature is $16^{\circ} C$? Take, Emissivity of metal $= 5 \times 10^{-2}$ and $\sigma = 5.67 \times 10 J s^{-1} m^{-2} K^{-4}$

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21. The initial temperature of a black body is $527^\circ C$. What should be its temperature so as to double the emitted radiations?

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22. An energy radiator at $0^\circ C$ is radiating energy at the rate of $2.2 \times 10^4 ergcm^{-2}s^{-1}$. Calculate the heat radiated per second by a spherical body of radius 2 cm and at a temperature of $100^\circ C$.

$\sigma = 5.67 \times 10^{-5} ergcm^{-2}s^{-1}K^{-4}$

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23. A hot body at $800^{\circ}C$ is radiating 500 J of energy per minute. Calculate the surface area of the body if emissivity is 0.23 and Stefan's constant is $5.67 \times 10^{-8} W m^{-2} K^{\cdot -4}$.

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24. The surface temperature of the hot body is $1127^{\circ}C$ find the wavelenght at which it radiates maximum energy. Given Wien's constant = 0.2898 cm K. To which spectrum region this wavelength belongs?

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25. The maximum wavelength observed in the spectral energy distribution of sun is at 4673 Å, at a temperature of about 6000 K. For a star, this maximum is at 9000 Å. Calculate the temperature of the star.

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26. The thermal emissivities of two bodies A and B are 0.02 and 0.09, respectively. λ_A and λ_B are the wavelengths corresponding to maximum intensity of radiations and λ_A is shifted from λ_B by μm . If the surface area and the total power radiated by the bodies are same, then calculate the temperature of B, given temperature of A is 5000 K.

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27. Calculate the electrical energy consumed per second in an electric bulb with tungsten filament of area $0.35cm^2$ when its temperature is raised to 2000 K, by passing an electric current through it. The emissivity of filament is 0.45. Stefan's constant, $\sigma = 5.67 \times 10^5 ergs^{-1}cm^{-2}K^{-4}$

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28. A sphere with radius 10 cm is radiating 500 W power at 700 K. Calculate the power radiated if radius of sphere is doubled and temperature is halved.

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Conceptual Questions

1. Why is it preferred to have small heat capacity of a thermometer bulb?

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2. Mercury boils at $367^\circ C$. However, mercury thermometers are made such that they can measure temperature up to $500^\circ C$. This is done by

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3. What is the necessary condition for the difference in lengths of a brass rod and an iron rod to be constant at all temperatures?

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4. In order to loosen a stopper from the neck of a glass bottle, boiling water is poured around the neck. Why?

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5. A long cylindrical metal vessel, having a linear coefficient (α), is filled with a liquid upto a certain level. On heating , it is found that the level of liquid in the cylinder remains the same. What is the volume coefficient of expansion of the liquid?

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6. There are two sphers of same radius and material at the same temperature but one being solid while the other hollow. Which sphere will expand more if they are given the same amount of heat ?

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7. Water is placed inside a closed tube and a candle is placed below the arms of tube as shown in the adjoining figure . In which direction will water begin to circulate indie the tube ?

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8. Three objects sphere , a cube and a circular plate of equal mass are constructed from same material . All of the three objects are initially heated to a temperature of $150^{\circ} C$ and then left to cool at room temperature. Will they all cool down at the same ? If not, which of them will cool faster and why ?

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9. On a hot day, a car is left in sunlight with all the windows closed. After sometimes, it is found that air inside the car is considerably warmer than the air outside. Explain why?

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10. A black platinum wire, when heated, first appears dull red, then yellow, then blue and finally white. Explain.

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11. Statement -1 : When hot water is poured in a beaker of thick glass, the beaker cracks.

Statement - 2: Glass is a bad conductor of heat and outer surface of the beaker does not expand.

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12. A beaker filled with water at $4.^\circ C$ over flows if the temperature of water increases or decreases. Explain why?

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13. In an experiment, a safety pin is placed on a sheet of paper and the sheet is held over a burning candle until it is yellow and charred. On removing the pin, its white trace is seen on the paper. Explain the observation with reasoning.

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14. Can we boil water inside a satellite revolving earth?

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15. Is it necessary that all black coloured objects should be considered black bodies ?

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16. Comment on the statement: "The radiation of a black body is white."

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Tough And Tricky Problem

1. Two spherical concentric shells of radii r and 3r are kept at temperatures T_1 and T_2 as shown in the adjoining figure. If the space between the shells is filled with a liquid of thermal conductivity K, what will be the radial flow of heat through the liquid?

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2. A metallic cylindrical shell of length 50 cm has inner radius of 3 cm and outer radius of 6 cm. If the inner and outer surfaces of the cylinder are maintained at $0^{\circ}C$ and $80^{\circ}C$, respectively, then find the rate of flow of heat from the outer surface to the inner surface. Take, thermal conductivity of metal $= 69.3Wm^{-1}k^{-1}$

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3. An ice layer of thickness d_1 is floating on a pond of water. The atmospheric temperature is -$T^{\circ}C$. What is the time taken for the thickness of the layer to increase from d_1 to d_2 if L, ρ and K are the latent heat of fusion of water, density of ice and thermal conductivity of ice, respectively?

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4. Among three rods, the first two are made of same material having coefficient of linear expansion α_1 and the third rod is made of material of coefficient of linear expansion α_2 . The third rod forms the base of the equilateral triangle when the three rods are arranged to form an equilateral triangle. If the altitude of triangle remains constant at all temperatures, what is the ratio of α_1 / α_2 ?

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5. An insulated container has a wooden lid at the top whose conductivity is $0.15 J/m^\circ Cs$, thickness is 5 mm and emissivity is 0.5. The temperature of the top of the wooden lid is maintained at $125^\circ C$ and the ambient temperature is $27^\circ C$. Hot liquid is now circulated through the container as shown in the figure. Determine the rate of loss of heat per unit area due to radiation from the wooden lid and temperature of the oil.

Take $\sigma = 5.66 \times 10^{-8} W m^{-2} K^{-4}$

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6. Let cube of mass 0.2 kg at $0^{\circ} C$ be placed in a container whose temperature is $127^{\circ} C$. The specific heat of the container varies with temperature T as s =$p + qT^2$, where p = 120 cal/kg K and q = 0.03 cal / kgK^3 . If the final temperature of the container is $27^{\circ} C$, what will be its mass? Take, latent heat of fusion of water $= 8 \times 10^4$ cal/kg and specific heat of water = 1000 cal/kg K.

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7. A solid sphere of radius R is made of a material of density ρ and specific heat c . The sphere is initially at 220 K and is later suspended inside a chamber whose walls are at 0K. What time is required for the temperature of the sphere to drop to 160 K?

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8. A thin metal disc of mass 0.5 kg and cross sectional area $0.05m^2$ is placed coaxially with a cylindrical block of height 0.5 m and same cross sectional area. The top face of the cylindrical block is maintained at a constant temperature of 300 K. If the initial temperature of the metal disc is 200 K, how long will it take for its temperature to raise to 250 K? The thermal conductivity of cylinder's material is $10Wm^{-1}K^{-1}$ and specific heat capacity of disc's metal is $600Jkg^{-1}K^{-1}$

Note: Consider that the thermal conductivity of disc is very high and the system is thermally insulated except the top face of cylinder.

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9. A solid body A of mass m and specific heat capacity 's' has temperature $T_1 = 400K$. It is placed, at time $t = 0$, in atmosphere having temperature $T_0 = 300K$. It cools, following Newton's law of cooling and its temperature was found to be $T_2 = 350K$at time t_0. At time t_0, the body A is connected to a large water bath maintained at atmospheric temperature T_0, using a conducting rod of length L, cross section A and thermal conductivity k. The cross sectional area A of the connecting rod is small compared to the overall surface area of body A. Find the temperature of A at time $t = 2t_0$.

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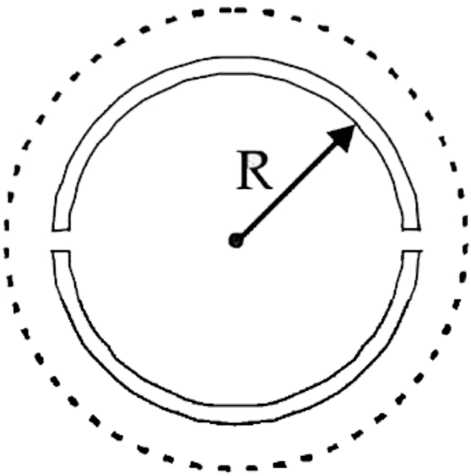
10. A wooden wheel of radius R is made of two semicircular part . The two parts are held together by a ring made of a metal strip of cross sectional area S and length L. L is slightly less than $2\pi R$. To fit the ring on the wheel, it is heated so that its temperature rises by ΔT and it just steps over the wheel. As it cools down to surrounding temperature, it process the semicircle parts together. If the coefficient of linear expansion of the metal is α, and it Young's modulus is Y, the force that one part of the wheel applies on the other part is :



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Ncert File Textbook Exercise

1. The triple point of neon and carbon dioxide are $24.57K$ and $216.55K$ respectively. Express these temperature on the Celsius and Fahrenheit scales.

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2. Two absolute scales A and B have triple points of water defined to be $200A$ and $350B$. What is the relation between T_A and T_B?

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3. The electrical resistance in ohms of a certain thermometer varies with temperature ac cording to the approximate law: $R = R_0[1 + \alpha(T - T_0)]$

The resistances is 101.6Ω at the triple-point of water $273.16K$, and 165.5Ω at the normal melting point of lead $(600.5K)$. What is the temperature when the resistance is 123.4Ω?

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4. Answer the following :

(a) The triple-point of water is a standard fixed point in modern thermometry. Why ? What is wrong in taking the melting point of ice and the boiling point of water as standard fixed points (as was originally done in the Celsius scale) ?

(b) There were two fixed points in the original Celsius scale as mentioned above which were assigned the number $0^\circ C$ and $100^\circ C$ respectively. On the absolute scale, one of the fixed points is the triple-point of water, which on the Kelvin absolute scale is assigned the number 273.16 K. What is the other fixed point on this

(Kelvin) scale ?

(c) The absolute temperature (Kelvin scale) T is related to the temperature t_c on the Celsius scale by

$t_c = T - 273.15$

Why do we have 273.15 in this relation, and not 273.16 ?

(d) What is the temperature of the triple-point of water on an absolute scale whose unit interval size is equal to that of the Fahrenheit scale ?

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5. Answer the following :

(a) The triple-point of water is a standard fixed point in modern thermometry. Why ? What is wrong in taking the melting point of ice and the boiling point of water as standard fixed points (as was originally done in the Celsius scale) ?

(b) There were two fixed points in the original Celsius scale as mentioned above which were assigned the number $0^\circ C$ and $100^\circ C$ respectively. On the absolute scale, one of the fixed points is the triple-point of water, which on the Kelvin absolute scale is assigned the number 273.16 K. What is the other fixed point on this (Kelvin) scale ?

(c) The absolute temperature (Kelvin scale) T is related to the temperature t_c on the Celsius scale by

$t_c = T - 273.15$

Why do we have 273.15 in this relation, and not 273.16 ?

(d) What is the temperature of the triple-point of water on an absolute scale whose unit interval size is equal to that of the Fahrenheit scale ?

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8. Two ideal gas thermometer A and B use oxygen and hydrogen respectively . The following observations are made:

Temperature, Pressure therometer A, Pressure therometer B

Triple point of water, $1.250 \times 10^5 Pa, 0.200 \times 10^5 Pa$

Normal melting point of sulphur, $1.797 \times 10^5 Pa$, $0.287 \times 10^5 Pa$

(a) What is the absolute temperature of normal melting point of sulphur as read by thermometers A and B ?

(b) What do you think is the reason for the slightly different answers from A and B ? (The thermometers are not faulty). what further procedure is needed in the experiment to reduce the discrepancy between the two readings.

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9. A steel tape 1m long is correctly calibrated for a temperature of $27^\circ C$. The length of a steel rod measured by this tape is found to be $63.0cm$ on a hot day when the temperature is $45.0^\circ C$. What is the acutual length of the steel rod on that day? what is the length of the same steel rod on a day when the temperature is $27.0^\circ C$?

coefficient of linear expansion of steel $= 1.20 \times 10^{-5} . ^\circ C^{-1}$.

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10. a large steel wheel is to be fitted on to a shaft of the same material. At $27^\circ C$, the outer diameter of the shaft is $8.70 cm$ and the diameter of the central hole in the wheel is $8.69 cm$. The shaft is cooled using 'dry ice' , At what temperature of the shaft does the wheel slip on the shaft? Assume coefficient of linear expansion of the steel to be constant over the required temperature range: $\alpha_{steel} = 1.20 \times 10^{-5} K^{-1}$.

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11. A hole is drilled in a copper sheet. The diameter of the hole is 4.24cm at $27.0^{\circ} C$. What is the change in the diameter of the when the sheet is heated to $227^{\circ} C$? Coefficient of linear expansion of copper $= 1.70 \times 10^{-5 \circ} C^{-1}$?

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

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13. A brass rod of length 50 cm and diameter 3.0 mm is joined to a steel rod of the same length and diameter. What is the change in length of the combined rod at $250^{\circ} C$, if the original lengths are at $40.0^{\circ} C$? Is there a 'thermal stress' developed at the junction ? The ends of the rod are free to expand. Coefficient of linear expansion of brass $= 2.0 \times 10^{-5} .^{\circ} C^{-1}$ and that of steel $= 1.2 \times 10^{-5} .^{\circ} C^{-1}$.

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14. The coefficient of volume expansion of glycerine is $49 \times 10^{-5} / {}^{\circ} C$. What is the fractional change in its density (approx.) for $30^{\circ} C$ rise in temperature?

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15. A $10kW$ drilling machine is used to drill a bore in a small aluminium block of mass $8.0kg$. 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 surrounding? Specific heat of aluminium $= 0.91J / g^{\circ} C$.

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16. A copper block of mass $2.5kg$ is heated in a furnace to a temperature of $500^\circ C$ and then placed on a large ice block. What is the maximum amount (approx.) of ice that can melt? (Specific heat copper $= 0.39J/g^\circ C$ heat of fusion of water $= 335J/g$).

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17. In an experiment on the specific heat of a metal a 0.20 kg block of the metal at 150°C is dropped in a copper calorimeter (of water equivalent 0.025 kg) containing 150 cc of water at 27°C. The final temperature is 40°C. Calcualte the specific heat of the metal. If heat losses to the surroundings are not negligible, is our answer greater or smaller than the actual value of specific heat of the metal?

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18. Given below are observations on molar specific heats at room temperature of some common gases

Gas	Molar specific heat (C_v) (cal mol^{-1} K^{-1})
Hydrogen	4.87
Nitrogen	4.97
Oxygen	5.02
Nitric oxide	4.99
Carbon monoxide	5.01
Chlorine	6.17

The measured molar specific heats of these gases are markedly different from those for monoatomic gases. Typically, molar specific heat of a monoatomic gas is 2.92

cal/mol K. Explain this difference. What can you infer from the somewhat larger (than the rest) value for chlorine ?

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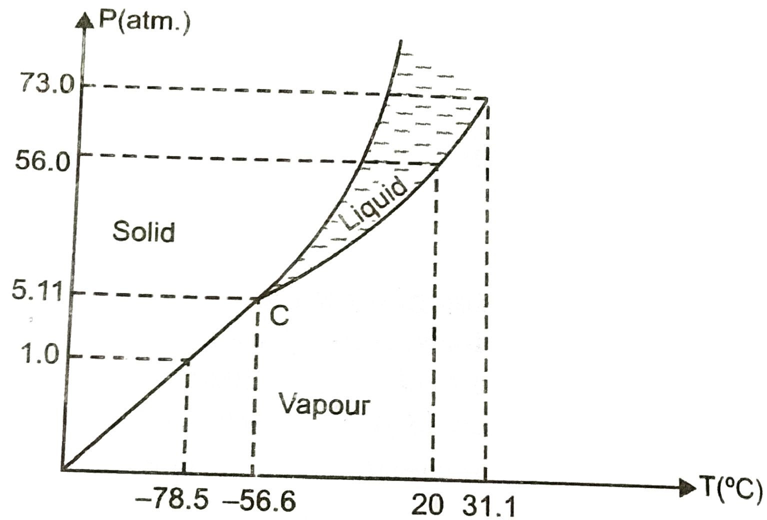
19. Answer the following question beased on tbhe P-T phase diagram of carbon dioxide.



(a) At what temperature and pressure can the solid, liquid and vapour phases of CO_2 co-exist is equilibrium ? (b)

What is the effect of decrease of pressure on the fusion and bolling point of CO_2 ? (c) What are the critical temperature and pressure for CO_2 ? What is their significane ? (d) Is CO_2 solid, liquid or gas at (a) $-70^\circ C$ under 1 atm, (b) $-60^\circ C$ under 10 atm, (c) $15^\circ C$ under 56 atm ?

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20. Answer the following questions based on the P – T phase diagram of CO_2:

(a) CO_2 at 1 atm pressure and temperature$-60^\circ C$ is compressed isothermally. Does it go through a liquid phase ?

(b) What happens when CO_2 at 4 atm pressure is cooled from room temperature at constant pressure ?

(c) Describe qualitatively the changes in a given mass of solid CO_2 at 10 atm pressure and temperature $-65^\circ C$ as it is heated up to room temperature at constant pressure.

(d) CO_2 is heated to a temperature $70^\circ C$ and compressed isothermally. What changes in its properties do you expect to observe ?

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21. A child running a temperature of $101^\circ F$ is given an antipyrine (i.e. a medicine that lowers fever) which causes an increase in the rate of evaporation of sweat from his body. If the fever is brought down to $98^\circ F$ in 20 min , what is the average rate of extra evaporation caused by the drug? Assume the evaporation mechanism to be the only way by which heat is lost. the mass of the child is $30kg$. the specific heat of human body is approximately the same as that of water, and latent heat of water at that temperature is about $580cal/g$.

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22. A thermocole cubical icebox of side 30 cm has a thickness of 5.0 cm if 4.0 kg of ice are put ini the box, estimate the amount of ice remaining after 6 h. The outside temperature is $45^{\circ}C$ and coefficient of thermal conductivity of thermocole $= 0.01J/kg$.

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23. A brass boiler has a base area of $0.15m^2$ and thickness 1 cm. It boils water at the rate of 6 kg per minute when placed on a gas stove. Estimate the temperature of the part of the flame in contact with the boiler. Thermal conductivity of brass is $= 109Js^{-1}m^{-1}K^{-1}$, Heat of vapourisation of water is $2256 \times 10^3 Jkg^{-1}$

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24. Explain why:

(a) A body with large reflectivity is a poor emitter (b) A brass tumbler feels much colder than a wooden tray on a chilly day. (c) An optical pyrometer (for measuring high temperature) calibrated for an ideal black body radiation gives too low value for the temperature of a red-hot iron piece in the open, but gives a correct value for the temperature when the same piece is in the furnace. (d) The earth without its atmosphere would be inhospitably cold. (e) Heating systems based on circulation of steam are more efficient in warming a building than those based on circulation of hot water.

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25. A body cools from $80^{\circ}C$ to $50^{\circ}C$ in 5 min-utes Calculate the time it takes to cool from $60^{\circ}C$ to $30^{\circ}C$ The temperature of the surroundings is $20^{\circ}C$.

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High Order Thinking Skills And Advanced Level

1. A composite slab consists of two rectangular slabs of different materials, having coefficients of conductivity 2K and K. The two ends of the slabs are at temperatures T_1 and T_2 (where $T_1 > T_2$). How will the rate of heat flow depend on a where 3a and a are the lengths of two slabs? Consider that the two slabs have equal thickness.

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2. An optional pyrometer is used for measuring high temperature, if it is calibrated for an ideal black body radiation. When the temperature of a red-hot piece of iron is measured in the open, the pyrometer gives too low value but when the same piece is in the furnace, the pyrometer gives the correct values of temperature for the iron piece . Explain.

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3. 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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4. Three rods of same cross sectional area are made of same material and form the sides of a right-angled isosceles triangle PQR, right angled at Q. P and Q are maintained at temperature T and 2T, respectively. If the temperature of end R is T', then what is the ratio of T'/T. Assume that only heat conduction takes place.

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5. A cubical icebox made of thermocol of thickness 4 cm has each side equal to 20 cm. An ice block of mass 500 g is placed inside the box. If the box is suspended in a room at $50^\circ C$, what will be the approximate mass of unmelted ice left in 2 hours? Take, coefficient of thermal conductivity of thermocol $= 10^{-2} W m^{-1} K^{-1}$

Latent heat of fusion of water $= 3.35 \times 10^5 J kg^{-1}$

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6. The phase diagram of CO_2 in the figure shows that at atmospheric pressure, solid CO_2 sublimes at $-78.5^\circ C$. The triple point of CO_2 is at $-56.6^\circ C$ and 5.11 atm pressure.

Answer the following questions on the basis of the phase diagram:

(a) What happens when CO_2 at 1 atm pressure and $-62^\circ C$ is compressed isothermally?

(b) What changes will be produced when a given mass of CO_2 at 12 atm pressure and $-68^\circ C$ temperature is heated to room temperature at constant pressure?

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7. A heater of resistance R maintains a room at $T_0{}^\circ C$ and is connected to a mains supply of V volt. The heat is transmitted through a glass window of area A and thickness d. If the thermal conductivity of the glass is K, find the expression for the outside temperature.

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8. A window with double-pane is used for insulating a room thermally from outside. It consists of two glass sheets, each of area A and thickness d with a separation x between them. At equilibrium, the room-glass interface and glass-outside interface are at constant temperature of T_r and T_a respectively. What will the rate of heat flow through the window pane? The thermal conductivity of glass and air are K_1 and K_2 , respectively.

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9. A solid sphere of copper of radius R and a hollow sphere of the same materail of inner radius r and outer radius A are heated to the same temperature and allowed to cool in the same environment. Which of tehm starts cooling faster?

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10. An electric heater is used to maintain a temperature of $15^\circ C$ inside a room of total wall area 125 m". The outside temperature is $-10^\circ C$. The walls of the room are made of three different layers, innermost layer is made of wood of thickness 2 cm, middle layer is made of brick of thickness 20 cm and outermost layer is made of cement of thickness 2 cm. If there is no loss of heat through the floor and ceiling, find the power of heater. Take, thermal conductivities of wood, brick and cement as $0.125 Wm^{-1} {}^{\circ}C^{-1}$, $1.0 Wm^{-1} {}^{\circ}C^{-1}$ and $1.5 Wm^{-1} {}^{\circ}C^{-1}$, respectively.

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Revision Exercise Very Short Answer Question

1. SI unit of heat is

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2. Define temperature.

Watch Video Solution

3. Example Celsius and fahrenheit scales of temperature.Obtain the relation between celsius and fahrenheit scales of temperature celsius (Centigrade)scale of temperature.

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4. The temperature of a gas is increased by $20^{\circ}C$. What is the corresponding change on the Kelvin scale?

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5. Define coefficient of linear expansion of solids

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6. Relate the thermal coefficient of linear expansion, α, the the thermal coefficient of area expansion β.

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7. the coefficient of volume expansion is

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8. At what temperature will both the Celsius and Fahrenheit scales read the same value?

Watch Video Solution

9. Define specific heat of a substance

Watch Video Solution

10. What are the values of specific heat of water and hydrogen?

Watch Video Solution

11. Write the relation between linear, arial and volumetric expansion

Watch Video Solution

12. On what factors the values of α, β, γ depend?

Watch Video Solution

13. In engines water is used as coolant, because

Watch Video Solution

14. Define water equivalent

Watch Video Solution

15. What is the unit of α, β, γ ?

Watch Video Solution

16. When are the two bodies in thermal equilibrium?

Watch Video Solution

17. A metal sheet with a cricular hole in heated. The hole

Watch Video Solution

18. The specific heat of a gas in an isothermal process is

Watch Video Solution

19. What is specific heat of a gas is an adiabatic process?

Watch Video Solution

20. Name the three modes of transmission of heat.

Watch Video Solution

21. With which mode heat transfers in solids?

Watch Video Solution

22. Which mode of transfer of heat is quickest?

Watch Video Solution

23. What is relegation ?

Watch Video Solution

24. SUBLIMATION

Watch Video Solution

25. Coefficient of thermal conductivity depends on ?

Watch Video Solution

26. Why in winters birds swell their feathers?

Watch Video Solution

27. Can thermal radiations pass through vacuum?

Watch Video Solution

28. Why metallic handles of a wooden door appear colder in winter?

Watch Video Solution

29. Statement-1 : A cloudy night is hotter than a clear sky night.

Statement-2: Clouds are bad absorbers of heat.

Watch Video Solution

30. What is the basic condition for Newton's law of cooling to be obeyed?

Watch Video Solution

31. Define absorptive power and emissive power of a body.

Watch Video Solution

32. What is black body radiation ?

Watch Video Solution

33. What will happen to the emission rate if the temperature of a black body is increased from 200 K to 400 K?

Watch Video Solution

Revision Exercise Additional Question

1. The thermal conductivity of a rod depends on

A. of oils decreases with rise of temperature.

B. of alloys increases with rise of temperature.

C. of water increases with rise of temperature.

D. all of above are correct.

Answer: D

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2. Thermal radiations

A. require no medium for their propagation.

B. heat the intervening medium through which they pass.

C. don't obey inverse square law.

D. travel with speed less than speed of light.

Answer: A

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3. The specific heat of a gas in an isothermal process is

A. negative

B. zero

C. infinite

D. less than 1

Answer: C

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Revision Exercise Fill In The Blanks

1. The pressure under which liquid and vapour can co-exist at equilibrium is called the

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2. The amount of heat required to melt 1 kg of ice completely at its melting point to form water is equal to .... Joules.

Watch Video Solution

3. The .... of the surface of a body is the ratio of amount of thermal radiations reflected in a given time to the total amount of thermal radiations incident.

Watch Video Solution

4. An opaque body that neither reflects nor transmits the incident heat radiations but absorbs thermal radiations of all wavelengths falling on it, is called a .... body.

Watch Video Solution

5. .... of a body at a given temperature is the ratio of total emissive power of the body to the total emissive power of a perfectly black body at the same temperature.

Watch Video Solution

6. The amount of thermal radiation energy emitted from the surface of a body is found to be proportional to the

.... power of the absolute temperature of the body.

Watch Video Solution

7. .... is the amount of radiant power that a unit surface area of the earth would receive in the absence of the atmosphere, when placed at right angles to the incident radiation at a distance of 1 AU.

Watch Video Solution

8. The wavelength corresponding to maximum intensity of radiation from the sun is close to...........Angstrom.

Watch Video Solution

9. Natural convection arises due to unequal heating and .... force.

Watch Video Solution

10. The value of Stefan-Boltzmann constant in SI units is ....

Watch Video Solution

Revision Exercise Short Answer Question

1. Why a clinical thermometer should not be sterilized by boiling water?

Watch Video Solution

2. Statement-1: Water is considered unsuitable for use in thermometers.

Statement-2: Thermal Expansion of water is non uniform.

Watch Video Solution

3. The gas thermometers are more sensitive than liquid thermometers because gases

Watch Video Solution

4. A solid expands upon heating because

Watch Video Solution

5. Pendulum clocks generally go fast in winter and slow in summer.Why ?

Watch Video Solution

6. Example Celsius and fahrenheit scales of temperature.Obtain the relation between celsius and fahrenheit scales of temperature celsius (Centigrade)scale of temperature.

Watch Video Solution

7. Derive the relation between (i) α and γ and (ii) β and α where α, β and γ are coefficients of linear, superficial and cubical coefficients of expansion, respectively.

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8. Discuss the effect of temperature on the viscosity of liquids and gases.

Watch Video Solution

9. Explain what is meant by specific heat of a substance. What are its units? How is molar specific heat different from specific heat?

Watch Video Solution

10. How specific heat capacity of a substance varies with temperature?

Watch Video Solution

11. Two bodies of specific heats C_1 and C_2 having same heat capacities are combined to form a single composite body. What is the specific heat of the composite body?

Watch Video Solution

12. Triple point of water is

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13. What is critical temperature? Can a gas be liquefied at any temperature by increasing its pressure?

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14. What do you mean by latent heat of fusion and latent heat of vaporisation? What are its units and dimensions?

Watch Video Solution

15. The relation between principal specific heats of gases at constant pressure annd at volume is

Watch Video Solution

16. Mention atleast three applications of conductivity in daily life.

Watch Video Solution

17. What are the basic differences between , conduction, convection and radiation?

Watch Video Solution

18. Distinguish between natural and forced convections. Give one example of each.

Watch Video Solution

19. Distinguish between land breeze and sea breeze.

Watch Video Solution

20. Water is heated from below but not from top. Why?

Watch Video Solution

21. What are thermal radiations? Write their basic characteristics.

Watch Video Solution

22. GREEN HOUSE EFFECT

Watch Video Solution

23. Green house effect is caused by

Watch Video Solution

24. What is a black body ?

Watch Video Solution

25. What do you mean by Kirchhoff's law? Discuss at least two applications of it in daily life.

Watch Video Solution

26. State and explain Stefan's law.

Watch Video Solution

27. What do you mean by Wien's displacement law? What are the units and dimensions of Wien's constant?

Watch Video Solution

28. On a hot day, a car is left in sunlight with all the windows closed. After sometimes, it is found that air inside the car is considerably warmer than the air outside. Explain why?

Watch Video Solution

29. Why bottoms of cooking utensils are blackened and tops are polished?

Watch Video Solution

Revision Exercise Long Answer Question

1. Explain what is meant by the coefficients of linear (α), superficial (β) and cubical expansion (γ) of a solid. Given their units, find the relationship between them.

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2. Name the three modes of transmission of heat.

Watch Video Solution

3. what is meant by thermal conductivity and its coefficient . What are its SI units and cgs units.

Watch Video Solution

4. Explain (I) Stefan's law and (ii) energy distribution of black body.

Watch Video Solution

5. State and explain Newton's law of cooling. Also discuss its experimental verification.

Watch Video Solution

Revision Exercise Numerical Problem

1. At what temperature will both the Celsius and Fahrenheit scales read the same value?

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2. The air pressure in the thermometer bulb at constant volume is 70 cm of mercury at $0^{\circ} C$, 90 cm of mercury at $100^{\circ} C$ and 80 cm of mercury at room temperature T. Find the value of T.

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3. A thermometer is first dipped in water and then taken to a warm liquid. The mercury level rises to $\frac{3}{4}$th of the distance between lower and upper fixed points. Calculate the temperature of liquid in $^{\circ} C$ and K

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4. A metal block is heated through $10^{\circ}C$ till the volume of it changes by 0.31%. Calculate the coefficient of linear expansion of block.

View Text Solution

5. The driver of an automobile gets his steel gasoline tank filled with 50 ltrs of gasoline at surrounding temperature of $20^{\circ}C$. At afternoon, the temperature rises to $40^{\circ}C$. How much of the gasoline will overflow? Coefficient of linear expansion for steel , $\alpha_s = 1.3 \times 10^{-5} {}^{\circ}C^{-1}$ and for gasoline $\gamma_g = 9.4 \times 10^{-4} {}^{\circ}C^{-1}$

Watch Video Solution

6. By how much amount should the temperature of a steel rod be increased so that its length increases by 0.5%? The coefficient of linear expansion of steel is $1.2 \times 10^{-5} C^{-1}$

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7. At $0^{\circ} C$ a thermally isolated container has 200 g of water. When air above water is pumped out, then some of water evaporates and some of it freezes. What will be the mass of ice formed on freezing when there will be no water left in container? Latent heat of vaporisation of water = 2.2×10^6 J/kg and latent heat of fusion of ice = 3.37×10^5 J/kg.

Watch Video Solution

8. 500 gms of water is to be cooled from $3.5^\circ C$ to $20^\circ C$. How many grams of ice at $-10^\circ C$ will be required for this purpose?

Specific heat of ice = $0.5 cal g^{-1} {}^\circ C^{-1}$

Latent heat of ice = $80 cal g^{-1}$?

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9. What is calorific value of petroleum if 0.25 g of petroleum is burnt in a calorimeter containing 3 kg of water and having a water equivalent of 400 gm. The rise in temperature is $10^{\circ}C$

Watch Video Solution

10. A wooden box having dimensions 80 cm x 60 cm x 30 cm and thickness 3 cm contains ice. What will be the rate of melting of ice if external temperature is $30^{\circ}C$ and coefficient of thermal conductivity is $0.176Wm^{-1}K^{-1}$ and latent heat of ice = 80 cal/g.

View Text Solution

11. What will be the difference in temperatures between two sides of a metallic plate 10 mm thick if heat is conducted at the rate of 5×10^5 cal/min/m^2 . K for metal is $0.7 cal s^{-1} cm^{-1} {}^\circ C^{-1}$.

View Text Solution

12. A long metallic bar of length 0.5 m is placed in such a way that its one end is in ice and other end is in steam at $100^\circ C$. What will be the thermal conductivity of the metal if amount of ice melt in 1 minute is 20 g, Cross sectional area of the bar $= 4 \times 10^{-4} m^2$ and latent heat of ice $= 80 cal g^{-1}$.

Watch Video Solution

13. A body cools from $40^\circ C$ to $30^\circ C$ in 5 minutes and to $26^\circ C$ in next 3 minutes. What will be the temperature of surroundings?

Watch Video Solution

14. Water placed in a container cools from $80^\circ C$ to $70^\circ C$ in 5 minutes. How long will it take to cool from $60^\circ C$ to $40^\circ C$ if temperature of surroundings is $12^\circ C$

View Text Solution

15. What will be the surface area of a filament of 200 W incandescent lamp at 2000 K.

$\sigma = 5.67 \times 10^{-8} W m^{-2} K^{-4}$ and emissivity e = 0.3?

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16. By which factor the radiation emitted by a body will increase if the temperature of a hot body is increased from $127^{\circ} C$ to $227^{\circ} C$?

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17. A metallic ball of surface area $300 cm^2$ at a temperature of $227^{\circ} C$ is placed in a container at $27^{\circ} C$. Calculate the rate of loss of heat radiation by the ball if emissivity of ball is 0.3, $\sigma = 5.67 \times 10^{-5} erg cm^{-2} s^{-1} K^{-4}$.

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18. The wavelength of maximum energy distribution by a star A is 4500 Å at a temperature of 5000 K. Calculate the temperature of star B for which wavelength of maximum energy distribution is 8000 Å.

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19. The temperature of a furnace is $827^{\circ}C$. At which wavelength will it radiate maximum energy?

Watch Video Solution

Competition File Objective Type Question A Multiple Choice Question With Only One Correct Answer

1. When a piece of metal floats in mercury at $T^\circ C$, a fraction f_1 of its volume is submerged. If their temperature is increased by $\Delta T^\circ C$, fraction f_2 of metal piece is seen to be submerged. If the coefficients of volume expansion of the metal and the mercury are γ_1 and γ_2 , respectively, then the ratio f_1 / f_2 is

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

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

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

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

Answer: A

Watch Video Solution

2. When a thin iron wire of length l is heated from a temperature T_1 to T_2 , a change of 1% in its length is observed. The percentage change in area of iron plate of dimension $2l \times l$ when it is heated from T_1 to T_2 is

Watch Video Solution

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. angular speed increases but moment of inertia decreases

B. angular speed decreases but moment of inertia increases

C. angular speed and moment of inertia both decrease

D. angular speed and moment of inertia both increase.

Answer: B

Watch Video Solution

4. 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. $\frac{\Delta T}{\alpha T}$

B. $\frac{2\alpha\Delta T}{T}$

C. $(\alpha\Delta T$

D. $2\alpha\Delta T$

Answer: D

Watch Video Solution

5. A uniform metal rod of length 1 and mass m is rotating with an angular velocity of magnitude o about an axis passing through its centre and perpendicular to the rod. If the temperature of the rod increases by $T^{\circ}C$, then change in its magnitude of angular velocity varies directly with

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

B. $\sqrt{\omega}$

C. ω

D. ω^2

Answer: C

View Text Solution

6. 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. $\alpha_1 + \alpha_2$

C. $\frac{(\alpha_1 + \alpha_2)}{2}$

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

Answer: C

Watch Video Solution

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

A. solid sphere will expand more than hollow sphere.

B. hollow sphere will expand more than solid sphere.

C. both spheres will expand with same rate.

D. hollow sphere will not expand due to lack of volume inside it.

Answer: C

Watch Video Solution

8. A wooden cylindrical block floats vertically with 70% of its volume immersed in a liquid at $0^\circ C$. When temperature increases to $70^\circ C$, the block sinks in the liquid. The coefficient of cubical expansion of liquid in K^{-1} is

A. $12.6 \times 10^{-3} K^{-1}$

B. $61.2 \times 10^{-3} K^{-1}$

C. $6.12 \times 10^{-3} K^{-1}$

D. $6.00 \times 10^{-3} K^{-1}$

Answer: C

Watch Video Solution

9. A glass container of volume V contains some mercury. The coefficients of cubical expansion for glass and mercury are γ_g and γ_m , respectively. If the volume of air inside the flask remains constant at different temperature, then the volume of mercury in the flask is

A. $\frac{\gamma_m V}{\gamma_g}$

B. $\frac{\gamma_g V}{\gamma_m}$

C. $\left(1 - \frac{\gamma_m}{\gamma_g}\right)V$

D. $\left(1 - \frac{\gamma_g}{\gamma_m}\right)V$

Answer: B

View Text Solution

10. The coefficient of apparent expansion of a liquid when determined using two different vessle A and B are γ_1 and $\gamma_{2,}$ respectily. If the coefficient of linerar expansion of vesel A is α. Find the coefficient of linear expension of the vessel B.

A. $\dfrac{\gamma_A + \gamma_B}{3}$

B. $\dfrac{\gamma_A - \gamma_B}{3}$

C. $\dfrac{\gamma_A + \gamma_B}{3} - \alpha$

D. $\dfrac{\gamma_A - \gamma_B}{3} + \alpha$

Answer: D

Watch Video Solution

11. A block of ice at $-5^{\circ}C$ is slowly heated and converted to steam at $100^{\circ}C$. The process can be qualitatively represented by the curve

A.

B.

C.

D.

Answer: C

Watch Video Solution

12. In which of the following process, convection does not take place primarily

A. boiling of water

B. sea and land breeze

C. heating of air around a furnace

D. warning of glass bulb of thermometer due to filament

Answer: D

Watch Video Solution

13. Three rods of same material and of equal cross sectional area and length have been connected together as shown in the figure. The temperature of the junction of the rods approximately is

A. $35^{\circ}C$

B. $47^{\circ}C$

C. $51^\circ C$

D. $57^\circ C$

Answer: B

Watch Video Solution

14. Two metallic spheres A and B are made up of same material and also have identical surfaces. Both spheres are heated to same temperature and are then placed in a chamber which is at a lower temperature, thermally insulated from each other. If ratio of masses of A and B is 3:1, then the ratio of their initial rate of cooling is

A. $\frac{1}{\sqrt{3}}$

B. $\sqrt{3}/1$

C. $\frac{1}{3}$

D. $\left(\frac{1}{3}\right)^{\frac{1}{3}}$

Answer: D

Watch Video Solution

15. Consider the sun as a black body of radius 7×10^8 m and the earth receiving its surface radiations from the sun at a rate of approximately $1500W/m^2$. If the distance of the centre of the sum from the earth's surface is 15×10^{10} m, then the surface temperature of the sun is

A. 4990.5 K

B. 5706.8 K

C. 5903.7K

D. 6063.4 K

Answer: C

View Text Solution

16. Variation of intensity (I) versus wavelength (λ) for three black bodies at temperature T_1, T_2 and T_3 respectively is shown in the figure. Which of the following options is correct?

A. $T_1 < T_2 < T_3$

B. $T_1 < T_3 < T_2$

C. $T_3 < T_1 < T_2$

D. $T_3 < T_2 < T_1$

Answer: C

View Text Solution

17. A graph showing the variation of temperature with time for two bodies P and Q due to emission of radiation is shown. If P and Q have surface area, then the correct relation between the emissivity and absorptivity power of the two bodies is

A. $e_P > e_Q$ and $a_P < a_Q$

B. $e_P < e_Q$ and $a_P > a_Q$

C. $e_P < e_Q$ and $a_P < a_Q$

D. $e_P > e_Q$ and$a_P > a_Q$

Answer: D

View Text Solution

18. If liquefied oxygen at 1 atmospheric pressure is heated from 50K to 300k by supplying heat at constant rate. The graph of temperature vs time will be

A. 

B.

C.

D.

Answer: D

Watch Video Solution

19. A metallic cylinder of radius R is made of a material of thermal conductivity K_1 . It is surrounded by cylindrical sheet of inner radius R and outer radius 15 R, made of another metal of conductivity K_2 . Two ends of the combined system are maintained at different temperature as shown in the figure. If there is no loss of heat and the system is in steady state, then the effective thermal conductivity of the system is

A. $\left(K_1+K_2\right)/1.25$

B. $\left(K_1+3K_2\right)/2$

C. $\left(\frac{K_1+1.25K_2}{2.25}\right)$

D. $\left(\frac{1.35K_1+K_2}{3}\right)$

Answer: C

View Text Solution

20. An ideal Black-body at room temperature is thrown into a furnace. It is observed that

A. cannot be distinguished initially and is the darkest body at a later time.

B. is the darkest body at all times.

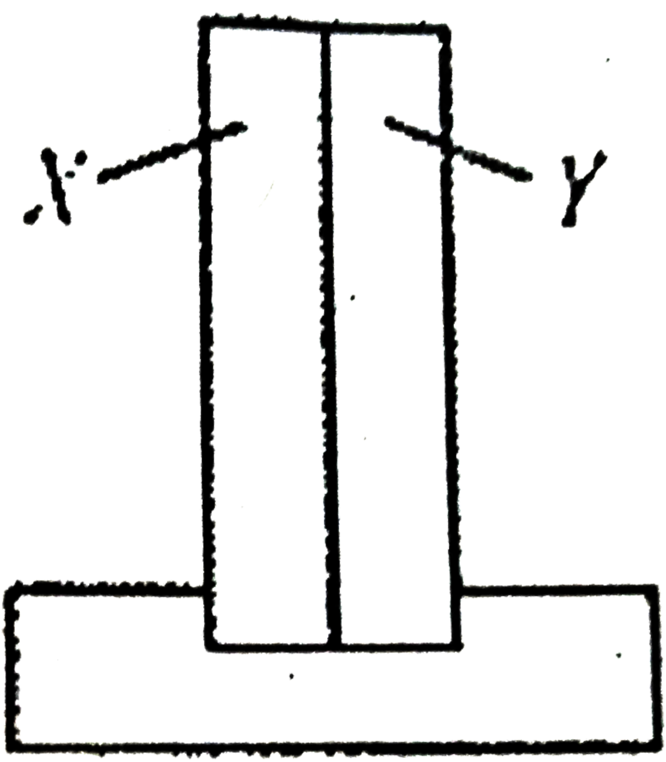
C. initially is the darkest body and at later times, it cannot be distinguished.

D. initially is the darkest body and at later times, it is the brightest body.

Answer: D

Watch Video Solution

1. A bimetallic strip consists of metals X and Y. It mounted rigidly at the base as shown. The metal X has a higher coefficient of expansion compared to that for metal Y. When the bimetallic strip is placed in a cold bath



A. it will bend towards the right

B. it will not bend but shrink

C. it will bend towards the left

D. it will neither bend or shrink.

Answer: C

Watch Video Solution

2. A black body is at $727^{\circ} C$. It emits energy at a rate which is proportional to

A. $(1000)^4$

B. $(1000)^2$

C. $(727)^4$

D. $(727)^2$

Answer: A

Watch Video Solution

3. The power radiated by a black body is P and it radiates maximum energy at wavelength, λ_0. If the temperature of the black body is now changed so that it radiates maximum energy at wavelength $\frac{3}{4}\lambda_0$, the power radiated by it becomes nP. The value of n is

A. $\frac{256}{81}$

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

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

D. $\frac{81}{256}$

Answer: A

Watch Video Solution

4. 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. $139^\circ W$

B. $78^\circ W$

C. $117^\circ W$

D. $200^\circ W$

Answer: C

Watch Video Solution

5. A deep rectangular pond of surface area A, containing water (density = ρ), specific heat capacity = s), is located in a region where the outside air temperature is at a steady value of $-26^\circ C$. The thickness of the frozen ice layer in this pond, at a certain instant is x. Taking the thermal conductivity of ice as K, and its specific latent heat of fusion as L, the rate of increase of the thickness of ice layer, at this instant, would be given by

A. $26K / \rho x(L + 4s)$

B. $(26K / \rho x(L - 4s)$

C. $26K / (\rho x^2 L)$

D. $26K / (\rho x L)$

Answer: D

Watch Video Solution

6. A black body at $227^\circ C$ radiates heat at the rate of $7 cal cm^{-2} s^{-1}$. At a temperature of $727^\circ C$, the rate of heat radiated in the same unit will be

A. 50

B. 112

C. 80

D. 60

Answer: B

Watch Video Solution

7. The total radiant energy per unit area, normal to the direction of incidence, received at a distance R from the centre of a star of radius r whose outer surface radiates as a black body at a temperature TK is given by

(where σ is Stefan's constant)

A. $\sigma r^4 T^4 / r^4$

B. $4\pi\sigma r^2 T^4 / R^2$

C. $\sigma r^2 T^4 / R^2$

D. $\sigma r^2 T^4 / 4\pi r^2$

Answer: C

Watch Video Solution

8. 1 g of water, of volume $1 cm^3$ at $100^\circ C$, is converted into steam at same temperature under normal atmospheric pressure $(= 1 \times 10^5 Pa)$. The volume of steam formed equals $1671 cm^3$. If the specific latent heat of vaporisation of water is 2256 J/g, the change in internal energy is

A. 2256 J

B. 2423 J

C. 2089 J

D. 167J

Answer: C

Watch Video Solution

9. A slab of stone of area of $0.36m^2$ and thickness $0.1m$ is exposed on the lower surface to steam at $100^\circ C$. A block of ice at $0^\circ C$ rests on the upper surface of the slab. In one hour $4.8kg$ of ice is melted. The thermal conductivity of slab is

(Given latent heat of fusion of ice $= 3.63 \times 10^5 Jkg^{-1}$)

A. $1.02J/s/^{\circ}C$

B. $1.24J/s/^{\circ}C$

C. $1.29J/m/s/^{\circ}C$

D. $2.05J/m/s/^{\circ}C$

Answer: B

Watch Video Solution

10. Liquid oxygen at $50K$ is heated to $300K$ at constant pressure of $1atm$. The rate of heating is constant. Which of the following graphs represents the variation of temperature with time?

A.

B.

C.

D.

Answer: B

Watch Video Solution

11. If the radius of a star is R and it acts as a black body, what would b the temperature of the star, in which the rate of energy production is Q?

A. $(Q/4\pi R^2\sigma)^{1/4}$

B. $Q/4\pi R^2\sigma$

C. $(Q/4\pi R^2\sigma)^{-1/2}$

D. $(4\pi R^2 Q/\sigma)^{1/4}$

Answer: A

Watch Video Solution

12. A piece of iron is heated in a flame. It first becomes dull red then becomes reddish yellow and finally turns to white hot. The correct explanation for the above observation is possible by using.

A. Wien's displacement Law

B. Kirchhoff's Law

C. Newton's Law of cooling

D. Stefan's Law

Answer: A

Watch Video Solution

13. Stream at $100^\circ C$ is passed into 20 g of water at $10^\circ C$. When water acquires a temperature of $80^\circ C$, the mass of water present will be [Take specific heat of water $= 1 cal g^{-1}.^\circ C^{-1}$ and latent heat of steam $= 540 cal g^{-1}$]

A. 24 g

B. 31.5 g

C. 42.5 g

D. 22.5 g

Answer: D

Watch Video Solution

14. An object kept in a large room having air temperature of $25^{\circ} C$ takes 12 minutes to cool from $80^{\circ} C$ to $70^{\circ} C$. The time taken to cool for the same object from $70^{\circ} C$ to $60^{\circ} C$ would be nearly,

A. 15 min

B. 10 min

C. 12 min

D. 20 min

Answer: A

Watch Video Solution

15. The two ends of a metal rod are maintained at temperature $100^\circ C$ and $110^\circ C$. The rate of heat flow in the rod is found to be $4.0 J / s$. If the ends are maintained at temperature s $200^\circ C$ and $210^\circ C$. The rate of heat flow will be

A. 44.0 J/s

B. 16.8 J/s

C. 8.0 J/s

D. 4.0 J/S

Answer: D

Watch Video Solution

16. A black body is at a temperature of $5760K$. The energy of radiation emitted by the body at wavelength $250nm$ is U_1 at wavelength $500nm$ is U_2 and that at $1000nm$ is U_3. Wien's consant, $b = 2.88 \times 10^6 nmK$. Which of the following is correct?

A. $U_1 > U_2$

B. $U_2 > U_1$

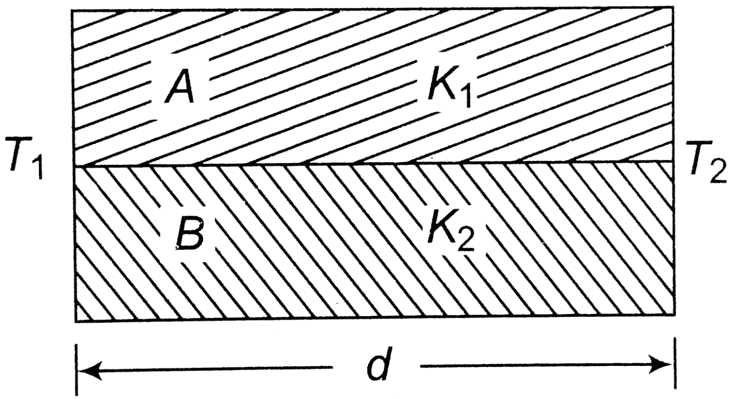
C. $U_1 = 0$

D. $U_3 = 0$

Answer: B

Watch Video Solution

17. Two rods A and B of different materials are welded together as shown in figure. Their thermal conductivities are K_1 and K_2. The thermal conductivity of the composite rod will be



A. $\dfrac{K_1 + K_2}{2}$

B. $\dfrac{3(K_1 + K_2)}{2}$

C. $k_1 + K_2$

D. $2(K_1 + K_2)$

Answer: A

Watch Video Solution

18. Coefficient of linear expansion of brass and steel rods are α_1 and α_2. Length of brass and steel rods are l_1 and l_2 respectively. If $(l_2 - l_1)$ is maintained same at all temperature, which one of the following relations holds good?

A. $apha_1 l_2^2$

B. $\alpha_1^2 l_2 = \alpha_2^2 l_1$

C. $\alpha_1 l_1 = \alpha_2 l_2$

D. $\alpha_1 l_2 = \alpha_2 l_1$

Answer: C

Watch Video Solution

Competition File Objective Type Question B Multiple Choice Question From Cpmpetitive Examination Jee Main And Other State Boards For Engineering Entrance

1. An aluminium sphere of $20cm$ diameter is heated from $0^{\circ}C$ to $100^{\circ}C$. Its volume changes by (given that the coefficient of linear expanison for aluminium $\left(\alpha_{Al} = 23 \times 10^{-6/0}C\right)$

A. 2.89 cc

B. 9.28 cc

C. 49.8 cc

D. 28.9 cc

Answer: D

Watch Video Solution

2. A cylinder witih fixed capacity of 67.2 lit contains helium gas at STP. The amount of heat needed to raise the temperature of the gas by 20° C is _______ J. [Given that R = 8.31 $Jmol^{-1}K^{-1}$]

A. 350J

B. 374 J

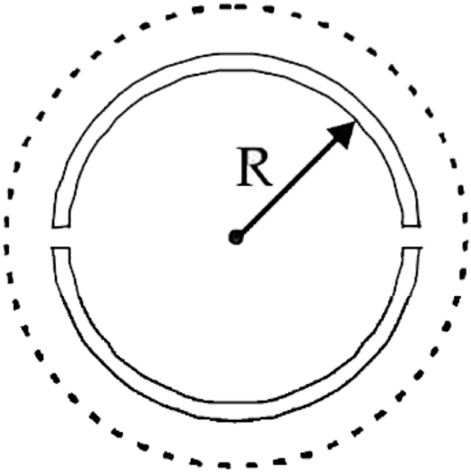
C. 748 J

D. 700J

Answer: C

Watch Video Solution

3. A wooden wheel of radius R is made of two semicircular part . The two parts are held together by a ring made of a metal strip of cross sectional area S and length L. L is slightly less than $2\pi R$. To fit the ring on the wheel, it is heated so that its temperature rises by $\Delta T$and it just steps over the wheel. As it cools down to surrounding temperature, it process the semicircle parts together. If the coefficient of linear expansion of the metal is α, and it Young's modulus is Y, the force that one part of the wheel applies on the other part is :



A. $2SY\alpha\Delta T$

B. $2SY\alpha\Delta T$

C. $2\pi SY\Delta T$

D. $SY\alpha\Delta T$

Answer: A

Watch Video Solution

4. The pressure that has to be applied to the ends of a steel wire of length 10cm to keep its length constant when its temperature is raised by $100^{\circ}C$ is : (For steel Young's modulus is $2 \times 10^{11} Nm^{-2}$ and coefficient of thermal expansion is $1.1 \times 10^{-5} K^{-1}$)

A. $2.2 \times 10^{6} pa$

B. $2.2 \times 10^{8} Pa$

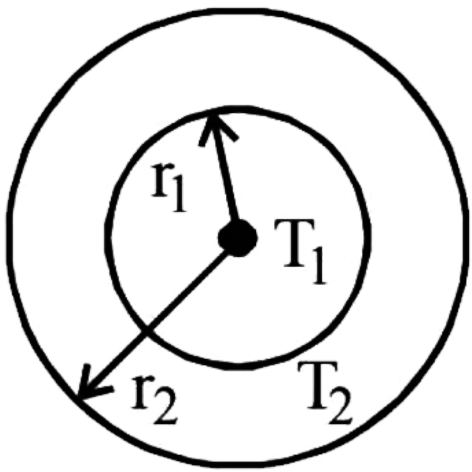
C. $2.2 \times 10^{9} Pa$

D. $2.2 \times 10^{7} Pa$

Answer: B

Watch Video Solution

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



A. $(r_2 - r_1) / r_1 r_2$

B. $\ln\left(\frac{r_2}{r_1}\right)$

C. $\frac{r_1 r_2}{(r_2 - r_1)}$

D. $(r_2 - r_1)$

Answer: C

Watch Video Solution

6. A liquid in a beaker has temperature $\theta(t)$ at time t and θ_0 is temperature of surroundings, then according to Newton's law of cooling the correct graph between $\log_e(\theta - \theta_0)$ and t is :

A.

B.

C.

D.

Answer: B

Watch Video Solution

7. A $50 \mathrm{~W} \mathrm{~m}^{-2}$ energy density of sunlight is incident normally on the surface of a solar panel. Some part of incident energy (25%) is reflected from the surface and the rest is absorbed. The force exerted on $1 m^2$ surface area will be close to

$(c = 3 \times 10^8 m s^{-1})$

A. $10 \times 10^{-8} N$

B. $20 \times 10^{-8} N$

C. $15 \times 10^{-8} N$

D. $35 \times 10^{-8} N$

Answer: B

Watch Video Solution

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. 6.0 cal/s

B. 1.2 cal/s

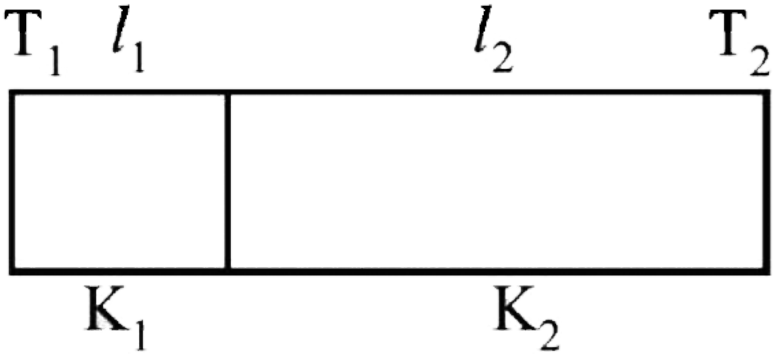
C. 2.4 cal/s

D. 4.8 cal/s

Answer: D

Watch Video Solution

9. One end of a thermally insulated rod is kept at a temperature T_1 and the other at T_2. The rod is composed of two sections of length l_1 and l_2 and thermal conductivities K_1 and K_2 respectively. The temperature at the interface of the two section is



A. $(k_2 l_2 T_1 + k_1 l_1 T_2) / (k_1 l_1 + k_2 l_2)$

B. $(k_2 l_2 T_1 + k_1 l_1 T_2) / (k_2 l_1 + k_1 l_2)$

C. $(k_1 l_2 T_1 + k_2 l_1 T_2) / (k_1 l_2 + k_2 l_1)$

D. $(k_1 l_1 T_1 + k_2 l_2 T_2) / (k_1 l_1 + k_2 l_2)$

Answer: C

Watch Video Solution

10. A long metallic bar is carrying heat from one of its ends to the other end under steady-state. The variation of temperature θ along the length x of the bar from its hot end is best described by which of the following figure.

A.

B.

C.

D.

Answer: B

Watch Video Solution

11. Water of volume 2 litre in a container is heated with a coil of $1kW at 27^{\circ} C$. The lid of the container is open and energy dissipates at rate of $160 J / s$. In how much time temperature will rise from $27^{\circ} C \rightarrow 77^{\circ} C$ Given specific heat of water is

$[4.2 kJ / kg]$

A. 8 min 20 s

B. 6 min 2 s

C. 7 min

D. 14 min

Answer: A

Watch Video Solution

12. 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

Watch Video Solution

13. 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. $25^\circ C$

B. $10^\circ C$

C. $15^\circ C$

D. $20^\circ C$

Answer: B

Watch Video Solution

14. black colored solid sphere of radius "R" and mass "M" is inside a cavity with vacuum inside.The walls of the cavity are maintained at temperature T_0 .The initial temperature of the sphere is $3T_0$ .If the specific heat of the material of the sphere varies as αT^3 per unit mass with the temperature of the sphere,where α is a constant,then the time taken for the sphere to cool down to temperature $2T_0$ will be (σ Stefan Boltzmann constant)

A. $\frac{M\alpha}{4\pi R^2\sigma}\ln\left(\frac{3}{2}\right)$

B. $\frac{M\alpha}{4\pi R^2\sigma}\ln\left(\frac{16}{3}\right)$

C. $\frac{M\alpha}{16\pi R^2\sigma}\ln\left(\frac{16}{3}\right)$

D. $\frac{M\alpha}{16\pi R^2\sigma}\ln\left(\frac{3}{2}\right)$

Answer: C

Watch Video Solution

15. A simple pendulum made of bob of mass m and a metallic wire of negligible mass has time period $2s$ at $T = 0^{\circ} C$. If the temperature of the wire is increased and the corresponding change in its time period is plotted against its temperature, the resulting graph is a line of slope S. If the coefficient of linear expansion of metal is α then value of S is :

A. α

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

C. 2α

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

Answer: A

Watch Video Solution

16. 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

Watch Video Solution

17. A steel rail of length 5 m and area of cross section $40cm^2$ 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

View Text Solution

18. In an experiment a sphere of aluminium of mass 0.20 kg is heated upto 150° C. Immediately, it is put into water of volume 150 cc at $27^\circ C$ kept in a calorimeter of water equivalent to 0.025 kg. Final temperature of the system is $40^\circ C$. The specific heat of aluminium is (take 4.2 Joule = 1 calorie)

A. $378J/kg^{\circ}C$

B. $315J/kg^{\circ}C$

C. $476J/kg/{}^{\circ}C$

D. $434J/kg/{}^{\circ}C$

Answer: D

Watch Video Solution

19. 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. $800^\circ C$

B. $885^\circ C$

C. $1250^\circ C$

D. $825^\circ C$

Answer: B

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Competition File Objective Type Question B Multiple Choice Question From Cpmpetitive Examination Jee Advanced For Iit Entrance

1. In which of the following process, convection does not take place primarily

A. sea and land breeze

B. boiling of water

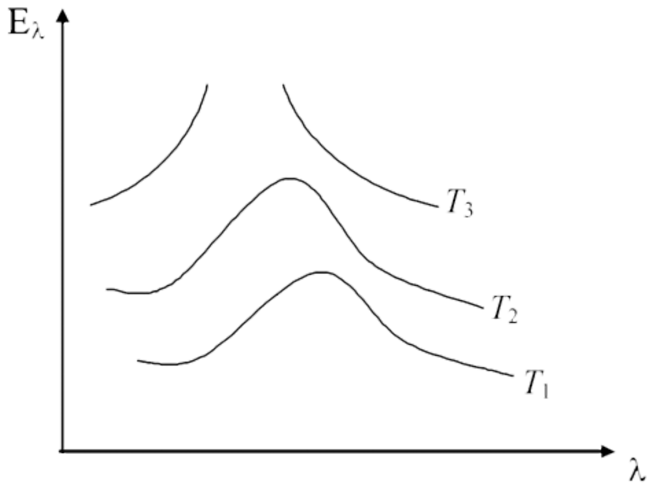
C. warming of glass of bulb due to filament

D. heating air around a furnace.

Answer: C

Watch Video Solution

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



A. Sun-T_1, tungsten filament-T_2, welding arc-T_3

B. Sun-T_2, tungsten filament-T_1 , welding arc-T_3

C. Sun-T_3, tungsten filament-T_1 , welding arc-T_2

D. Sun-T_1, tungsten filament-T_3, welding arc-T_2

Answer: B

Watch Video Solution

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

[σ is Stefan's constant]

A. $0.60\sigma AT^4$

B. $1.00\sigma AT^4$

C. $0.80\sigma AT^4$

D. $0.40\sigma AT^4$

Answer: B

Watch Video Solution

4. A metal rod AB of length 10x has its one end A in ice at $0^{\circ} C$, and the other end B in water at $100^{\circ} C$. If a point P one the rod is maintained at $400^{\circ} C$, then it is found that equal amounts of water and ice evaporate and melt per unit time. The latent heat of evaporation of water is $540 cal / g$ and latent heat of melting of ice is $80 cal / g$. If the point P is at a distance of λx from the ice end A, find the value λ. [Neglect any heat loss to the surrounding.]

A. 3

B. 6

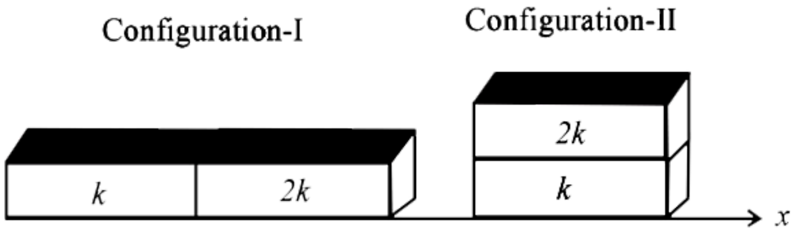
C. 9

D. 12

Answer: C

Watch Video Solution

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



A. 2.0 s

B. 3.0 s

C. 4.5 s

D. 6.0 s

Answer: A

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6. Parallel rays of light of intensity $I = 912WM^{-2}$ are incident on a spherical black body kept in surroundings of temperature 300K. Take Stefan-Boltzmann constant $\sigma = 5.7 \times 10^{-8}$

$Wm^{-2}K^{-4}$ and assume that the energy exchange with the surroundings is only through radiation. The final steady state temperature of the black body is close to

A. 330K

B. 660K

C. 990K

D. 1550 K

Answer: A

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

A. 0.78 mm

B. 0.90mm

C. 1.56 mm

D. 2.34 mm

Answer: A

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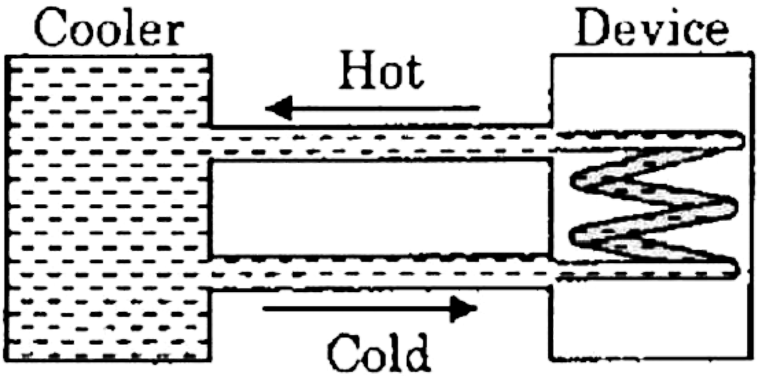
8. A water cooler of storages capacity 120 liters can cool water at a constant rate of P watts. In a closed circulation system (as shown schematically in the figure), the water from the cooler is used to cool an external device that generates constantly 3kW of heat (thermal load). The temperature of water fed into the device cannot exceed $30^\circ C$ and the entire stored 120 liters of water is initially cooled to $10^\circ C$. The entire system is thermally insulated. The minimum value of P (in watts) for which the device can be operated for 3hours is



(Specific heat of water is $4.2kJkg^{-1}K^{-1}$ and the density of water is $1000kgm^{-3}$)

A. 1600

B. 2067

C. 2533

D. 3933

Answer: B

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9. A current carrying wire heats a metal rod. The wire provides a constant power P to the rod. The metal rod is enclosed in an insulated container. It is observed that the temperature (T) in the metal rod change with the (t) as $T(t) = T_0\left(1 + \beta t^{1/4}\right)$ where β is a constant with appropriate dimension of temperature. the heat capacity of metal is :

A. $\dfrac{4P(T(t) - T_0)^3}{\beta^4 T_0^4}$

B. $\dfrac{4P(T(t) - T_0)}{\beta^4 T_0^2}$

C. $\dfrac{4P(T(t) - T_0)^4}{\beta^4 T_0^5}$

D. $\dfrac{4P(T(t) - T_0)^4}{\beta^4 T_0^3}$

Answer: A

Watch Video Solution

Competition File Objective Type Question C Multiple Choice Question With More Than One Correct Answer

1. 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 angular speed increases

B. its angular speed decreases

C. its moment of inertia increases

D. its moment of inertia decreases

Answer: B::C

Watch Video Solution

2. The radiation emitted by a black body at a temperature of 2618 K with the wavelength between 599 nm and 600 nm is U_a , between 1099 nm and 1100 nm is _ bU and between 1599 nm and 1600 nm is U_c . If the Wien's constant is $b = 2.88 \times 10^6 nmK$ then,

A. $U_a \neq 0$

B. $U_c = 0$

C. $U_b > U_a$

D. $U_b > U_c$

Answer: A::C::D

Watch Video Solution

3. Two bodies A and B having equal outer surface areas have thermal emissivity 0.04 and 0.64 respectively. They emit total radiant power at the same rate. The difference between wavelength corresponding to maximum spectral radiance in the radiation from B and that from A is $2\mu m$. If the temperature of A is 6000 K, then

A. the temperature of B is 2500 K

B. the temperature of B is 3000 K

C. $\lambda_B = 1.5 \mu m$

D. $\lambda_B = 4 \mu m$

Answer: B::D

Watch Video Solution

4. A black body initially at absolute temperature T_1 is kept inside a closed box at absolute temperature T_2 . The chamber is now slightly opened so that it allows sunrays to enter. If T_1 and T_2 remain constant, then

A. rate of energy emitted from the black body increases.

B. rate of energy emitted from the black body remains same.

C. energy radiated by black body remains equal to the energy absorbed by it.

D. rate of energy absorption by the black body decreases.

Answer: B::C

Watch Video Solution

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

Then in steady state

A. heat flow through A and E slabs is same

B. heat flow through slab E is maximum

C. temperature difference across slab E is smallest

D. heat flow through C = heat flow through B + heat flow through D.

Answer: A::C::D

View Text Solution

6. A bimetallic strip is composed of two identical strips, one of steel and other of brass. When the temperature of the strip is raised by ΔT , it bends to form arc of curvature R. If the coefficients of linear expansion of steel and brass are α_1 and α_2 , respectively, then R is

A. directly proportional to $|\alpha_1 - \alpha_2|$

B. inversely proportional to $|\alpha_1 - \alpha_2|$

C. directly proportional to ΔT

D. NONE OF THESE`

Answer: B

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7. A clock with a metallic pendulum gains 5 seconds each day at $22^{\circ}C$ and loses 10 seconds each day at $45^{\circ}C$. Then,

A. clock keeps correct time at t $\frac{79}{3}{}^{\circ}C$

B. clock keeps correct time at t=$\frac{89}{3}{}^{\circ}C$

C. coefficient of linear expansion of metallic pendulum is $2.1 \times 10^{-5} {}^{\circ}C^{-1}$

D. coefficient of linear expansion of metallic pendulum is $1.5 \times 10^{-5} C^{-1}$

Answer: B::D

View Text Solution

8. Two rods X and Y of different metals have lengths l_1 and l_2 at a certain temperature. If $l_1 - l_2 = 4$ cm at all temperatures and coefficients of linear expansion of X and Y are $1.5 \times 10^{-5} {}^{\circ}C$ and $2.0 \times 10^{-5} {}^{\circ}C^{-1}$ respectively, then

A. $l_1 = 14cm$

B. $l_1 = 16cm$

C. $l_2 = 10cm$

D. $l_2 = 12cm$

Answer: B::D

View Text Solution

9. One litre glass bottle is completely filled with water at $25^\circ C$. If the bottle and water both are heated to $75^\circ C$, then the volume of water that overflows is

A. $30cm^3$, if the expansion of bottle is neglected

B. $32cm^3$, if the expansion of bottle is neglected

C. $27cm^3$, if the expansion of bottle is not neglected

D. $29cm^3$, if the expansion of bottle is neglected

Answer: A::D

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10. Two spherical stars A and B emit blackbody radiation. The radius of A is 400 times that of B and A emits 10^4

times the power emitted from B. The ratio $\left(\frac{\lambda_A}{\lambda_B}\right)$ of their wavelengths λ_A and λ_B at which the peaks occur in their respective radiation curves is

A. the ratio of temperature of A and B is 2:1

B. the ratio of temperature of A and B is 1:2

C. the ratio of wavelength of A and B is 2:1

D. the ratio of temperature of A and B is 1:2

Answer: B::C

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11. A human body has a surface area of approximately 1 m^2. The normal body temperature is 10 K above the surrounding room temperature T_0. Take the room temperature to be $T_0 = 300K$. For $T_0 = 300K$, the value of $\sigma T_0^4 = 460 W m^{-2}$ (where σ is the Stefan-Boltzmann constant). Which of the following options is/are correct?

A. If the surrounding temperature reduces by a small amount $\Delta T_0 < < T_0$ then to maintain the same body temperature the same (living) human being needs to radiate $\Delta W = 4\sigma T_0^3 \Delta T_0$ more energy per unit time.

B. Reducing the exposed surface area of the body (e.g. by curling up) allows humans to maintain the same body temperature while reducing the energy lost by radiation.

C. If the body temperature rises significantly, then the peak in the spectrum of electromagnetic radiation emitted by the body would shift to longer wavelength.

D. The amount of energy radiated by the body in 1 second is close to 60 joules.

Answer: A::B::D

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Competition File Objective Type Question D Multiple Choice Question Based On A Given Passage Comprehension

1. A rod of length 50 cm is made of metal A and elongates by 0.2 cm when it is heated from $0^\circ C$ to $100^\circ C$. Another rod made of metal B is of length 60 cm and elongates by 0.18 cm when heated from $0^\circ C$ to $100^\circ C$. A composite rod of length 80 cm is made by welding pieces of rods A and B, placed end to end. When metal C is heated from $0^\circ C$ to $50^\circ C$, it gets elongated by 0.08 cm.

What is the ratio of linear expansion of metal A and metal B?

A. $2:1$

B. $3:2$

C. $4:3$

D. $5:3$

Answer: C

View Text Solution

2. A rod of length 50 cm is made of metal A and elongates by 0.2 cm when it is heated from $0^{\circ} C$ to $100^{\circ} C$. Another rod made of metal B is of length 60 cm and elongates by 0.18 cm when heated from $0^{\circ} C$ to $100^{\circ} C$. A composite rod of length 80 cm is made by welding pieces of rods A and B, placed end to end. When metal C is heated from $0^{\circ} C$ to $50^{\circ} C$, it gets elongated by 0.08 cm.

The length of the rod of metal A in the composite rod is

A. 10 cm

B. 20 cm

C. 30 cm

D. 40 cm

Answer: A

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3. A rod of length 50 cm is made of metal A and elongates by 0.2 cm when it is heated from $0^\circ C$ to $100^\circ C$. Another rod made of metal B is of length 60 cm and elongates by 0.18 cm when heated from $0^\circ C$ to $100^\circ C$. A composite rod of length 80 cm is made by welding pieces of rods A and B, placed end to end. When metal C is heated from $0^\circ C$ to $50^\circ C$, it gets elongated by 0.08 cm.

The length of the rod of metal B in the composite rod is

A. 10 cm

B. 20 cm

C. 30 cm

D. 40 cm

Answer: D

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4. Heat energy of 10,000 J is supplied to a metal block of mass 600 g at atmospheric pressure. The initial temperature of the block is $20^{\circ} C$, specific heat of metal $= 300 Jkg^{-1}C^{-1}$, relative density of metal = 7.0, coefficient of volume expansion of metal

$= 6 \times 10^{-5} {}^\circ C^{-1}$ and atmospheric pressure, $P = 10^5$ Pa. Also, Heat energy supplied = mass x specific heat x change in temperature

The final temperature of the block is

A. $46.43^\circ C$

B. $55.55^\circ C$

C. $61.15^\circ C$

D. $75.55^\circ C$

Answer: D

Watch Video Solution

5. Heat energy of 10,000 J is supplied to a metal block of mass 600 g at atmospheric pressure. The initial temperature of the block is $20^\circ C$, specific heat of metal $= 300 Jkg^{-1}C^{-1}$, relative density of metal = 7.0, coefficient of volume expansion of metal $= 6 \times 10^{-5}{}^\circ C^{-1}$ and atmospheric pressure, $P = 10^5$ Pa. Also, Heat energy supplied = mass x specific heat x change in temperature

The amount of work done by the block on the surroundings where $\Delta W = P \Delta V$ is

A. 0.042 J

B. 0.051 J

C. 0.063 J

D. 0.074 J

Answer: B

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6. Heat energy of 10,000 J is supplied to a metal block of mass 600 g at atmospheric pressure. The initial temperature of the block is $20^\circ C$, specific heat of metal $= 300 J kg^{-1} C^{-1}$, relative density of metal = 7.0, coefficient of volume expansion of metal $= 6 \times 10^{-5} {}^\circ C^{-1}$ and atmospheric pressure, $P = 10^5$ Pa. Also, Heat energy supplied = mass x specific heat x change in temperature

Find the change in internal energy if it is calculated as heat energy supplied minus the work done by the block on surroundings.

A. 10,000.051 J

B. 1999.51 J

C. 9999.95 J

D. 10999.95 J

Answer: C

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7. The spectra of all stars show a continuous spectrum like the solar spectrum, in which dark absorption lines are superimposed. The photosphere (inner layer of the star) emits radiations of all wavelengths, producing a continuous spectrum. On passing through the outer (comparatively cooler) layer of the star, radiations of certain wavelengths are selectively absorbed by this layer. This is the cause behind the dark lines in the star's spectrum. These dark lines are characteristics of the substances present in the outer layer of the star. For measuring the surface temperature of the star, we need to measure the wavelength at which the intensity of emitted radiation is maximum and then using Wien's displacement law, given below

$\lambda_m = T = b$ where b is the Wien's constant and its experimentally determined value is $2.89 \times 10^{-3} mK$

Which of the following options is true for spectrum of light received from a star?

A. Continuous emission spectrum

B. absorption line spectrum

C. emission line spectrum

D. emission band spectrum

Answer: B

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8. The spectra of all stars show a continuous spectrum like the solar spectrum, in which dark absorption lines are superimposed. The photosphere (inner layer of the star) emits radiations of all wavelengths, producing a continuous spectrum. On passing through the outer (comparatively cooler) layer of the star, radiations of certain wavelengths are selectively absorbed by this layer. This is the cause behind the dark lines in the star's spectrum. These dark lines are characteristics of the substances present in the outer layer of the star. For measuring the surface temperature of the star, we need to measure the wavelength at which the intensity of emitted radiation is maximum and then using Wien's displacement law, given below

$\lambda_m = T = b$ where b is the Wien's constant and its experimentally determined value is $2.89 \times 10^{-3} mK$

The factor on which the colour of a star depends is

A. mass

B. surface temperature

C. gaseous content

D. size

Answer: B

View Text Solution

9. The spectra of all stars show a continuous spectrum like the solar spectrum, in which dark absorption lines are superimposed. The photosphere (inner layer of the star) emits radiations of all wavelengths, producing a continuous spectrum. On passing through the outer (comparatively cooler) layer of the star, radiations of certain wavelengths are selectively absorbed by this layer. This is the cause behind the dark lines in the star's spectrum. These dark lines are characteristics of the substances present in the outer layer of the star. For measuring the surface temperature of the star, we need to measure the wavelength at which the intensity of emitted radiation is maximum and then using Wien's displacement law, given below

$\lambda_m = T = b$ where b is the Wien's constant and its experimentally determined value is $2.89 \times 10^{-3} mK$

The study of dark lines in the spectrum of a star shows that the atmosphere of stars contain

A. nitrogen

B. helium

C. hydrogen

D. uranium

Answer: B

View Text Solution

Competition File Assertion Reason Type Question

1. Assertion: If water is kept in an open container on the surface of moon, it will quickly evaporate.

Reason: Moon's surface temperature is greater than the boiling point of water.

A. If both assertion and reason are correct and reason is a correct explanation of the assertion.

B. If both assertion and reason are correct but reason is not the correct explanation of assertion.

C. If assertion is correct but reason is incorrect.

D. If assertion is incorrect but reason is correct.

Answer: C

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2. Assertion: Air above the fire at some distance is hotter than the air below it at the same distance.

Reason: Air surrounding the fire carries more heat upwards than downwards.

A. If both assertion and reason are correct and reason is a correct explanation of the assertion.

B. If both assertion and reason are correct but reason is not the correct explanation of assertion.

C. If assertion is correct but reason is incorrect.

D. If assertion is incorrect but reason is correct.

Answer: A

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3. Assertion: Red star is at lower temperature than blue star.

Reason: According to Wien's displacement law, $\lambda_m \propto \frac{1}{T}$

A. If both assertion and reason are correct and reason is a correct explanation of the assertion.

B. If both assertion and reason are correct but reason is not the correct explanation of assertion.

C. If assertion is correct but reason is incorrect.

D. If assertion is incorrect but reason is correct.

Answer: A

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4. Assertion: When hot liquid is poured in a tumbler of thick glass bottom, it cracks.

Reason: Outer surface of the tumbler expands suddenly.

A. If both assertion and reason are correct and reason is a correct explanation of the assertion.

B. If both assertion and reason are correct but reason is not the correct explanation of assertion.

C. If assertion is correct but reason is incorrect.

D. If assertion is incorrect but reason is correct.

Answer: C

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5. Statement-1 : Heat from the sun reaches the earth by convection.

Statement-2 : Air can be heated only by convection

A. If both assertion and reason are correct and reason is a correct explanation of the assertion.

B. If both assertion and reason are correct but reason is not the correct explanation of assertion.

C. If assertion is correct but reason is incorrect.

D. If assertion is incorrect but reason is correct.

Answer: D

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6. Assertion : For higher temperature, the peak emission wavelength of a black body shifts to lower wavelengths.

Reason : Peak emission wavelength of a black body is proportional to the fourth power of temperature.

A. If both assertion and reason are correct and reason is a correct explanation of the assertion.

B. If both assertion and reason are correct but reason is not the correct explanation of assertion.

C. If assertion is correct but reason is incorrect.

D. If assertion is incorrect but reason is correct.

Answer: C

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7. Assertion : Perspiration from human body helps in cooling the body.

Reason : A thin layer of water on the skin enhances its emissivity.

A. If both assertion and reason are correct and reason is a correct explanation of the assertion.

B. If both assertion and reason are correct but reason is not the correct explanation of assertion.

C. If assertion is correct but reason is incorrect.

D. If assertion is incorrect but reason is correct.

Answer: C

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8. Assertion : Liquid molecules have greater potential energy at the melting point.

Reason : Intermolecular spacing between molecules increases at melting point.

A. If both assertion and reason are correct and reason is a correct explanation of the assertion.

B. If both assertion and reason are correct but reason is not the correct explanation of assertion.

C. If assertion is correct but reason is incorrect.

D. If assertion is incorrect but reason is correct.

Answer: C

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9. Assertion : A body that is a good radiator is also a good absorber of radiation at a given wavelength.

Reason : According to Kirchhoff's law the absorptivity of a body is equal to its emissivity at a given wavelength

A. If both assertion and reason are correct and reason is a correct explanation of the assertion.

B. If both assertion and reason are correct but reason is not the correct explanation of assertion.

C. If assertion is correct but reason is incorrect.

D. If assertion is incorrect but reason is correct.

Answer: A

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10. Assertion: A hollow metallic container closed from all sides can act as a source of black body radiation if maintained at a certain temperature,

Reason: All metallic objects act as a black body.

A. If both assertion and reason are correct and reason is a correct explanation of the assertion.

B. If both assertion and reason are correct but reason is not the correct explanation of assertion.

C. If assertion is correct but reason is incorrect.

D. If assertion is incorrect but reason is correct.

Answer: C

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Competition File Matrix Match Type Question

1. Each question contains statements given in two columns, which have to be matched. Statements in column I are labelled as A, B, C and D, whereas statements in column II are labelled as p, q, r and s. Match the entries of column I with appropriate entries of column II. Each entry in column I may have one or more than one correct option from column II. The answers to these questions have to be appropriately bubbled as illustrated in the given example. If the correct matches are A $\rightarrow$ (q, r), B $\rightarrow$ (p, s), C $\rightarrow$ (r, s) and D $\rightarrow$ (q), then correctly bubbled matrix will look like the following:

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2. Each question contains statements given in two columns, which have to be matched. Statements in column I are labelled as A, B, C and D, whereas statements in column II are labelled as p, q, r and s. Match the entries of column I with appropriate entries of column II. Each entry in column I may have one or more than one correct option from column II. The answers to these questions have to be appropriately bubbled as illustrated in the given example. If the correct matches are A $\rightarrow$ (q, r), B $\rightarrow$ (p, s), C $\rightarrow$ (r, s) and D $\rightarrow$ (q), then correctly bubbled matrix will look like the following:

View Text Solution

Competition File Integer Type Question

1. A copper wire of length l and radius 2 mm is suspended from a fixed support vertically and a mass m is hung from its other end. The wire initially at $30^\circ C$ is cooled down to

$20^{\circ} C$ to bring it back to its original length l . The coefficient of linear thermal expansion of the copper is $1.7 \times 10^{-5} {'}^{\circ} C^{-1}$. If l >> the diameter of wire,then find the value of m/5 in kg close to nearest integer. Take, $g = 10 m / s^2, Y = 1.1 \times 10^{11} N / m^2$

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2. A brass boiler of base area $0.10 m^2$ and thickness 1.0 boils water at the rate of $5.0 kg \min^{-1}$ when placed on a stove. The thermal conductivity of brass is $109 J s^{-1} m^{-1} {}^{\circ} C^{-1}$ and heat of vaporisation of water is $2256 J g^{-1}$. If the temperature of the part of the flame in contact with the boiler is $T = \frac{3^p 2^q 5^r 11^s}{109}$, then find the value of p+q+r+s.

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3. A feverish person is running a temperature of $101^{\circ} F$ and is given paracetamol to lower his temperature. Due to medicine, there is an increase in rate of evaporation of sweat from his body. The mass of the person is 50 kg and the specific heat of human body is approximately about $1 cal g^{-1} {}^{\circ}C^{-1}$. If the fever is brought down to $98^{\circ} F$ in 25 mins, the average rate of extra evaporation caused by the medicine is R in g $\min^{-1}$, then the value of 87R/100 is (Latent heat of water at that temperature=580 g/cal)

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4. A heater of resistance 20 Ω is used to heat a room at $10^{\circ} C$ and is connected to 220 V mains. The temperature is uniform inside the room and heat is transmitted outside the room through a glass window of area $1.2m^2$ and thickness 0.1 cm. If $T^{\circ} C$ is the temperature outside and thermal conductivity of glass is$0.2 cal s^{-1} m^{-1} {}^{\circ} C^{-1}$, then find the value of 10T - 75 close to nearest integer.

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5. A sphere of diameter 6 cm and mass 250 g is floating in a beaker containing a liquid. When the temperature is raised, the sphere just begins to sink at a temperature of $30^{\circ} C$. The density of the liquid at $0^{\circ} C$ is $2.92 g / cm^3$. If the expansion of the sphere is ignored, the coefficient of cubical expansion of the sphere is γ, then $\frac{10^9\gamma}{13837} = 2^a 3^b 11^c$. Compute the value of $\frac{ab}{c}$

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6. A brass wire is 2.0 m long at $40.02^\circ C$ and is held taut with a little tension between the two rigid supports. The wire is now cooled down to $-47.5^\circ C$. If the tension developed in the wire is now T and the radius of the wire is 1.0 mm, find $\frac{T}{100} - 3$. Take, Coefficient of linear expansion of brass = $2.0 \times 10^{-5} \, ^\circ C^{-1}$

Young's modulus of brass =$0.91 \times 10^{11} Pa$

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7. Two conducting cylinders of equal length but different radii are connected in series between two heat baths kept at temperatures $T_1 = 300K$ and $T_2 = 100K$, as shown in the figure. The radius of the bigger cylinder is twice that of the smaller one and the thermal conductivities of the materials of the smaller and the larger cylinders are K_1 and K_2 respectively. If the temperature at the junction of the two cylinders in the steady state is 200 K, then $K_1 / K_2 =$ _________.

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8. An electric bulb with a tungsten filament has an area of 0.20 cm^2 and is raised to a temperature of the bulb to

3000 K emissivity of the filament is 0.40 and Stefan's constant is $5.7 \times 10^{-5} ergs^{-1} cm^{-1} K^{-4}$. The electrical energy consumed by the bulb is E_1 watt. If due to fall in voltage, the temperature of the filament falls to 2800 K, then the wattage of the bulb is E_2 watt. Calculate the value of $E_1 - E_2$, close to nearest integer.

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9. A layer of 2 cm thick ice is formed on a lake when the temperature of air is $-20^{\circ} C$. The density of ice is $1g/cm^3$ and latent heat of ice $= 0.008 cals^{-1} cm^{-1} {}^{\circ}C^{-1}$. If it takes t mins for the thickness of ice to increase by 2 mm and $t = a \times 10^2 + b \times 10 + c$, then find the value of a +b-c.

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10. A metallic cylinder of radius R and thermal conductivity K_1 is surrounded concentrically by a metallic shell of inner radius R and outer radius 2R and has thermal conductivity K_2 . It is given that $K_1 : K_2 = 2 : 1, K_2 = K$ and ends of the composite system are maintained at constant temperature T_1 and $T_2 (T_1 > T_2)$. If the equivalent thermal conductivity of the system is $K' = \frac{\alpha K}{\beta}$, then compute $\alpha - \beta$

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11. One mole of a monatomic ideal gas undergoes an adiabatic expansion in which its volume becomes eight times its initial value. If the initial temperature of the gas is 100 universal gas constant 8.0, the decrease in its internal energy, in , is________.

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12. A liquid at 30°C is poured verly slowly into a Calorimeter that is at temperature of 110°C. The boiling temperature of the liquid is 80°C. It is found that the first 5 gm of the liquid completely evaporates. After pouring another 80 gm of the liquid the equilibrium temperature is found to be 50°C. The ratio of the Latent heat of the liquid to its specific heat will be ___C°.

[Neglect the heat exchange with surrounding.]

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Competition File Exemplar Problem Objective Type Question Multiple Choice Question Type I

1. A bimetallic strip is made of aluminium and steel $(\alpha_{Al} > \alpha_{steel}$. On heating, the strip will

A. remain straight.

B. get twisted.

C. will bend with aluminium on concave side.

D. will bend with steel on concave side.

Answer: D

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2. A uniform metallic rod rotates about its perpendicular bisector with constant angualr speed. If it is heated uniformly to raise its temperature slightly, then

A. its speed of rotation increases.

B. its speed of rotation decreases.

C. its speed of rotation remains same.

D. its speed increases because its moment of inertia increases.

Answer: B

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3. The graph between two temperature scales A and B is as shown in figure. Between upper fixed point and lower fixed point, there are 150 equal divisions on scale A and 100 on scale B. The relationship for conversion between the two scales is given by

A. $\frac{t_A - 180}{100} = \frac{t_B}{150}$

B. $\frac{t_A - 30}{150} = \frac{t_B}{100}$

C. $\frac{t_B - 180}{150} = \frac{t_A}{100}$

D. $\frac{t_B - 40}{100} = \frac{t_A}{180}$

Answer: B

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4. An aluminium sphere is dipped into water. Which of the following is true ?

A. Buoyancy will be less in water at $0^\circ C$ than that in water at $4^\circ C$.

B. Buoyancy will be more in water at $0^\circ C$ than that in water at $4^\circ C$.

C. Buoyancy in water at $0^{\circ}C$ will be same as that in water at $4^{\circ}C$.

D. Buoyancy may be more or less in water at $4^{\circ}C$ depending on the radius of the sphere.

Answer: A

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5. A the temperature is increased, the time period of a pendulum

A. increases as its effective length increases even though its centre of mass still remains at the centre of the bob

B. decreases as its effective length increases even though its centre of mass still remains at the centre of the bob.

C. increases as its effective length increases due to shifting of centre of mass below the centre of the bob.

D. decreases as its effective length remains same but the centre of mass shifts above the centre of the bob

Answer: A

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6. Heat is associated with

A. kinetic energy of random motion of molecules.

B. kinetic energy of orderly motion of molecules.

C. total kinetic energy of random and orderly motion of molecules.

D. kinetic energy of random motion in some cases and kinetic energy of orderly motion in other.

Answer: A

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7. The radius of a metal sphere at room temperature T is R, and the coefficient of linear expansion of the metal is α. The sphere is heated a little by a temperature ΔT so that its new temperature is $T + \Delta T$. The increase in the volume of the sphere is approximately

A. $2\pi R \propto \Delta T$

B. $\pi R^2 \alpha \Delta T$

C. $4\pi R^3 \alpha \Delta T / 3$

D. $4\pi R^3 \alpha \Delta T$

Answer: D

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8. A sphere, a cube and a thin circular plate, all of same material and same mass are initially heated to same high temperture.

A. Plate will cool fastest and cube the slowest.

B. Sphere will cool fastest and cube the slowest.

C. Plate will cool fastest and sphere the slowest.

D. Cube will cool fastest and plate the slowest.

Answer: C

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Competition File Exemplar Problem Objective Type Question Multiple Choice Question Type Ii

1. Mark the correct options:

A. A system X is in the thermal equilibrium with Y but not with Z. Systems Y and Z may be in thermal equilibrium with each other.

B. A system X is in thermal equilibrium with Y but not with Z. Systems Y and Z are not in thermal equilibrium with each other.

C. A system X is neither in thermal equilibrium with Y nor with Z. The systems Y and Z must be in thermal equilibrium with each other.

D. A system X is neither in thermal equilibrium with Y nor with Z. The systems Y and Z may be in thermal equilibrium with each other.

Answer: B::D

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2. Gulab jamuns (assumed to be spherical) are to be heated in on oven They are available in two sizes, one twice bigger (in radius) than the other Pizzas (assumed to discs) are also to be heated ibn oven They are also in two sizes, one twice bigger (in radius) than the other All four are put together to be heated option to oven temperature. Choose the correct option from the following .

A. Both size gulab jamuns will get heated in the same time.

B. Smaller gulab jamuns are heated before bigger ones.

C. Smaller pizzas are heated before bigger ones.

D. Bigger pizzas are heated before smaller ones.

Answer: B::C

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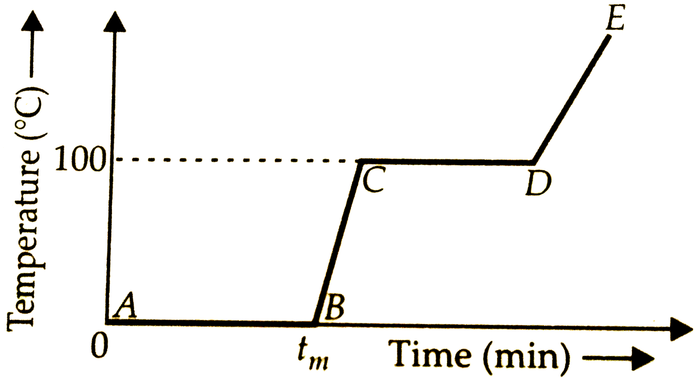
3. Refer to the plot of temperature versus time showing the changes in the state of ice on heating (not to scale).



Which of the following is correct ?

A. The region AB represents ice and water in thermal equilibrium.

B. At B water starts boiling.

C. At C all the water gets converted into steam.

D. C to D represents water and steam in equilibrium at boiling point.

Answer: A::D

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4. A glass full of hot milk is poured in the table. It begins to cool gradually.

Which of the following is incorrect?

A. The rate of cooling is constant till milk attains the temperature of the surrounding.

B. The temperature of milk falls off exponentially with time.

C. While cooling, there is a flow of heat from milk to the surrounding as well as from surrounding to the milk but the net flow of heat is from milk to the surroundings and that is why it cools.

D. All three phenomenon, conduction, convection and radiations are responsible for the loss of heat from milk to the surroundings.

Answer: B::C::D

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1. Is the bulb of a thermoeter made of diathermic or adiabatic wall ?

A. The bulb of a thermometer is made up of diathermic wall so that it may conduct heat.

B.

C.

D.

Answer:

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2. A student records the initial length l, change in temperature ΔT and change in length Δl of a rod as follows:

If the first observation is correct, what can you say about observations 2, 3 and 4?

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3. Why does a metal bar appear hotter than a wooden bar at the same temperature? Equivalently it also appears cooler than wooden bar if they are both colder than room temperature.

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4. Calculate the temperature which has same number value on Celsius and Fahrenheit scale.

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5. These days people use steel utensiles with copper bottom. This is supposed to be good for uniform heating of food. Explain this effect using the fact tha copper is the better conductor.

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Competition File Exemplar Problem Subjective Question Short Answer Type Question

1. find out the increase in moment of inertia I of a uniform rod (coefficient of linear expansion α) about its perpendicular bisector when its temperature is slightly increased by ΔT.

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2. During summers in india, one of the common practice to keep cool is to make ice balls of crushed ice, dip it in flavored sugar syrup and sip it. For this a stick is inserted into crushed ice and is squeezed in the palm to make it into the ball. Equivalently in winter in those areas where it snows, people make snow balls and throw around.

Explain the formation of ball out of crushed ice or snow in the light of P - T diagram of water.

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3. 100 g of water is supercooled to - $10^{\circ} C$. At this point, due to same disturbance mechanised or otherwise some of it suddenly freezes to ice. What will be the temperautre of the resultant mixture and how much mass would freeze ? $\left[s_w = 1cal/g/.^{\circ} C \text{ and } L_{Fusion}^{w} = 80cal/g\right]$

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4. One day in the morning, Ramesh filled up 1//3 bucket of hot water from geyser, to take bath, Remaining 2//3 was to be filled by cold water (at room temperature) to bring mixture to a comfortable temperature. Suddenly Ramesh had to attend to something which would take some times, say 5 -10 minutes before he could take bath. Now he had two options : (i) fill the remaining bucket completely by cold water and then attend to the work, (ii) first attend to the work and fill the remaining bucket just before taking bath. Which option do you think would have kept water warmer ? Explain.

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Chapter Practice Test

1. Why burns from steam are more serious than those from boling water?

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2. Which of the following compounds can be used as antifreeze in automobile radiators?

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3. What is specific heat of a gas is an isothermal process?

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4. What is the principle of calorimetry.

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5. Is J a physical constant or a conversion factor?

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6. Animals curl into a ball, when they feel very cold.

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7. Water is heated from below but not from top. Why?

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8. Is the rate of cooling the same thing as the rate of loss of heat? Explain.

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9. State Stefan's law. What are the units and dimensions of Stefan's constant?

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10. "Good reflectors are poor emitters of thermal radiation." explain.

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11. State Kirchhoff's law of radiations.

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12. What are the basic differences between , conduction, convection and radiation?

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13. Distinguish between land breeze and sea breeze.

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14. The relation between principal specific heats of gases at constant pressure annd at volume is

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15. State Newton's law of cooling.

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