SOLVED EXAMPLES

Ex.1 A cubical ice box of thermocule has each side 30 cm and a thickness of 5 cm.4 kg of ice is put in the box. If out side temp. is 45° C and coefficient of thermal conductivity = 0.01 JS^{-1} m^{-1} $°C^{-1}$, calculate the mass of ice left after 6 hours. Take latent heat of fusion of ice = 335×10^3 J/Kg.

Sol. Here, length of each side, ℓ = 30 cm = 0.3 m

Thickness of each side, dx = 5 cm = 0.05 m

Total surface area through which heat enters into the box, $A = 6\ell^2 = 6 \times 0.3 \times 0.3 = 0.54\ m^2$

Temp. diff. $\Delta T = 45 - 0 = 45°C$

$K = 0.01\ J\ s^{-1}\ m^{-1}\ °C^{-1}$

time, $\Delta t = 6$ hrs $= 6 \times 60 \times 60$ s

Latent heat of fusion $L = 335 \times 10^3$ J/kg

let m be the mass of ice melted in this time

$$= \Delta Q = mL = KA\left(\frac{\Delta T}{\Delta x}\right)\Delta t = KA\left(\frac{\Delta T}{\Delta x}\right)\frac{\Delta t}{L}$$

$$= 0.01 \times 0.54 \times \frac{45}{0.05} \times \frac{6 \times 60 \times 60}{335 \times 10^3}$$

= 0.313 kg

mass of ice left = 4 – 0313 = 3.687 kg

Ex.2 An ice box made of 1.5 cm thick styrofoam has dimensions 60 cm × 60 cm × 30 cm. It contains ice at 0ºC and is kept in a room at 40ºC. Find the rate at which the ice is melting. Latent heat of fusion of ice = 3.36×10^5 J/kg. and thermal conductivity of styrofoam = 0.04 W/m–ºC.

Sol. The total surface area of the walls

= 2(60 cm × 60 cm + 60 cm × 30 cm + 60 cm × 30 cm)

= 1.44 m^2.

The thickness of the walls = 1.5 cm = 0.015 m.

The rate of heat flow into the box is

$$\frac{\Delta Q}{\Delta t} = \frac{KA(\theta_1 - \theta_2)}{x}$$

$$= \frac{(0.04 W/m\text{–}^{o}C)(1.44 m^2)(40^{o}C)}{0.015 m} = 154\ W.$$

The rate at which the ice melts is

$$= \frac{154 W}{3.36 \times 10^5 J/kg} = 0.46\ g/s.$$

Ex.3 Calculate approximately the heat passing per hour through the walls and windows of room 5 by 5 meters if the walls are of bricks of thickness 30 cms and have windows of glass 3mm thick and total area 5 square meters. The temperature of the room is 30º below that of the outside and the thermal conductivity of bricks and of glass is 12×10^{-4} and 25×10^{-4} C.G.S. units respectively.

Sol. Let Q_1 be the heat passing through the walls, then

$$Q = \frac{KA(T_1 - T_2)t}{x}$$

Here area of four walls including windows

= 500 × 500 × 4 = 10,00,000

Area of all windows

= 5 sq. meter = 50,000 sq. cn

∴ Net area of brick walls

= 10,00,000 – 50,000 = 9,50,000 sq.cm

K for bricks = 12×10^{-4} C.G.S. units

x = 30cm, $(T_1 - T_2)$ = 30ºC and

t = 1 hr = 3600 sec.

$$\therefore \quad Q_1 = \frac{(12 \times 10^{-4})(9{,}50{,}000)(30)(3600)}{30}$$

= 4104000 cal

Heat passing through glass windows

$$Q_2 = \frac{(25 \times 10^{-4})(50{,}000)(30)(3600)}{0.3}$$

= 45000000 cal.

Total heat passing $Q = Q_1 + Q_2$

= 4104000 + 45000000

= 49104×10^3 calories.

Ex.4 A compound bar 2m long is constructed of a solid copper core 1 cm in diameter surrounded by a steel casing whose outer diameter is 2cm. The outer surface of the bar is thermally insulated and one is maintained at 100ºC, the other is at 0ºC.

(i) Find the total heat current in the bar.

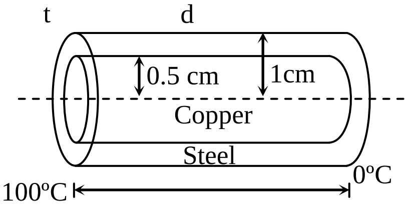
(ii) What percentage is carried by each material.

K for copper = 0.9 cal-$cm^{-1}sec^{-1}(ºC)^{-1}$,

and K for steel = 0.12 cal-$cm^{-1}sec^{-1}(ºC)^{-1}$,

Sol. The compound bar is shown in fig. The rate of flow through copper bar is given by

$$\frac{Q_1}{t} = \frac{K_1 \pi r_1^2 (T_1 - T_2)}{d}$$



where r_1 is the radius

$$\therefore \quad \frac{Q_1}{t} = \frac{0.9 \times 3.14 \times (0.5)^2 100}{200}$$

for steel bar

$$\frac{Q_2}{t} = \frac{0.12[3.14\{(1)^2 - (0.5)^2\}]100}{200}$$

(i) Total heat current in the bar

$$\frac{Q}{t} = \frac{Q_1 + Q_2}{t}$$

$$= \frac{0.9 \times 3.14(0.5)^2 100}{200} + \frac{0.12 \times 3.14 \times 0.75 \times 100}{200}$$

$$= \frac{3.14 \times 100}{200} [0.9 \times 0.25 + 0.12 \times 0.75]$$

$$= \frac{3.14}{2} \times [0.225 + 0.09]$$

$$= \frac{3.14 \times 0.315}{2}$$

= 0.4945 cal per second.

(ii) On simplification, we get

$$\frac{Q_1}{Q} = \frac{0.9 \times (0.5)^2}{0.9 \times (0.5)^2 + 0.12 \times 0.75}$$

$$= \frac{0.9 \times 0.25}{0.315} = \frac{0.9}{1.26} = 71.42\%$$

$$\frac{Q_2}{Q} = 100 - 71.42 = 28.58\%$$

Ex.5 A rod of negligible heat capacity has length 20 cm, area of cross-section 1.0 cm2 and thermal conductivity 200 W/m–°C. The temperature of one end is maintained at 0°C and that of the ether end is slowly and linearly varied from 0°C to 60°C in 10 minutes. Assuming no loss of heat through the sides find the total heat transmitted through the rod in these 10 minutes.

Sol. Since temperature is varying linearly so

$$T = \frac{60}{10 \times 60} t^\circ C/sec. = \frac{t}{10} {}^\circ C/sec$$

Now, $\frac{dH}{dt} = \frac{KA(T_1 - T_2)}{\ell}$

$$\frac{dH}{dt} = \frac{KAT}{\ell}$$

$$\frac{dH}{dt} = \frac{KAt}{10\ell}$$

$$H = \frac{KAt^2}{20\ell}$$

$$= \frac{200 \times 1 \times 10^{-4} \times (600)^2}{20 \times 20 \times 10^{-2}}$$

= 1800 Joule

Ex. 6 A metal rod of length 20 cm and diameter 2 cm is covered with a non conducting substance. One of its ends is maintained at 100°C while the other end is put at 0°C. It is found that 25 g of ice melts in 5 min. Calculate the coefficient of thermal conductivity of the metal. Latent heat of ice = 80 cal $gram^{-1}$

Sol. Here, length of the rod,

$\Delta x = 20$ cm $= 20 \times 10^{-2}$ m

Diameter = 2 cm,

radius = r = 1 cm = 10^{-2} m

Area of cross section

$a = \pi r^2 = \pi(10^{-2})^2\ \pi$ sq. m

$\Delta T = 100 - 0 = 100°C$

Mass of ice melted, m = 25g

As L = 80 cal.g–1

Heat conducted, $\Delta Q = mL = 25 \times 80$

= 2000 cal = 2000 × 4.2J

$\Delta t = 5$ min = 300 s

From $\frac{\Delta Q}{\Delta t} = KA\frac{\Delta T}{\Delta x}$

$$K = \frac{2000 \times 4.2 \times 20 \times 10^{-2}}{300 \times 10^{-4} \pi \times 100}$$

$= 1.78 Js^{-1} m^{-1}\ °C^{-1}$

LEVEL # 1

Questions based on **Heat conduction**

Q.1 Under steady state the temperature of a body
(A) increases with time
(B) decreases with time
(C) does not change with time and is same at all points of the body
(D) does not change with time and can be different at different points of the body

Q.2 In the steady state of temperature the flow of heat across the body depends :
(A) only upon its thermal conductivity
(B) upon its thermal capacity
(C) upon its thermal conductivity and upon its thermal capacity
(D) neither upon its thermal conductivity nor upon its thermal capacity

Q. 3 The rate of flow of heat through a metal bar of area of cross-section 1 m^2 when temperature gradient is 1°C/m under steady state is called -
(A) thermal resistance
(B) thermal conductivity
(C) diffusibility
(D) resistivity

Q. 4 Metals are good conductors of heat because-
(A) they contain a large number of free electrons
(B) their atoms collide frequently
(C) they have shining surfaces
(D) they are habitual of heat flow

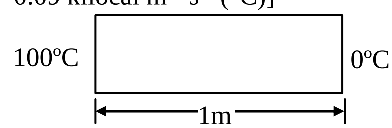
Q.5 The coefficients of thermal conductivity of a metal depends on -
(A) temperature difference between the two sides
(B) thickness of the metal plate
(C) area of the plate
(D) none of the above

Q.6 In which case does the thermal conductivity increase from left to right -
(A) Al, Cu, Ag (B) Ag, Cu, Al
(C) Cu, Ag, Al (D) Al, Ag, Cu

Q. 7 Four rods with different radii r and length ℓ are used to connect two reservoirs of heat at different temperatures. Which one will conduct most heat ?
(A) r = 1 cm, ℓ = 1m (B) r = 2 cm, ℓ = 2 m
(C) r = 1 cm, ℓ = 1/2 m (D) r = 2 cm, ℓ = 1/2 m

Q. 8 Heat is flowing through two cylindrical rods of same material. The diameters of the rods are in the ratio 1 : 2 and their lengths are in the ratio 2 : 1. If the temperature difference between their ends is same, then the ratio of amounts of heat conducted through them per unit time will be :
(A) 1 : 1 (B) 2 : 1 (C) 1 : 4 (D) 1 : 8

Q. 9 A rod of 1 m length and area of cross-section 1 cm^2 is connected across two heat reservoirs at temperatures 100°C and 0°C as shown. The heat flow per second through the rod in steady state will be [Thermal conductivity of material of rod = 0.09 kilocal $m^{-1}s^{-1}(°C)$]



(A) 9×10^{-4} kilocal/sec
(B) 9 kilocal/sec
(C) 0.09 kilocal/sec
(D) 9×10^{-6} kilocal/sec

Q.10 The quantity of heat which crosses unit area of a metal plate during conduction depends upon –
(A) The density of the metal
(B) The temperature gradient perpendicular to the area
(C) The temperature to which the metal is heated
(D) The area of the metal plate

Q.11 The coefficient of thermal conductivity of copper, mercury and glass are respectively K_c, K_m and K_g such that $K_c > K_m > K_g$. If the same quantity of heat is to flow per second per unit area of each and the corresponding temperature gradients are X_c, X_m and X_g, then
(A) $X_c = X_m = X_g$ (B) $X_c > X_m > X_g$
(C) $X_c < X_m < X_g$ (D) $X_m < X_c < X_g$

Questions based on **Combination of rods**

Q.12 The S.I. unit of thermal conductivity is -

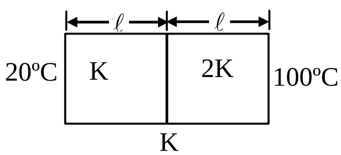
(A) $Js^{-1}\ m^{-1}°C^{-1}$ (B) $Js\ m^{-1}°C^{-1}$

(C) $Js^{-1}\ m^{-1}°C$ (D) $Js^{-1}m°C^{-1}$

Q.13 If ℓ is the length and A is the area of cross-section of a rod and K is thermal conductivity of material, then the thermal resistance is given by

(A) $\frac{K\ell}{A}$ (B) $\frac{\ell}{KA}$ (C) $\frac{\ell K}{A}$ (D) $\frac{A}{K\ell}$

Q.14 Two rods are connected as shown. The rods are of same length and same cross sectional area. In steady state, the temperature (θ) of the interface will be –



(A) 60°C (B) 73.3°C

(C) 46.7°C (D) 37.3°C

Q.15 Two walls of thickness d_1 and d_2, thermal conductivities K_1 and K_2 are in contact. In the steady state if the temperatures at the outer surfaces are T_1 and T_2, the temperature are the common wall will be-

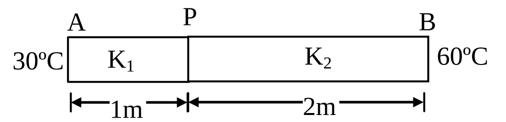
(A) $\frac{K_1T_1 + K_2T_2}{d_1d_2}$

(B) $\frac{K_1T_1d_2 + K_2T_2d_1}{K_1d_2 + K_2d_1}$

(C) $\frac{(K_1d_1 + K_2d_2)T_1T_2}{T_1 + T_2}$

(D) $\frac{K_1d_1T_1 + K_2d_2T_2}{K_1d_1 + K_2d_2}$

Q.16 Two rods A and B are connected in series as shown in fig. the conductivity of A is K_1 = 100 w/m -°C and conductivity of B is K_2 = 50 w/m -°C. The free ends of the rods A and B has temp. 30° and 60° respectively the temp. of common meeting point will be -



(A) 36°C (B) 40°C

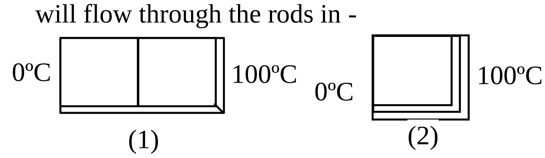
(C) 45°C (D) 50°

Q.17 In above Q.16, what is the equivalent conductivity of rods A and B –

(A) 50 w/m-°C (B) 60 w/m-°C

(C) 80 w/m-°C (D) 100 w/m-°C

Q.18 Two identical square rods of metal are welded end to end as shown in fig (1). 20 cal of heat flows through it in 4 min. If the rods are welded as shown in fig. (2), the same amount of heat will flow through the rods in -



(A) 1 min (B) 2 min

(C) 4 min (D) 16 min.

Q. 19 Two rods of length d_1 and d_2 and coefficients of thermal conductivities K_1 and K_2 are kept touching each other. Both have the same area of cross-section. The equivalent thermal conductivity is :

(A) $K_1 + K_2$ (B) $K_1d_1 + K_2d_2$

(C) $\frac{K_2d_1 + K_1d_2}{d_1 + d_2}$ (D) $\frac{d_1 + d_2}{\frac{d_1}{K_1} + \frac{d_2}{K_2}}$

RADIATION

Ex.1 In a solar spectrum dark lines (fraunhofer lines) are obtained due to

(A) absorption (B) reflection

(C) emission (D) transmission

Sol.(A) Fraunhorfer lines are obtained due to the absorption of certain characteristic radiations.

Hence the correct answer is (A)

Ex.2 Fraunhofer lines are explained by

(A) Provosts theory of heat exchanges

(B) Newton's law of cooling

(C) Stefan's law

(D) Kirchoft's law

Sol.(D) Fraunhofer lines are explained on the basis of Kirchhoff's law.

Hence the correct answer is (D)

Ex.3 The nature of radiation emitted by a black body depends only on -

(A) the shape of a body

(B) the nature of a body

(C) the temperature of a body

(D) the medium

Sol.(C) The nature of radiations emitted by a black body depends only upon the temperature of the body

Hence the correct answer is (C)

Ex.4 Two identical balls of wax are attached on the outer surface of two tin sheets. The inner surface of P is coated with lamp black and that of Q is polished. If a source of heat is placed between P and Q then which ball will melt first

(A) Q ball

(B) P ball

(C) both simultaneously

(D) nothing can be predated

Sol.(B) As the black surfaces are good absorbers of heat. Hence the P will melt first.

Hence the correct answer is (B)

Ex.5 Energy spectrum of radiations emitted by a black body is

(A) line spectrum

(B) continuous spectrum

(C) bond spectrum

(D) line and continuous spectrum

Sol.(B) Energy spectrum of radiation emitted by a black body is continuous

Hence the correct answer is (B)

Ex.6 If the rate of emission of radiation from a body is equal to the rate of absorbing, then the temperature of the body will be -

(A) less than the temperature of the surrounding

(B) greater then the temperature of the surrounding

(C) equal to the temperature of the surrounding

(D) nothing can be said

Sol.(C) The temperature of the body will be equal to the temperature of surrounding

Hence the correct answer is (C)

Ex.7 For the analysis of spectral energy of thermal radiations emitted by a body the prism used made of

(A) quartz (B) crown glass

(C) flint glass (D) rock salt

Sol.(D) For the analysis of spectral energy of radiation prism of rock salt is used because it does not absorb thermal radiation. All other absorbs thermal radiations and spectrum is not obtained.

Hence the correct answer is (D)

Ex.8 If the temperature of a body is increased by 50%, then the increase in the amount of radiation emitted by it will be :

(A) 500% (B) 400%

(C) 200% (D) 100%

Sol.(B) $\because$ Percentage increase in the amount of radiations emitted

$$\therefore \quad \frac{E_2 - E_1}{E_1} \times 100 = \frac{(1.5T_1)^4 - T_1^4}{T_1^4} \times 100$$

$$\Rightarrow \quad \frac{E_2 - E_1}{E_1} \times 100 = [(1.5)^4 - 1] \times 10$$

$$\frac{E_2 - E_1}{E_1} \times 100 = 400\%$$

Hence the correct answer is (B)

Ex.9 A blackened platinum wire of length 5cm and perimeter 0.02cm is maintained at atemperature of 3000K. Then at what rate the wire is losing its energy?

(Take s = 57×10^{-8} units)

(A) 4.62 W (B) 0.462W

(C) 46.2W (D) 4620W

Sol.(C) The rate of radiation heat loss is

$$\frac{dQ}{dt} = \in A\sigma T^4 \text{ (watts)}$$

for blackened surface $\in = 1$

and A = $(2\pi r)l = P_{erimeter}$ x length

$\therefore$ A = $0.02 \times 5 \times 10^{-2}$. Thus

$\therefore \frac{dQ}{dt} = 0.02 \times 5 \times 10^{-4} \times 5.7 \times 10^{-8} \times (3000)^4$

$\Rightarrow \frac{dQ}{dt} = 46.2W$

Hence correct answer is (C) .

Ex.10 A blackened sphere of radius 10cm at a temperature 227ºC is placed in a chamber with blackened wall, maintained at 27ºC. Calculate the rate of loss of heat ?

(A) 9.224 cal/s (B) .9224 cal/s

(C) 922.4 cal/s (D) 92.24 cal/s

Sol.(D) Rate of heat loss

$\frac{dQ}{dt} = A\sigma (T^4 - T_0^4)$

$\therefore \frac{dQ}{dt} = 4\pi \times 10^2 \times 10^{-4} \times 5.67 \times 10^{-8} \times (500^4 - 300^4)$

Solve it to get

$\Rightarrow \frac{dQ}{dt} = 387.4$ Joule/sec

$\Rightarrow \frac{dQ}{dt} = \frac{387.4}{4.2}$ cal/sec

$\Rightarrow \frac{dQ}{dt} = 92.24$ cal/s.

Hence the correct answer is (D)

Ex.11 A blackened metal disc is held normal to the sun's rays, Both of its surfaces are exposed to atmosphere if the distance of earth from sun is 216 times the radius of sun and the temperature of sun is 6000K, the temperature of the disc in steady state will be –

(A) 80ºC (B) 70ºC

(C) 60ºC (D) 50ºC

Sol.(B) in the steady state the heat received from sun will be equal to heat radiated out. Heat received from sun will be on one side only and it will radiate from both sides.

$\therefore \sigma A \left(\frac{Rs}{d}\right)^2 T^4 = 2\sigma A T'^4, \quad \frac{Rs}{d} = \frac{1}{216}$

$\therefore T' = \frac{T}{(216)^{1/2} 2^{1/4}} = \frac{6000}{14.7 \times 1.189} = 343K$

$\therefore$ T' = 70ºC

Hence correct answer is (B)

Ex.12 In the example 10, if the heat capacity (thermal capacity) of the sphere is 1000 cal/ºC then what is the rate of cooling of the sphere ?

(A) 55ºC/min (B) 55ºC/min

(C) 550ºC/min (D) 5.5ºC

Sol.(D) The heat capacity of the sphere is

ms = 1000 cal/ºC

the rate of colling

$\frac{d\theta}{dt} = \frac{1}{ms} \cdot \left(\frac{dQ}{dt}\right)$

$\therefore \frac{d\theta}{dt} = \frac{1}{1000} \times 92.2$

$\Rightarrow \frac{d\theta}{dt} = 0.092$ºC per second

$\therefore \frac{d\theta}{dt} = 5.5$ ºC/ min.

Hence the correct answer is (D)

Ex.13 A slab of stone of area 3600 sq cm. and thickens 10cm is exposed on the lower surface to steam at 100ºC, block of ice of mass 4.8 kg placed on upper surface is melted in one hour. The thermal conductivity of stone is (in cal/cm-ºC) given (latent heat of ice = 80 cal/gm)

(A) 0.003 (B) 0.03

(C) 0.3 (D) none of these

Sol. (A) $Q = \frac{KA(Q_1 - Q_2)t}{x}$

$\Rightarrow 4800 \text{ x } 80 = \frac{K \times 3600 \times 100 \times 3600}{10}$

$\Rightarrow$ K = 0.003 cal/cm/ºC

Ex.14 Behaving like a black body sun emits maximum radiation at wavelength 0.48μm. The mean radius of the sun is 6.96×10^8m. Stefan's constant is 5.67×10^{-8} $wm^{-2}k^{-4}$ and Wien's constant is 0.293 cm-k. The loss of mass per second by the emission of radiation from sun is-

(A) 5.32×10^9kg/s (B) 6.24×10^{10}kg/s (C) 8.65×10^{12} kg/s (D) 2.46×10^{14}kg/s

Sol.(A) Using wien's law

$T = \frac{b}{\lambda_m} = \frac{0.293 \times 10^{-2}}{0.48 \times 10^{-6}} = 6104$ K

Energy given out by sun per second

$E = A\sigma T^4$

$= 4\pi (6.96 \times 10^8)^2 \times 5.67 \times 10^{-8} (6104)^4$

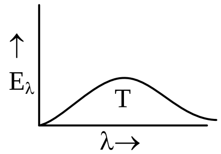
$\Rightarrow 49.285 \times 10^{25}$J

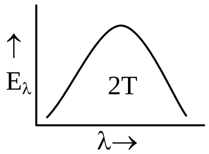
Loss of mass per second

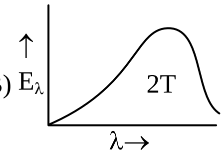
$m = \frac{E}{c^2} = \frac{49.285 \times 10^{25}}{9 \times 10^{16}} \Rightarrow m = 5.4 \times 10^9$kg/s

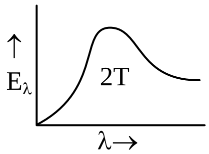
Hence correct answer is (A)

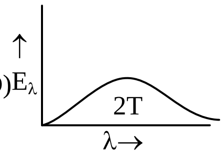
Ex.15 If the $E_\lambda - \lambda$ curve for a black body at temperature T is as shown in the figure, then curve at temperature 2T will be



(A) 

(B) 

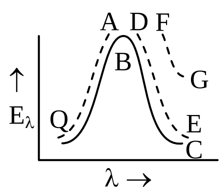
(C) 

(D) 

Sol.(C) $E_m \propto T^5$ and $\lambda_m \propto \frac{1}{T}$ i.e. on increasing temperature λ_m decrease and E_m increases

Hence the correct answer is (C).

Ex.16 Which part of E_λ-λ graph represents wien's –



(A) OA part (B) BC part

(C) DE part (D) FG part

Sol.(A) Wien's law is valid for low wavelength region. Hence the part OA of curve represents wien's law.

Hence the correct answer is (A)

Ex.17 50g of water and an equal volume of alcohol (relative density 0.8) are placed one after the other in the same calorimeter. They are found to cool from 60ºC to 50ºC is 2 minutes and 1 minute respectively if the water equivalent of the calorimeter is 2g then what is the specific heat of the alcohol?

(A) 0.6 cal/gºC (B) 6.0 cal/gºC

(C) 60 cal/gºC (D) 600 cal/gºC

Sol.(A) Given t_w = 2 min, t_{alco}= 1 min

m_w = 50g, m_{alco} = 50 × 0.8 40g

S_w = 1 in cgs units, W = 2g

Therefore,

$$\frac{dQ}{dt_A} = \frac{dQ}{dt_W}$$

$$\frac{m_A S_A + W}{t_A} = \frac{m_W S_W + W}{t_W}$$

$$\frac{40S_A + 2}{1} = \frac{50\times1+2}{2}$$

$80S_A + 4 = 50 + 2$

$$S_A = \frac{48}{80}$$

$$S_A = \frac{6}{10} = 0.6 \text{ cal/g}^{\circ}\text{C}$$

Questions based on

Fundamental definitions

Q.1 Nature of thermal radiations is similar to the nature of -
(A) electro magnetic waves
(B) gravity waves
(C) β rays
(D) sound waves

Q.2 The amount of thermal radiations emitted per second by a surface depends upon-
(A) nature of the surface only
(B) area of the surface only.
(C) difference of temperature between surface and its surrounding only.
(D) all of the above.

Q.3 Heat radiations travel in vacuum with a velocity equal to -
(A) 3×10^8 m/sec (B) 3×10^{10} m/sec
(C) 1120 ft/sec (D) 3×10^6 m/sec

Q.4 Unit of emissive power is equal to -
(A) Intensity (B) power
(C) Energy (D) Work

Q.5 The absorptive power of a body has numerical values such that-
(A) $0 < a_\lambda < 1$ (B) $-1 < a_\lambda < 0$
(C) $1 < a_\lambda < 2$ (D) $0 < a_\lambda < \infty$

Q.6 Heat radiation exhibit the phenomenon of polarization which means that the radiation is in the form of -
(A) Electromagnetic waves which are longitudinal.
(B) Electromagnetic waves which are transverse.
(C) Of ray of longitudinal photons.
(D) Of ray of transverse photon.

Q.7 Following is not a property of radiation –
(A) It travels with velocity of light
(B) Medium is necessary for propagation
(C) Its nature is electromagnetic
(D) It has quantum nature

Q.8 Transfer of heat in friction is by –
(A) Convection
(B) Conduction
(C) Radiation
(D) None of the above

Q.9 Which of the following surface will emit least heat radiation –
(A) White (bright)
(B) White and rough
(C) Polished black
(D) Black and rough

Q.10 Coefficient reflection of black body is –
(A) Zero (B) Infinity
(C) 1 (D) 0.5

Q.11 If p calorie heat energy falls on a body and q calorie heat is absorbed then the absorption coefficient will be –
(A) p/q (B) p – q
(C) q/p (D) q + p

Q.12 Emissive power of any surface (e), Absorptive power (a), Reflecting power (r) and transmission power (t) are related as –
(A) a + e + t = 1 (B) a + r + t = 1
(C) r + e + t = 1 (D) r + e + a = 1

Q.13 If transmission power of a surface is $\frac{1}{6}$ and reflective power is $\frac{1}{3}$, then its absorptive power will be-
(A) $\frac{1}{3}$ (B) $\frac{1}{2}$
(C) $\frac{1}{6}$ (D) $\frac{1}{12}$

Q.14 If same amount of ice in placed in black and white cloth then ice in black cloth will –
(A) Melt more (B) Melt less
(C) Melt equal (D) Not melt at all

Q.15 Out of the radiations falling on surface of a body, 30% radiations are absorbed and 30% are transmitted then its reflection coefficient will be –

(A) 0.3 (B) 0.6 (C) 0.4 (D) Zero

Q.16 Reflection and absorption coefficient's of a given surface at 0ºC for a fixed wavelength are 0.5 each. At same temperature and wavelength the transmission coefficient of surface will be –

(A) 0.5
(B) 1.0
(C) Zero
(D) In between zero and one

Q.17 The feature which is wrong for a black body is –

(A) $a_\lambda = 1$
(B) a = 1
(C) $e_\lambda = 0$
(D) absorbs radiations of all wavelengths incident upon it

Q.18 The coefficient of transmission for an ideal black body is –

(A) Zero (B) Infinity
(C) One (D) More than one

Q.19 In a room heat is transferred via –

(A) Conduction only
(B) Convection only
(C) Radiation only
(D) All the three modes

Q.20 That object which completely absorbs all the incident radiation, is called –

(A) Black body (B) Good absorber
(C) Black object (D) Good emitter

Q.21 If a black body is heated, then it emits –

(A) White radiation
(B) Only infrared radiation
(C) Only ultraviolet radiation
(D) Black radiation

Q.22 Black body is –

(A) Only a good absorber
(B) Only a good emitter
(C) Good absorber as well as a good emitter
(D) A good absorber but a poor emitter

Q.23 We get heat from the sun by –

(A) Conduction (B) Convection
(C) Radiation (D) Diffusion

Q.24 The velocity of heat radiation in vacum is-

(A) equal to that of light
(B) less than that of light
(C) greater than that of light
(D) equal to that of sound

Questions based on Kirchoff's Law

Q.25 From Kirchoff's law the ratio of emissive power and absorption power of all bodies –

(A) Are different.
(B) Is equal to emissive power of black body at same temperature.
(C) Is equal to emissive power of white body.
(D) Is equal to emissive power of black body at any temperature.

Q.26 If at temperature T, the emissive power and absorption power of a body for wavelength are e_λ and a_λ respectively, then –

(A) $e_\lambda \propto a_\lambda$
(B) $e_\lambda > a_\lambda$
(C) $e_\lambda < a_\lambda$
(D) There will not be any definite relation between e_λ and a_λ

Q.27 A substance when at high temperature emits wave length λ_1, λ_2, λ_3 and λ_4 only, When this substance is at low temperature then it will absorb only following wavelengths –

(A) λ_1
(B) λ_2
(C) λ_1 and λ_2
(D) λ_1, λ_2, λ_3 and λ_4

Q.28 Fraunhoffer lines are found –

(A) In solar spectrum
(B) Spectrum produced by light of neon bulb
(C) Spectrum produced by light of discharge tube
(D) None of the above

Q.29 Fraunhoffer lines can be explained by –
(A) Stefan's law (B) Planck's law
(C) Kirchoff's law (D) Newton's law

Q.30 A polished metal plate with a rough black spot on it is heated to about 1400K and quickly taken into a dark room. Which one of the following statements will be true:
(A) The spot will appear brighter than the plate
(B) The spot will appear darker than the plate
(C) The spot and plate will appear equally bright.
(D) The spot and the plate will not be visible in the dark room.

Q.31 A blackened steel plate is put in a dark room after being heated up to a high temperature. A white spot on the plate appears-
(A) brighter than the plate
(B) as bright as the plate
(C) dull as compared to the plate
(D) appears to be yellow

Q.32 In the solar spectrum the Fraunhoffer lines are produced due to-
(A) emission (B) absorption
(C) reflection (D) transmission.

Questions based on Stefan's law

Q.33 The MKS unit of Stefan's constant is-
(A) Watt / m^2-K^4. (B) Watt m^2-K^4.
(C) Watt / m^2-K (D) Watt/m^2

Q.34 The temperature of a black body becomes half of its original temperature, the amount of radiation emitted by the body will reduce to-
(A) 1/16
(B) 1/4
(C) 1/2
(D) remains unchanged.

Q.35 Choose the correct statement-
(A) Stefan's law and Newton's law of cooling both hold true at all the temperature.
(B) Stefan's law holds when the excess of temperature over the surroundings is small, whereas Newton's law is valid at all the temperature.
(C) Newton's law holds when the excess of temperature over the surroundings is small, whereas Stefan's law is valid at all temperatures.
(D) Excess of temperature over the surroundings should be small for both the laws to hold true.

Q.36 Four bodies of specific heats s_1, s_2, s_3 and s_4 are cooled in the same surroundings. If $s_1 > s_2 > s_3 > s_4$, and temperature of all the four bodies is the same, then the specific heat of body which cools fastest, will be –
(A) s_1 (B) s_2 (C) s_3 (D) s_4

Q.37 At any temperature the radiation energy emitted by a cube of length L is proportional to –
(A) L
(B) L^2
(C) L^3
(D) None of the above

Q.38 Temperature of a piece of metal is increased from 27ºC to 327ºC. The rate of emission of radiation by a metal will become –
(A) Double (B) Four times
(C) Eight times (D) Sixteen times

Q.39 If the temperature of a black is increased by 50% then the amount of radiation emitted by it will –
(A) Increase by 400%
(B) Decrease by 400%
(C) Decrease by 50%
(D) Increase by 50%

Q.40 The effective area of a black body is 0.1 m^2 and its temperature is 1000 K . The amount of radiations emitted by it per min is –
(A) 1.34 k – cal (B) 81 k – cal
(C) 5.63 k – cal (D) 1.34 k – J.

Q.41 The energy emitted per second by a black body at 1227ºC is E. If the temperature of the black body is increased to 2727ºC, the energy emitted per second in terms of E is -
(A) 16 E (B) E (C) 4E (D) 2E

Q.42 A body at temperature T (K) is kept in the surroundings at T_0 (K) . If $T >> T_0$, then the rate of emission of heat by the body to the surroundings is proportional to-
(A) $(T – T_0)^4$ (B) $T^4 – T_0^4$
(C) $(T – T_0)^{1/4}$ (D) T / T_0

Q.43 A solid sphere of radius R and a hollow sphere of internal radius r and external radius R are made of copper. These are heated to same temperature and then allowed to cool in the same surroundings, then –

(A) Solid sphere will cool first
(B) Hollow sphere will cool first
(C) Both will cool at the same rate
(D) Only solid sphere will cool

Q.44 Amount of heat radiations emitted by a solid sphere of radius r at any temperature is proportional to the following –

(A) r (B) r^2 (C) r^3 (D) r^4

Q.45 Radius of a sphere is R, density is d and specific heat is s, It is heated and then allowed to cool. Its rate of decrease of temperature will be proportional to –

(A) Rds (B) 1/Rds (C) $1/R^2ds$ (D) R^2ds

Q.46 If a body at 27ºC emits 0.3 watt of heat then at 627ºC, it will emit heat equal to –

(A) 24.3 watt (B) 0.42 watt
(C) 2.42 watt (D) 0.9 watt

Q.47 If temperature of surface of sun becomes half then the energy emitted by it to earth per second will reduce to –

(A) $\frac{1}{2}$ (B) $\frac{1}{4}$ (C) $\frac{1}{16}$ (D) $\frac{1}{64}$

Q.48 The energy emitted by a black body at 727ºC is E. If the temperature of the body is increased to 2227ºC, then the emitted energy will become –

(A) 19 times (B) 13 times
(C) 39 times (D) 227 times

Questions based on Newton's law of cooling

Q.49 The rate of cooling of a body depends on –

(A) The difference of temperature of the body and the surrounding.
(B) Area of surface of body.
(C) Nature of surface of body.
(D) All of the above.

Q.50 Hot coffee is to be taken after 10 minutes it is put into a cup. To obtain much hotness at the time of drinking, when should the cream be put into coffee –

(A) Some time before drinking.
(B) Just after putting the coffee in cup.
(C) Five minutes before drinking.
(D) Any time between putting the coffee and drinking.

Q.51 When placed in air at 30ºC, the temperature of a body decreases from 60ºC to 50ºC in ten minutes. After next ten minutes its temperature will be –

(A) Less than 40ºC (B) 40ºC
(C) More than 40ºC (D) Not definite

Q.52 A body takes 4 minutes to cool from 100ºC to 70ºC. If the room temperature is 15ºC then how many minutes will it need to cool from 70ºC to 40ºC –

(A) 4 (B) 5 (C) 6 (D) 7

Q.53 A solid sphere, a cube and a plate, all are made of same material and all have same mass. These are heated to a temperature 100ºC and then allowed to cool at the temperature of room. Which of these will cool down first –

(A) Cube
(B) Plate
(C) Sphere
(D) All will cool down simultaneously

Q.54 A liquid takes 10 minutes to cool from 80ºC to 50ºC. The temperature of the surroundings is 20ºC. Assuming that the Newton's law of cooling is obeyed, the cooling constant will be –

(A) 0.056/mt (B) 0.042/mt
(C) 0.081/mt (D) 0.069/mt

Q.55 Radius of a calorimeter is r and depth is ℓ. It is filled completely with water and then cooled from temperature θ in the surroundings at a temperature θ_0 .If the emissive power of the surface of calorimeter is 1 and that of open surface of water is 0.5, then the ratio of rates of heat radiated by the surface of calorimeter and open surface of water will be –

(A) $\frac{\ell}{r}$ (B) $1+\frac{\ell}{r}$
(C) $1+\frac{2\ell}{r}$ (D) $2\left(1+\frac{2\ell}{r}\right)$

Q.56 A metallic sphere cools from 50ºC to 40ºC in 300 seconds. If the room temperature is 20ºC then its temperature in next 5 minutes will be –

(A) 38ºC (B) 36ºC
(C) 33.3ºC (D) 30ºC

Q.57 Negative sign in the equation $dQ/dt = -K(T - T_0)$ shows that –

(A) Heat of the body increases with time.
(B) Heat of the body remains same.
(C) Heat of the body reduces with time.
(D) Constant is negative.

Q.58 Which qualities are needed for cooking utensils –

(A) More specific heat and less thermal conductivity.
(B) Less specific heat and more thermal conductivity.
(C) More specific heat and more thermal conductivity.
(D) Less specific heat and less thermal conductivity

Q.59 Heat capacities of two bodies are in the ratio 1 : 4. If in the same surroundings the rate of loss of heat from the bodies are equal then the ratio of their rates of fall of temperature will be –

(A) 1 : 4 (B) 4 : 1
(C) 1 : 8 (D) 8 : 1

Q.60 Temperatures of two hot bodies B_1 and B_2 are 100ºC and 80ºC respectively. The temperature of surrounding is 40ºC. At t = 0, the ratio of rates of cooling of the two bodies (liquid) $R_1 : R_2$ will be –

(A) 3 : 2 (B) 5 : 4
(C) 2 : 1 (D) 4 : 5

Q.61 According to Newton's law of cooling $ms\frac{d\theta}{dt} = -K(\theta - \theta_0)$. If σ is Stefan's constant, A is surface area of the body and T_o is temperature of surroundings in K, then the value of K on the basis of Stefan-Boltzmann law is –

(A) $\sigma A T_0^4$ (B) $\sigma A T_0^3$
(C) $4\sigma A T_0^4$ (D) $4\sigma A T_0^3$

Q.62 If by taking same volume of water and kerosene in two identical calorimeters, they are cooled for same temperature difference in identical circumstances, then for them –

(A) The changes in internal energies are same.
(B) The rates of cooling (rate of loss of heat) are same.
(C) The rates of loss of heat and fall of temperature are same.
(D) The rates of fall of temperature are same.

Q.63 According to Newton's law of cooling the rate of loss of heat is –

(A) Directly proportional to $(\theta - \theta_0)$
(B) Inversely proportional to $(\theta - \theta_0)$
(C) Directly proportional to $(\theta^4 - \theta_0^4)$
(D) Directly proportional to $(\theta^2 - \theta_0^4)$

Questions based on Wein's law

Q.64 The vertex in the spectrum of radiations emitted by a black body, on increasing the temperature–

(A) Shifts towards the greater wavelength
(B) Shifts towards the lesser wavelength
(C) Does not shift
(D) None of the above

Q.65 Increasing the temperature of a black body –

(A) Frequency and wavelength both increase for maximum radiation.
(B) Frequency and wavelength both decrease for maximum radiation.
(C) Wavelength increases while frequency decreases for maximum radiation.
(D) Frequency increases while wavelength decreases for maximum radiation.

Q.66 Wein's law is –

(A) $\lambda_m \propto T$ (B) $\lambda_m \propto T^2$
(C) $\lambda_m \propto T^{-1}$ (D) $\lambda_m \propto T^{-2}$

Q.67 Frequency for maximum energy radiation of ideal black body at temperature T is υ_m. If Wein's constant is b and velocity of heat radiation in vacuum is c then –

(A) $\upsilon_m = b/T$ (B) $\upsilon_m = b/cT$
(C) $\upsilon_m = cT/b$ (D) $\upsilon_m = bT/c$

Q.68 At 700ºK temperature, the wavelength of maximum energy emitted by a body is 4.08 micron. If the temperature of body is increased to 1400ºK, then the wavelength of maximum energy will be–

(A) 10.2 micron (B) 16.32 micron
(C) 8.16 micron (D) 2.04 micron

Q.69 Two stars A and B radiate maximum energy at wavelengths 4000Å and 5000Å respectively. The ratio of their temperature will be –

(A) 1 : 2 (B) 2 : 1
(C) 4 : 5 (D) 5 : 4

Q.70 The value of Wein's constant b (in micron X K) is –

(A) 2.9 (B) 0.29×10^{-3}
(C) 2.9×10^{3} (D) 0.29

Q.71 Two spheres of the same material have radii 1m and 4m and temperature 4000K and 2000K respectively. The ratio of the amounts of energies radiated by the two per second will be –

(A) 1 : 1 (B) 1 : 2
(C) 1 : 4 (D) 1 : 16

Q.72 The variation of maximum intensity (E_m) of radiation with temperature is proportional to the following–

(A) T (B) T^2 (C) T^5 (D) T^4

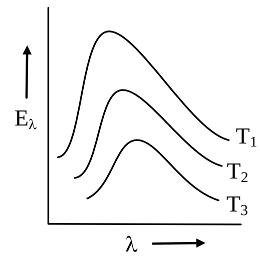
Q.73 Temperature of the surface of Sun is 6000 K and maximum emission is obtained at 5000Å. If in the light obtained from moon, the maximum energy is obtained at 100 micron then temperature of the moon will be –

(A) 30ºK (B) 300ºK
(C) 3000ºK (D) 120ºK

Q.74 Temperature of an ordinary bulb is 3000ºK. At what wavelength will it emit maximum energy –

(A) 10Å (B) 100Å
(C) 10^3Å (D) 10^4Å

Q.75 If for a black body the graph of change is emissive power at different temperatures T_1, T_2 and T_3 with wavelength is according to the figure then –



(A) $T_1 = T_2 = T_3$ (B) $T_3 > T_2 > T_1$
(C) $T_1 > T_2 > T_3$ (D) $T_3 > T_1 > T_2$

Q.76 At temperature of 1600K the wavelength of maximum emission of radiation is 2 μ, at temperature of 2000K the corresponding wavelength will be –

(A) 1μ (B) 1.6 μ
(C) 2 μ (D) 2.5 μ