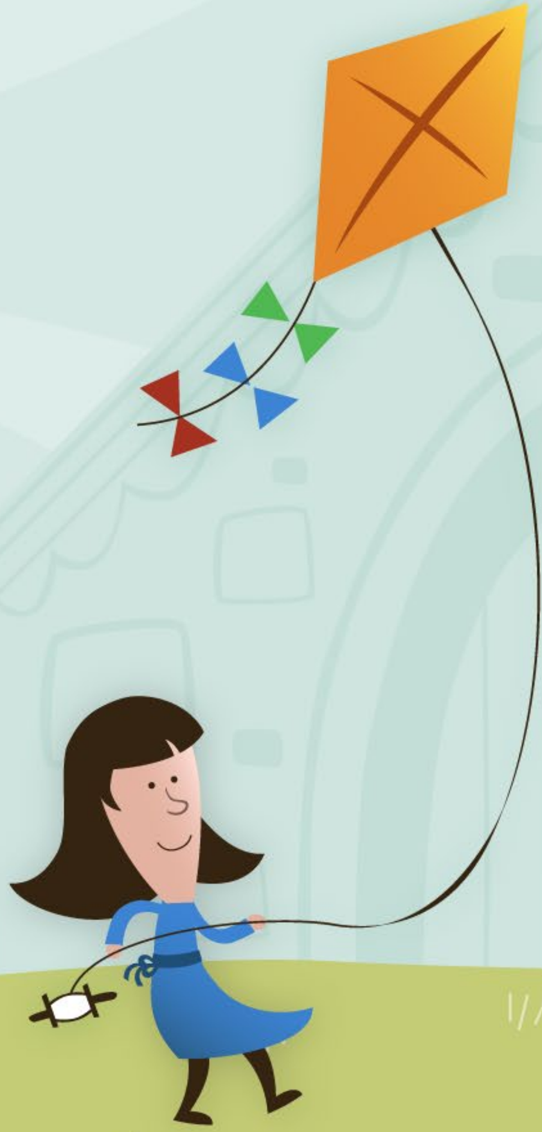
JEE Main 2021

Chapter wise Solution

Thermal Properties of Matter

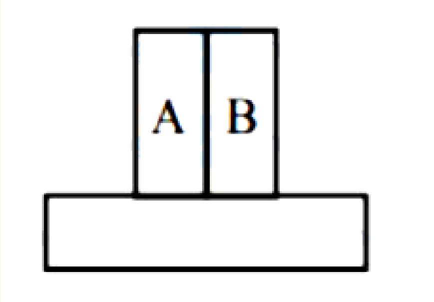
PHYSICS



MCQ

Q.1. A bimetallic strip consists of metals A and B. It is mounted rigidly as shown. The metal A has higher coefficient of expansion compared to that of metal B. When the bimetallic strip is placed in a cold both, it will:

[26 Feb 2021 Shift -2]



(1) Bend towards the right

(2) Not bend but shrink

(3) Neither bend nor shrink

(4) Bend towards the left

MCQ

Q.2. Two identical metal wires of thermal conductivities K_1 and K_2 respectively are connected in series. The effective thermal conductivity of the combination is:

[17 Mar 2021 Shift -1]

(1) $\frac{2K_1K_2}{K_1+K_2}$

(2) $\frac{K_1+K_2}{2K_1K_2}$

(3) $\frac{K_1+K_2}{K_1+K_2}$

(4) $\frac{K_1K_2}{K_1+K_2}$

MCQ

Q.3. Each side of a box made of metal sheet in cubic shape is 'a' at room temperature 'T', the coefficient of linear expansion of the metal sheet is $'\alpha'$. The metal sheet is heated uniformly, by a small temperature ΔT, so that its new temperature is $T + \Delta T$. Calculate the increase in the volume of the metal box-

[24 Feb 2021 Shift -1]

(1) $\frac{4}{3}\pi a^3 \alpha \Delta T$

(2) $4\pi a^3 \alpha \Delta T$

(3) $3\alpha^3 \alpha \Delta T$

(4) $4a^3 \alpha \Delta T$

MCQ

Q.4. A proton, a deuteron and an α particle are moving with same momentum in a uniform magnetic field. The ratio of magnetic forces action on them is ____ and their speed is ____ in the ratio.

[25 Feb 2021 Shift -1]

(1) 2 : 1 : 1 and 4 : 2 : 1

(2) 1 : 2 : 4 and 2 : 1 : 1

(3) 1 : 2 : 4 and 1 : 1 : 2

(4) 4 : 2 : 1 and 2 : 1 : 1

MCQ

Q.5. Two different metal bodies A and B of equal mass are heated at a uniform rate under similar conditions. The variation of temperature of the bodies is graphically represented as shown in the figure. The ratio of specific heat capacities is: **[25 July 2021 Shift -1]**

(1) $\frac{8}{3}$

(2) $\frac{3}{8}$

(3) $\frac{3}{4}$

(4) $\frac{4}{3}$

MCQ

Q.6. A body takes 4 min. to cool from 61°C to 59°C. If the temperature of the surroundings is 30°C, the time taken by the body to cool from 51°C to 49°C is: [27 July 2021 Shift -1]

(1) 4 min.

(2) 3 min.

(3) 8 min.

(4) 6 min.

MCQ

Q.7. Due to cold weather a 1m water pipe of cross-sectional area $1 cm^2$ is filled with ice at $-10°C$. Resistive heating is used to melt the ice. Current of 0.5 A is passed through $4 k\Omega$ resistance. Assuming that all the heat produced is used for melting, what is the minimum time required?

(Given latent heat of fusion for water/ice $= 3.33 \times 10^5$ J kg^{-1}, specific heat of ice $= 2 \times 10^3$ J kg^{-1} and density of ice $= 10^3 kg/m^3$ **[01 Sep 2021 Shift -2]**

(1) 0.353s

(2) 35.3s

(3) 3.53s

(4) 70.6s

Checkout Latest Crash courses/ Full Courses ?

Prepare for JEE (Main and Advanced) With India's Online Live Courses.

Like , Share and Subscribe the Channel

Download the App "Rankers JEE" from Playstore for Pdf and Courses .

Visit Website www.myrankers.com for Courses and More .

Call / WhatsApp to know about Latest ongoing /Upcoming Courses
9621270696

Always Check Description box for latest Courses .

Integer

Q.8. For an ideal heat engine, the temperature of the source is 127°C. In order to have 60% efficiency the temperature of the sink should be ___ °C.
(Round off to the Nearest Integer)
(write modulus or absolute value of the temperature)

[16 Mar 2021 Shift -2]

Integer

Q.9. In 5 minutes, a body cools from 75° C to 65°C. The temperature of body at the end of next 5 minutes is ____.

[22 July 2021 Shift -1]

Integer

Q.10. A steel rod with $y = 2.0 \times 10^{11}\ Nm^{-2}$ and $\alpha = 10^{-5}\,°C^{-1}$ of length 4m and area of cross-section $10 cm^2$ is heated from 0°C to 400°C without being allowed to extend. The tension produced in the rod is $x \times 10^5$ N where the value of x is .....

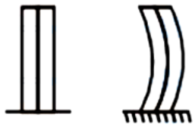
[01 Sep 2021 Shift -2]

Thermal Properties of Matter – Solution

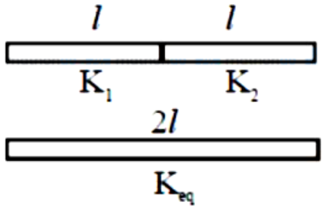
Q. 1 (4)

$\alpha_A > \alpha_B$

Length of both strips will decrease $\Delta L_A > \Delta L_B$



Q. 2 (1)



$$R_{eff} = \frac{l}{K_1\ A} + \frac{l}{K_2\ A} = \frac{2l}{K_{eq}A}$$

$$K_{eq} = \frac{2\,K_1\,K_2}{K_1+K_2}$$

Q. 3 (3)

volume expansion $\gamma = 3\alpha$

$$\frac{\Delta V}{V} = \gamma\Delta T$$

$$\Delta V = V\cdot\gamma\Delta T$$

$$\Delta V = a^3.3\alpha\Delta T$$

Q. 4 (1)

As $v = \frac{p}{m} \& F = qvB$

$$\therefore F = \frac{qp}{m}B$$

$$F_1 = \frac{qpB}{m}, v_1 = \frac{p}{m}$$

$$F_2 = \frac{qpB}{2m}, v_2 = \frac{p}{2m}$$

$$F_3 = \frac{2qpB}{4m}, v_3 = \frac{p}{4m}$$

$$F_1 : F_2 : F_3 \& V_1 : V_2 : V_3$$

$$1 : \frac{1}{2} : \frac{1}{2} \quad \& 1 : \frac{1}{2} : \frac{1}{4}$$

2 : 1 : 1   \& 4: 2: 1

Q. 5

$$\left(\frac{\Delta Q}{\Delta t}\right)_A = \left(\frac{\Delta Q}{\Delta t}\right)_B$$

$$mS_A\left(\frac{\Delta T}{\Delta t}\right)_A = mS_B\left(\frac{\Delta T}{\Delta t}\right)_B$$

Q. 6

$\frac{\Delta T}{\Delta t} = K\left(T_t - T_s\right) \quad T_t =$ average temp.

$T_S =$ surrounding temp

$$\frac{61-59}{4} = K\left(\frac{61+59}{2} - 30\right) \ldots(1)$$

$$\frac{51-49}{t} = K\left(\frac{51+49}{2} - 30\right) \ldots(2)$$

Divide (1) & (2) $\frac{t}{4} = \frac{60-30}{50-30} = \frac{30}{20}$

so, $t = 6$ minutes

Q. 7 (2)

mass of ice $m = \rho A\ell = 10^3 \times 10^{-4} \times 1 = 10^{-1}$ kg

Energy required to melt the ice

$$Q = ms \wedge T + mL$$
$$= 10^{-1}\left(2\times10^3\times10 + 3.33\times10^5\right) = 3.53\times10^4\ J$$
$$Q = i^2RT \Rightarrow 3.53\times10^4 = \left(\frac{1}{2}\right)^2\left(4\times10^3\right)(t)$$

Time $= 35.3$sec

Option (2)

Q. 8 (-113)

$$n = 0.60 = 1 = \frac{T_L}{T_H}$$

$$\frac{T_L}{T_H = 0.4 \Rightarrow T_L} = 0.4\times400$$

$$= 160\ K$$

$$= -113°C$$

Thermal Properties of Matter – Solution

Q. 9 By newton's law of cooling (with approximation)

$\frac{\Delta T}{\Delta t} = -C\left(T_{avg} - T_s\right)$

$1^{st}\ \frac{-10^\circ C}{5\ min} = -C\left(70^\circ C - 25^\circ C\right)$

$\Rightarrow \quad C = \frac{2}{45}\ min^{-1}$

$2^{nd}\ \frac{T-65}{5\ min} = -C\left(\frac{T+65}{2} - 25\right) = -\left(\frac{2}{45}\right)\left(\frac{T+15}{2}\right)$

$\Rightarrow \quad 9(T - 65) = -(T + 15)$

$\Rightarrow \quad 10\ T = 570$

$\Rightarrow \quad T = 57^\circ C$

Alternate Solution :

Newton's law of cooling (without approximation)

$T_P - T_S = (T_i - T_S)\, e^{-Ct}$

$1^{st} \quad 65 - 25 = (75 - 25)e^{-5C} \Rightarrow e^{-5C} = \frac{4}{5}$

$2^{nd} \quad T - 25 = (65 - 25)e^{-5C} = 40 \times \frac{4}{5} = 32$

$T = 57^\circ C$

Q. 10 **(8)**

Thermal force $F = Ay \propto \Delta T$

$F = \left(10 \times 10^4\right)\left(2 \times 10^{11}\right)\left(10^{-5}\right)(400)$

$F = 8 \times 10^5\ N$

$\Rightarrow x = 8$