NeetPreparation

Thermal Properties of Matter Important Questions With Answers

NEET Physics 2023

1. If the cold junction of a thermo-couple is kept at $0^{\circ}\mathrm{C}$ and the hot junction is kept at $\mathrm{T}^{\circ}\mathrm{C}$ then the relation between neutral temperature (T_n) and temperature of inversion (T_i) is_____

   a) $T_n = 2T_i$ b) $T_n = T_i - T$ c) $T_n = T_i + T$ **d)** $T_n = T/2$

   Solution : -
   Since $T_n = \frac{T_i+T_c}{2}$ = Neutral temperature
   $T_n = \frac{T_f+0}{2} + \frac{T_j}{2}$
   $[T_C = 0^{\circ}\mathrm{C} =$ temperature of cold junction]
   So $T_n = \frac{T}{2}$

2. A star emits wavelength 289.8 nm of maximum intensity. Then, radiant intensity of state is $(\sigma = 5.67 \times 10^{-8} W/m^2/k^4$, Wein's constant, b=2898X10^{-6} mK)

   a) 5.67X10^{16} W/m^2 b) 5.67X10^{14} W/m^2 c) 5.67X10^{10} W/m^2 **d) 5.67X10^{8} W/m^2**

   Solution : -
   Wein's law,
   $$\lambda_m T = \quad b \quad constant$$
   $$\Rightarrow T = \frac{b}{\lambda_m} = \frac{2898\times10^{-6}}{2898\times10^{-10}} = 10^4$$
   $$Now, \quad u = \sigma T^4$$
   $$\Rightarrow u = 5.67 \times 10^{-8} \times 10^{16} = 5.67 \times 10^8 W/m^2$$

3. A metal sphere 10.01 cm in diameter is placed on a brass ring of internal diameter l0 cm and at the same temperature of l0 ^{o}C. Determine the
   temperature (in ^{o}C) up to which they should be heated together so that the metal sphere just passes through the ring.
   (αmetal = 11.74 x 10-6/ ^{o}C and
   αbrass = 18.002 x 10^{-6}/ ^{o}C)

   a) 170 b) 120 c) 130 d) 150

   Solution : -
   Using d_2 = d1 (l + $\alpha \triangle$ t),
   Diameter of sphere = Diameter of ring
   10.01 [l + l1.74 x $l0^{-6}$(t_2- l0)] = 10[l + 18.002 x $l0^{-6}$(t_2 - 10)]
   $\therefore\ 10.01 - 10 = \left[\left(10 \times 18.002 \times 10^{-6}\right) - \left(10.01 \times 11.74 \times 10^{-6}\right)\right] \times (\mathrm{t}_2 - 10)$
   $\therefore\ 0.01 = \left[(180.02 - 117.52) \times 10^{-6}\right] \times (\mathrm{t}_2 - 10)$
   $\mathrm{t}_2 - 10 = \frac{0.01}{62.5\times10^{-6}} = \frac{1}{62.5} \times 10^4 = 160$
   t_2 = 170^{o}c

4. It is hotter at some distance ova the fire than front of it, because

a) heat is radiated upwards only b) convection of heat occurs downwards only
c) air conducts heat upwards **d) convection of heat occures upwards only**

5. Equal volumes of two liquids are cooled under identical circumstances from 72 ^{o}C to 40 ^{o}C and time taken by them are 510 and 850 seconds respectively. If ratio of their specific heats is 3 : 4, then the density of first liquid is ______________ times density of second liquid. (Work done may be neglected.)
a) 0.8 b) 0.7 c) 0.5 d) 0.6

Solution : -
$$\mathrm{Q} = \mathrm{mc}\theta$$
$$\frac{\mathrm{dQ}}{\mathrm{dt}} = \mathrm{mc}\frac{\mathrm{d}\theta}{\mathrm{dt}}$$
$$\text{Also, } \mathrm{m} = \rho \mathrm{V}$$
$$\frac{\mathrm{dQ}}{\mathrm{dt}} = \rho \mathrm{Vc}\frac{\mathrm{d}\theta}{\mathrm{dt}}$$
As, equal volumes are cooled under identical condition $\left(\frac{\mathrm{dQ}}{\mathrm{dt}}\right)_1 = \left(\frac{\mathrm{dQ}}{\mathrm{dt}}\right)_2$ and $\mathrm{V}_1 = \mathrm{V}_2 = \mathrm{V}$
$$\therefore \frac{\rho_2 V c_2 \frac{d\theta}{dt_2}}{\rho_1 V c_1 \frac{d\theta}{dt_1}} = 1$$
$$\therefore \frac{\rho_2}{\rho_1} \times \frac{c_2}{c_1} \times \frac{dt_1}{dt_2} = 1$$
$$\therefore \frac{\rho_1}{\rho_2} = \frac{c_2}{c_1} \times \frac{dt_1}{dt_2} = \frac{4}{3} \times \frac{510}{850} = \frac{4\times3}{3\times5} = 0.8$$
$$\therefore \rho_1 = 0.8\rho_2$$

6. A metal rod having a coefficient of linear expansion of 2.5 x l0^{-5} /^{o}C has a length of 1 m at 20 ^{o}C. The temperature at which it is shortened by 1 mm is _______ ^{o}C.
a) -20 b) -10 c) 2 d) 1

Solution : -
$$\Delta t = \frac{L_2 - L_1}{L_1\alpha}$$
$$t_2 = \frac{L_2 - L_1}{L_1\alpha} + t_1 = \frac{-10^{-1}}{100\times2.5\times10^{-5}} + 20$$
t_2 = -40 + 20
t_2 = - 20 ^{o}C

7. An electric heater, with power 10 W is used to heat a container filled with 0.5 kg of water. Ir is found that the temperature of water and the container rises by 3 K in 15 minutes. The container is then emptied, dried and filled with 2 kg of oil. The same heater now raises the temperature of container-oil system by 2 K in 20 minutes. Assuming that there is no heat loss in the process and the specific heat of water is 4200 Jkg $^{-1}$K^{-1}, the specific heat of oil in the same unit is equal to _________ x 10^{3}.
a) 3.55 b) 1.55 **c) 2.55** d) 5.55

Solution : -
Heat gained by water and container = Heat supplied by heater
$$\therefore (\mathrm{m_w} \times \mathrm{c_w} \times \Delta\theta_1) + (\mathrm{m_c} \times \mathrm{c_c} \times \Delta\theta_1) = \mathrm{P} \times \mathrm{t_1}$$
$$\therefore \left(\frac{1}{2} \times 4200 \times 3\right) + (\mathrm{m_c} \times \mathrm{c_c} \times 3) = 10 \times 15 \times 60$$
$$\therefore 6300 + 3\,(\,\mathrm{m_c} \times \mathrm{c_c}) = 9000$$
$$\therefore (\mathrm{m_c} \times \mathrm{c_c}) = \frac{2700}{3} = 900$$
In case of oil,
$$(\mathrm{m_o} \times \mathrm{c_o} \times \Delta\theta_2) + (\mathrm{m_c} \times \mathrm{c_c} \times \Delta\theta_2) = \mathrm{P} \times \mathrm{t_2}$$
$$\therefore (2 \times \mathrm{c_o} \times 2) + (\mathrm{m_c} \times \mathrm{c_c} \times 2) = (10 \times 20 \times 60)$$
$$\therefore 4\mathrm{c_o} + (900 \times 2) = 12000$$
$$\therefore \mathrm{c_o} = 2.55 \times 10^3 \mathrm{\ J\ kg^{-1}\ K^{-1}}$$

8. Ice at -20 ^oC is added to 40 g of water at 50 ^oC. When the temperature of the mixture reaches 0 ^oC, it is found that 25 g of ice is still unmelted. The amount of ice added to the water was ______________ g.
(Take, specific heat of water = 4.18 $Jg^{-1}\,^oC^{-1}$, specific heat of ice = 2.1 $Jg^{-1}\,^oC^{-1}$ and latent heat of fusion of water at 0 ^oC = 3341g^{-1})
a) 44.44 b) 44 c) 45.44 d) 45.44

Solution : -
Let amount of ice be 'x' g.
According to the principle of calorimeter, heat lost by water: heat gained by ice
Here, heat lost by water
$\Delta Q_w = mc_{\text{water}}\,\Delta T$
$\triangle Q_W$ = 40 x 4.18 x 50 = 8360
Heat gained by ice,
$\Delta Q_i = xc_{ice}\Delta T + (x-25)L$
$= x \times 2.1 \times 20 + (x-25) \times 334$
$= 20x \times 2.1 + 334x - 8350$
$\Delta Q_i = \Delta Q_w$
42x + 334x- 8350 = 8360
376 x = 16710
x = 44.44 g

9. When 100 g of a liquid A at 100 ^oC is added to 50 g of a liquid B at temperature 75 ^oC, the temperature of the mixture becomes 90 ^oC. The temperature of the mixture, if 100 g of liquid A at 100 ^oC is added to 50 g of liquid B at 50 ^oC will be__________ ^oC.
a) 49 **b) 80** c) 50 d) 89

Solution : -
In first case according to principle of calorimetry, heat lost by liquid A= heat gained by liquid B
$\therefore\ \mathrm{m_A c_A \Delta T_A = m_B c_B \Delta T_B}$
100 x c_A (100 - 90) = 50 x c_B (90 -75)
l000c_A = 50 x l5c_B
4c_A = 3c_B
Similarly, in second case,
100 x c_A (100- T) = 50 x c_B (T - 50)
4c_A (100 I T) = 2c_B (T - 50)
Using equation (i),
3c_B (100 - T) = 2 c_B (T - 50)
300 - 3T = 2T - 100
5T = 400
T = 80^{o}C

10. Two bars of having same length but unequal cross sections are heated to the same temperature.The change in length Will be
a) equal in both bar b) more in thicker bar c) more in thinner bar d) cannot say

11. The molar specific heat at constant pressure of an ideal gas is (7/2) R. The ratio of specific heat at constant pressure to that at constant volume is
a) 9/7 **b) 7/5** c) 8/7 d) 5/7

12. The density of water at 20^o C is 998 kg / m^3 and at 40^o C is 992 kg / m^3. The coefficient of volume expansion of water is_____.
a) $10^{-4/\rho}\mathrm{C}$ **b)** $3 \times 10^{-4/0}\mathrm{C}$ c) $2 \times 10^{-4/\rho}\mathrm{C}$ d) $6 \times 10^{-4/9}\mathrm{C}$

Solution : -

According to the question,
$\Delta\rho = (998 - 992)\mathrm{kg/m^3} = 6\ \mathrm{kg/m^3}$
$\rho = \frac{998+992}{2}\ \mathrm{kg/m^3} = 995\ \mathrm{kg/m^3}$
$\rho = \frac{m}{V}$
$\Rightarrow \frac{\Delta\rho}{\rho} = \frac{\Delta V}{V} \Rightarrow \left|\frac{\Delta\rho}{\rho}\right| = \left|\frac{\Delta V}{V}\right|$
therefore Coefficient of volume expansion of water,
$\frac{1}{V}\frac{\Delta V}{\Delta t} = \frac{1}{\rho}\frac{\Delta\rho}{\Delta t}$
$= \frac{6}{995\times 20} \approx 3\times 10^{-4}\gamma^{0}\mathrm{C}$

13. The radius of 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 T so that, new temperature is $T+\Delta T$. The increase in volume of sphere is approximately
a) $2\pi R\alpha\Delta T$ b) $\pi R^2\alpha\Delta T$ c) $4\pi R^3\alpha\Delta T/3$ **d)** $4\pi R^3\alpha\Delta T$

Solution : -
Since, coefficient of volume expansion,
$\gamma =$ 3x coefficient of linear expansion
$\Rightarrow \gamma = 3\alpha$
Now, $\frac{1}{\Delta T}\left(\frac{\Delta V}{V}\right) = 3\alpha$
$\Rightarrow\ \Delta V = 3V.\alpha.\Delta T$
$\Rightarrow \Delta V = \frac{4}{3}\pi R^3 \times 3\alpha \times \Delta T = 4\pi R^3\alpha\Delta T$

14. A beaker full of hot water is kept in a room and it cools from 80°C to 75°C in t_1 minutes, from 75°C to 70° C in t_2 minutes and from 70° C to 65° C in t_3 minutes. Then
a) $t_1 > t_2 > t_3$ b) $t_1 = t_2 = t_3$ c) $t_1 < t_2 = t_3$ **d) $t_1 < t_2 < t_3$**

15. The two ends of a metal rod are maintained at temperatures $100^\circ\mathrm{C}$ and $110^\circ\mathrm{C}$. The rate of heat flow in the rod is found to be $4.0\ \mathrm{J/s}$. If the ends are maintained at temperatures $200^\circ\mathrm{C}$ and $210^\circ\mathrm{C}$, the rate of heat flow will be____
a) $16.8\ \mathrm{J/s}$ b) $8.0\ \mathrm{J/s}$ **c)** $4.0\ \mathrm{J/s}$ d) $44.0\ \mathrm{J/s}$

Solution : -
We see that the temperature difference $\Delta T = 10^\circ\mathrm{C}$ as well as the thermal resistance is same for both the cases, so rate of heat flow will also be same for both the cases.

16. Certain quantity of water cools from 85 ^{o}C to 55 ^{o}C in the first l0 minutes and to 43 ^{o}C in the next l0 minutes. The temperature of the surroundings is _______ ^{o}C.
a) 35 b) 36 c) 65 d) 67

Solution : -
By Newton's lau' of cooling,
$\frac{\theta_1-\theta_2}{\Delta t} = K\left(\frac{\theta_1+\theta_2}{2} - \theta_0\right)$
For first l0 minutes,
$\frac{85-55}{10} = K\left(70-\theta_0\right)$
$\therefore\ 3 = K\times\left(70-\theta_0\right)$ ....(i)
Similarly, for next 10 minutes
$\frac{55-43}{10} = \mathrm{K}\left(49-\theta_0\right)$
$1.2 = \mathrm{K}\times\left(49-\theta_0\right)$ ....(ii)
Dividing equation (i) by equation (ii),
$\frac{3}{1.2} = \frac{70-\theta_0}{49-\theta_0}$

$2.5\,(49-\theta_0)=70-\theta_0$
$\therefore 122.5-2.5\theta_0=70-\theta_0$
$\therefore 1.5\theta_0=52.5$
$\therefore \theta_0=\frac{52.5}{1.5}=35^{\circ}\mathrm{C}$

17. 'M' kg of water at 80 ^{o}C is divided into two parts so that one part of mass 'm' kg when converted into ice at 0 ^{o}C would release enough heat to vaporise the other part entirely, then $\frac{\mathrm{m}}{\mathrm{M}}$ is equal to ___________
(Take Specific heat of water= 1 cal g -1 $^{o}C^{-1}$,
Latent heat of fusion of ice = 80 cal g^{-1},
Latent heat of steam = 540 cal g^{-l})
a) 4.78 b) 5.78 **c) 0.78** d) 1.78

Solution : -
Total mass of water = M kg
mass converted to ice = m kg
mass converted to steam = (M - m) kg
Heat lost during conversion of water - Heat gained during to ice vaporisation
$\therefore \mathrm{mc_w}\Delta\theta_{\mathrm{i}}+\mathrm{mL_i}=(\mathrm{M}-\mathrm{m})\mathrm{c_w}\Delta\theta_{\mathrm{s}}+(\mathrm{M}-\mathrm{m})\mathrm{L_s}$
$\therefore \mathrm{m}\times 1\times(80-0)+\mathrm{m}\times(80)=(\mathrm{M}-\mathrm{m})\times 1{\times}(100-80)+(\mathrm{M}-\mathrm{m})540$
$\therefore 160\ \mathrm{m}=20\mathrm{M}-20\ \mathrm{m}+540\mathrm{M}-540\ \mathrm{m}720\ \mathrm{m}=560\mathrm{M}$
$\therefore\ \frac{\mathrm{m}}{\mathrm{M}}=\frac{560}{720}=\frac{7}{9}=0.78$

18. One kilogram of water at 40 oC is heated in an electric kettle whose heating element has a mean (temperature averaged) resistance of 20 Ω. The rms voltage in the mains is 200 V. Ignoring heat loss from the kettle, time taken for water to evaporate fully in minutes is _________.
(Take specific heat of water = 4200 J/kg ^{o}C, latent heat of water = 2262 kJ/kg)
a) 26.85 b) 20 **c) 20.95** d) 25.95

Solution : -
Heat required by water for getting hot and then evaporated is
$\Delta Q=mc\Delta T+mL$
$\triangle$Q = 1 x 4200 x 60 + l x 2262 x 10^3
252 x 10^3 +2262 x 10^3
= 2514 x $l0^3$J ....(i)
This heat is provided by a heating coil of resistance R = 20 Ω connected with AC mains V_{rms} = 200 V
So, heat supplied by the heating coil is,
$Q=Pt=\frac{V_{\text{rms}}^2}{R}\times t$
$\therefore Q=\frac{(20\rho)^2}{20}\times t$
= 2x 10^3 x t ....(ii)
From equations (i) and (ii),
$\mathrm{t}=\frac{2514\times 10^3}{2\times 10^3}\ \mathrm{s}=\frac{2514}{2\times 60}\ \mathrm{min}=\frac{419}{20}\ \mathrm{min}$
= 20.95 min

19. As the temperature is increased, the 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 to 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

20. On observing light from three different stars P, Q and R, it was found that intensity of violet colour is maximum in the spectrum of P, the intensity of green colour is maximum in the spectrum of R and the intensity of red colour is maximum in the spectrum of Q. If T_P, T_Q and T_R are the respective absolute temperature of P, Q and R, then it can be concluded from the above observations that ___________ .

    a) $T_P > T_R > T_Q$ b) $T_P < T_R < T_Q$ c) $T_P < T_Q < T_R$ d) $T_P > T_Q > T_R$

    Solution : -

    According to Wein's displacement law,

    $\lambda_{m1} \times T =$ constant

    P - max. intensity is at violet $\Rightarrow \lambda_m$ is minimum $\Rightarrow$ temperature is maximum.

    R - max. intensity is at green $\Rightarrow \lambda_m$ is moderate $\Rightarrow$ temperature is moderate Q-max. intensity is at red $\Rightarrow \lambda_m$ is temperature is minimum i.e., $T_P > T_R > T_Q$

21. 336 g of ice at 0^0C is mixed With 336 g of water at 80^0C.The final temp of the mixture is

    a) 80^0C b) 40^0C c) 60^0C **d) 0^0C**

22. Two rods of same length and material transfer a given amount of heat in 12s, when they are joined end to end (ie. in series). But when they are joined in parallel, they will transfer same heat under same conditions in

    a) 2rs **b) 3s** c) 48s d) 1.5s

23. The common physical property which is to be used as the basis for constructing thermometer is

    a) the variation of the volume of a liquid with temperature

    b) the variation of the pressure of a gas with temperature

    c) the variation of the resistance of a wire with temperature **d) All of the above**

24. Radiation from which of the following sources, approximates black body radiation best?

    a) A tungsten lamp b) Sodium flame c) Hot lamp black

    d) A hole in a cavity, maintained at constant temperature

25. The temperature of sun is measured With

    a) platinum thermometer b) gas thermometer **c) Pyrometer** d) vapour pressure thermometer

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

    a) $r = 2r_0$; $l = 2l_0$ **b) $r = 2r_0$; $l = l_0$** c) $r = r_0$; $l = 2l_0$ d) $r = r_0$; $l = l_0$

27. If temperature of black body increases from 300 K to 900 K, then the rate of energy radiation increase by

    a) 81 b) 3 c) 9 d) 2

    Solution : -

    We can write, $\left(\frac{T_2}{T_1}\right)^4 = \frac{E_2}{E_1}$

    or $\frac{E_2}{E_1} = \left(\frac{900}{300}\right)^4 \Rightarrow \frac{E_2}{E_1} = (3)^4$

    or $E_2 = 81E_1 \quad \Rightarrow \quad \frac{E_2}{E_1} = 81$

28. Due to change in main voltage the temperature of the electric bulb rises from 3000K to 4000K. What is the percentage rise in electric power consumed?

    a) 216 b) 100 c) 150 d) 178

29. 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

30. Two identical rods of copper and iron are coated with wax uniformly. When one end of each is kept at temperature of boiling water, the length upto which wax melts are 7 .2 cm and 3.6 cm respectively. If thermal conductivity of copper is 0.92, then what is the thermal conductivity of iron?

    a) 1 **b) 0.23** c) 1.23 d) 3

Solution : -

$\frac{K_1}{K_2}=\frac{l_1^2}{l_2^2}$

$K_2=\frac{K_1 l_2^2}{l_1^2}=\frac{0.92\times(3.6)^2}{(7.2)^2}=\frac{0.92}{4}=0.23$

31. A beaker is completely filled With water at 4^0C. It will overflow
a) when heated, but not When cooled   b) when cooled, but not heated   **c) both with heated or cooled**
d) neither when heated nor when cooled

32. The molar specific heats of an ideal gas at constant pressure and volume are denoted by C_P and C_V respectively. If $Y=\frac{C_P}{C_V}$ and R is the universal gas constant, then C_V is equal to_____
a) $\frac{R}{(y-1)}$ b) $\frac{(\gamma-1)}{R}$ c) gR d) $\frac{1+\gamma}{1-\gamma}$

Solution : -

$C_p-C_v=R\Rightarrow C_p=C_v+R$

$\because\gamma=\frac{C_P}{C_v}=\frac{C_v+R}{C_v}=\frac{C_v}{C_v}+\frac{R}{C_v}$

$\Rightarrow\gamma=1+\frac{R}{C_v}\Rightarrow\frac{R}{C_v}=\gamma-1$

$\Rightarrow C_v=\frac{R}{\gamma-1}$

$K=1.24\ J/m/s^\circ C$

33. For nitrogen C_p-C_v = x and for argon, C_p-C_v = y.The relation between x and y is given by
a) x = y   b) x = 7y   c) y = 7x   d) x = 1/2y

34. Water is used as a coolant because of its
a) lower density   b) easy availability   **c) high specific heat**   d) low specific heat

35. The rate of radiation of a black body at 0^0C is E watt.The rate of radiation of this body at 273^0C will be
a) 16E   b) 8E   c) 4E   d) E

36. The value of coefficient of volume expansion of mercury is 1.8 x $10^{-4}K^{-1}$. The fractional change in the density of mercury for a rise of 50 ^oC in its temperature is____________x 10^{-3}.
a) 7   b) 8   c) 6   **d) 9**

Solution : -

$\rho=\frac{m}{V}\quad\Rightarrow V=\frac{m}{\rho}$

We know $V_2=V_1(1+\gamma\Delta T)$

$\therefore\ \frac{1}{\rho_2}=\frac{1}{\rho_1}(1+\gamma\Delta T)$

$\rho_2=\frac{\rho_1}{(1+\gamma\Delta T)}$

Fractional change

$=\frac{\rho_1-\rho_2}{\rho_1}=1-\frac{\rho_2}{\rho_1}=1-(1+\gamma\Delta T)^{-1}$

$=1-(1-\gamma\Delta T)\quad\ldots.[\because(1+x)^n\approx1+nx]$

$=\gamma\Delta T=1.8\times10^{-4}\times50=0.009=9\times10^{-3}$

37. The thickness of ice on a lake is 10 cm and the temperature of air is -10°C. If rate of cooling of water inside lake is 20000 cal min^{-1} through each square metre surface, then K for ice is
a) 14   b) 10   c) 3   d) 4

Solution : -

Given, thickness of ice, Δx = 10cm = 0.1m;

ΔT=0-(-10)=10°C

$\frac{\Delta Q}{\Delta t}=20000cal\quad min^{-1}=\frac{20000}{60}cal\quad s^{-1}$

$=\frac{20000}{60}\times4.2=1399.9\approx1400Js^{-1}$

A=1m^2, K=?

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

$\therefore \; K = \frac{\frac{\Delta Q}{\Delta t}}{A\left(\frac{\Delta T}{\Delta x}\right)} = \frac{1400}{1\left(\frac{10}{0.1}\right)} = 14W$°C^{-1}

38. A black body at $227^{\circ}\mathrm{C}$ radiates heat at the rate of 7 cals/cm^2 s. At a temperature of $727^{\circ}\mathrm{C}$, the rate of heat radiated in the same units will be _________ .

a) 50 **b) 112** c) 80 d) 60

Solution : -

From Stefan's law $\mathrm{E} = \mathrm{sT}^4$

$\mathrm{T}_1 = 500\ \mathrm{K}$

$\mathrm{T}_2 = 1000\ \mathrm{K}$

$\therefore \frac{\mathrm{E}_2}{\mathrm{E}_1} = \left(\frac{\mathrm{T}_2}{\mathrm{T}_1}\right)^4 = \left(\frac{1000}{500}\right)^4 = 16$

$\therefore E_2 = 16 \times 7 = 112 \mathrm{Cal/cm}^2 s$

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

a) 1 b) 2 c) 3 d) 4

40. Which of the following qualities are best suited for a cooking utensil?

a) High specific heat and low thermal conductivity b) High heat and high thermal conductivity

c) low specific heat and low thermal conductivity **d) Low specific heat and high thermal conductivity**

41. A cylindrical rod having temperature T_1, and T_2 at its end. The rate of flow of heat is $Q_1 \mathrm{cal/sec}$. If all the linear dimensions are doubled keeping temperature constant, then the rate of flow of heat Q_2 will be_____

a) 4 Q **b) 2 Q** c) Q_1 / 4 d) Q_1 / 2

Solution : -

We know that $Q = \frac{KA(\theta_1-\theta_2)t}{l}$

therefore Rate of heat flow = $H = \frac{Q}{t} = \frac{KA(\theta_1-\theta_2)}{l}$ ie., $H \alpha \frac{A}{1}$

Dimensions of Area $A = \left[L^2\right]$, dimensions of distance l =[L]

$\therefore H \alpha L \Rightarrow \frac{H_2}{H_1} = \frac{L_2}{L_1} = 2 \Rightarrow H_2 = 2H_1$

$\begin{bmatrix} \therefore H = Q \\ = 2Q \end{bmatrix}$

42. If specific heat of a substance is infinite, it means

a) heat is given out b) heat is taken in

c) no change in temperature takes place whether heat is taken in or given out d) All of the above

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

a) $\frac{dQ}{dt} = \frac{k(T_1-T_2)}{LA}$ b) $\frac{dQ}{dt} = kLA\left(T_1 - T_2\right)$ **c)** $\frac{dQ}{dt} = \frac{kA(T_1-T_2)}{L}$ d) $\frac{dQ}{dt} = \frac{kL(T_1-T_2)}{A}$

Solution : -

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

$[(\mathrm{T}_1 - \mathrm{T}_2)$ is the temperature difference].

44. If a cylinder of radius R having thermal conductivity K_1 is surrounded by other cylindrical shell of radius 2R having thermal conductivity K_2 . Two ends are maintained at two different temperatures. In steady state, the effective thermal conductivity of system is (assume no heat loss)

a) $\frac{k_1+4k_2}{4}$ **b)** $\frac{k_1+3k_2}{4}$ c) $\frac{4k_1+k_2}{4}$ d) $\frac{3k_1+k_2}{4}$

Solution : -

In steady state, $\left(\frac{dQ}{dt}\right) = \left(\frac{dQ_{inner}}{dt}\right) + \left(\frac{dQ_{outer}}{dt}\right)$

$\Rightarrow \frac{k\pi(2R)^2(\theta_1-\theta_2)}{l} = \frac{k_1\pi(R)^2(\theta_1-\theta_2)}{l} + k_2\frac{\left[\pi(2R)^2-\pi(R)^2\right](\theta_1-\theta_2)}{l}$

or $\frac{k4\pi(R)^2(\theta_1-\theta_2)}{l} = \frac{k_1\pi(R)^2(\theta_1-\theta_2)}{l} + \frac{k_2 3\pi(R)^2(\theta_1-\theta_2)}{l}$

or $4k = k_1 + 3k_2$

or $k = \frac{k_1+3k_2}{4}$

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

a) $(1000)^4$ b) $(1000)^2$ c) $(727)^4$ d) $(727)^2$

Solution : -

From Stefan's law,

Ea T^4

a $(t+273)^4$ K

a $(727+273)^4 K$

$[727^{\circ}\mathrm{C} = 727+273]$ K a $(1000)^4$ K

46. If the temperature of a black body is doubled, the wavelength at which the spectral radiancy has its maximum is

a) doubled **b) halved** c) quadrupled d) unchanged

47. The temperature of inversion of a thermocouple is $620^{\circ}\mathrm{C}$ and the neutral temperature is $300^{\circ}\mathrm{C}$. What is the temperature of cold junction?

a) 320°C b) 20°C **c) −20°C** d) 40°C

Solution : -

$\theta_n = \frac{\theta_c+\theta_j}{2}$

$\therefore \theta_c = 2\theta_n - \theta_i = 2(300) - 620 = -20^{\circ}\mathrm{C}$

48. A cylindrical metallic rod in thermal contact with two reservoirs of heat at its two ends conducts an amount of heat Q in time t. The metallic rod is melted and the material is formed into a rod of half the radius of the original rod. What is the amount of heat conducted by the new rod, when placed in thermal contact with the two reservoirs in time t?

a) $\frac{Q}{4}$ **b)** $\frac{Q}{16}$ c) $2\mathrm{Q}$ d) $\frac{Q}{2}$

Solution : -

The rate of flow of heat is given by

$\frac{Q}{t} = K \cdot \mathrm{A}, \frac{\Delta T}{l}$

Area of original rod $A = \pi R^2$

Area of new rod $A' = \frac{\pi R^2}{4}$

Volume of original rod will be equal to the volume of new rod.

$\therefore \pi R^2 l = \pi\left(\frac{R}{2}\right)^2 l'$

$\Rightarrow \frac{I'}{l} = \frac{R^2}{\left(\frac{R^2}{4}\right)} = 4$

$\therefore \frac{Q'}{Q} = \frac{A'l}{Al'} = \frac{1}{4} \cdot \frac{1}{4} = \frac{1}{16}$

$\therefore Q^4 = \frac{Q}{16}$

49. TWO layers of cloth Of equal thickness provide warmer covering than a Single layer of cloth of double the thickness, because they

a) behave like a therms b) have lesser thickness c) allow heat of atmosphere to come to body

d) enclose between them a layer of air

50. Wien's law is concerned with____

a) relation between emissivity and absorptivity of a radiating surface

b) total radiation, emitted by a hot surface

c) an expression for spectral distribution of energy of a radiation from any source

d)

a relation between the temperature of a black body and the wavelength at which there is maximum radiant energy per unit wavelength

Solution : -

As per Wein's displacement law, product of wavelength having maximum intensity and temperature is constant i.e.e, $\mathrm{I}_m T -$ constant.