PHYSICS

Thermal Properties of Matter

No. of Questions	Maximum Marks	Time
30	120	1 Hour

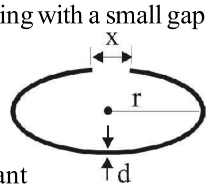
Speed TEST 10

Chapter-wise

GENERAL INSTRUCTIONS

- This test contains 30 MCQ's. For each question only one option is correct. Darken the correct circle/ bubble in the Response Grid provided on each page.
- You have to evaluate your Response Grids yourself with the help of solutions provided at the end of this book.
- Each correct answer will get you 4 marks and 1 mark shall be deduced for each incorrect answer. No mark will be given/ deducted if no bubble is filled. Keep a timer in front of you and stop immediately at the end of 60 min.
- The sheet follows a particular syllabus. Do not attempt the sheet before you have completed your preparation for that syllabus.
- After completing the sheet check your answers with the solution booklet and complete the Result Grid. Finally spend time to analyse your performance and revise the areas which emerge out as weak in your evaluation.

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



(a) x decreases, r and d increase
(b) x and r increase, d decreases
(c) x, r and d all increase
(d) x and r decrease, d remains constant

2. 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 T K is given by: (σ is Stefan's constant)

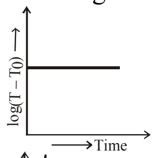
(a) $\dfrac{\sigma r^2 T^4}{R^2}$ (b) $\dfrac{\sigma r^2 T^4}{4\pi r^2}$

(c) $\dfrac{\sigma r^4 T^4}{r^4}$ (d) $\dfrac{4\pi \sigma r^2 T^4}{R^2}$

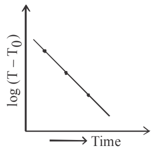
3. The sprinkling of water slightly reduces the temperature of a closed room because
(a) temperature of water is less than that of the room
(b) specific heat of water is high
(c) water has large latent heat of vaporisation
(d) water is a bad conductor of heat

4. Which of the given graphs proves Newton's law of cooling?

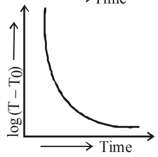
(a)



(b)



(c)

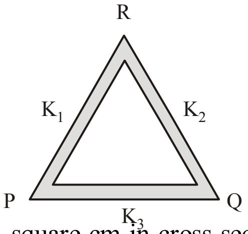


(d) None of these

RESPONSE GRID 1. ⓐⓑⓒⓓ 2. ⓐⓑⓒⓓ 3. ⓐⓑⓒⓓ 4. ⓐⓑⓒⓓ

5. If λ_m denotes the wavelength at which the radiative emission from a black body at a temperature T K is maximum. Then
(a) $\lambda_m \propto T^{-1}$
(b) $\lambda_m \propto T^4$
(c) λ_m is independent of T
(d) $\lambda_m \propto T$

6. Three rods of same dimensions are arranged as shown in figure, have thermal conductivities K_1, K_2 and K_3 . The points P and Q are maintained at different temeratures for the heat to flow at the same rate along PRQ and PQ. Then which of the following option is correct?



(a) $K_3 = \frac{1}{2}(K_1 + K_2)$
(b) $K_3 = K_1 + K_2$
(c) $K_3 = \frac{K_1 K_2}{K_1 + K_2}$
(d) $K_3 = -2(K_1 + K_2)$

7. A metallic rod ℓ cm long, A square cm in cross-section is heated through t°C. If Young's modulus of elasticity of the metal is E and the mean coefficient of linear expansion is α per degree celsius, then the compressional force required to prevent the rod from expanding along its length is
(a) $E A \alpha t$ (b) $E A \alpha t/(1 + \alpha t)$
(c) $E A \alpha t/(1 - \alpha t)$ (d) $E \ell \alpha t$

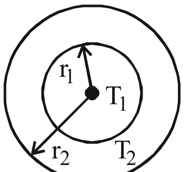
8. Which of the following statements is/are false about mode of heat transfer?
(a) In radiation, heat is transfered from one medium to another without affecting the intervening medium
(b) Radiation and convection are possible in vaccum while conduction requires material medium.
(c) Conduction is possible in solids while convection occurs in liquids and gases.
(d) All are correct

9. A wall has two layers A and B made of different materials. The thickness of both layers is the same. The thermal conductivity of A and B are K_A and K_B such that $K_A = 3K_B$. The temperature across the wall is 20°C. In thermal equilibrium
(a) the temperature difference across A is 15°C
(b) the temperature difference across A is 5°C
(c) the temperature difference across A is 10°C
(d) the rate of transfer of heat through A is more than that through B

10. The filament of an evacuated light bulb has a length 10 cm, diameter 0.2 mm and emissivity 0.2. Calculate the power it radiates at 2000 K. ($\sigma = 5.67 \times 10^{-8}$ W/m^2 K^4)
(a) 21.5 W (b) 15.5 W (c) 8.9 W (d) 11.4 W

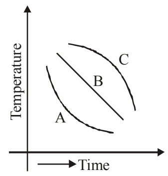
11. A rectangular block is heated from 0ºC to 100ºC. The percentage increase in its length is 0.10%. What will be the percentage increase in its volume?
(a) 0.03% (b) 0.10% (c) 0.30% (d) 0.5%

12. The figure shows a system of two concentric spheres of radii r_1 and r_2 are kept at temperatures 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) $\ell n\left(\frac{r_2}{r_1}\right)$ (b) $\frac{(r_2 - r_1)}{(r_1 r_2)}$
(c) $(r_2 - r_1)$ (d) $\frac{r_1 r_2}{(r_2 - r_1)}$

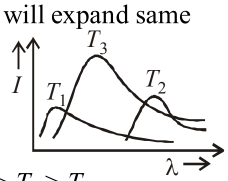
13. A block of steel heated to 100ºC is left in a room to cool. Which of the curves shown in fig., represents the correct behaviour?



(a) A (b) B
(c) C (d) None of these

14. Which of the following will expand the most for same rise in temperature?
(a) Aluminium (b) Glass
(c) Wood (d) All will expand same

15. The plots of intensity versus wavelength for three black bodies at temperatures T_1, T_2 and T_3 respectively are as shown. Their temperature are such that



(a) $T_1 > T_2 > T_3$ (b) $T_1 > T_3 > T_2$
(c) $T_2 > T_3 > T_1$ (d) $T_3 > T_2 > T_1$

RESPONSE GRID					
	5. ⓐⓑⓒⓓ	6. ⓐⓑⓒⓓ	7. ⓐⓑⓒⓓ	8. ⓐⓑⓒⓓ	9. ⓐⓑⓒⓓ
	10. ⓐⓑⓒⓓ	11. ⓐⓑⓒⓓ	12. ⓐⓑⓒⓓ	13. ⓐⓑⓒⓓ	14. ⓐⓑⓒⓓ
	15. ⓐⓑⓒⓓ				

16. When the temperature of a rod increases from t to t + Δt, its moment of inertia increases from I to I + ΔI. If α be the coefficient of linear expansion of the rod, then the value of $\frac{\Delta I}{I}$ is

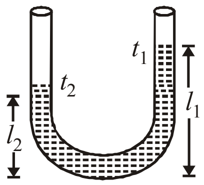
(a) $2\alpha\Delta t$ (b) $\alpha\Delta T$ (c) $\frac{\alpha\Delta t}{2}$ (d) $\frac{\Delta t}{\alpha}$

17. Two rods, one of aluminum and the other made of steel, having initial length ℓ_1 and ℓ_2 are connected together to form a single rod of length $\ell_1 + \ell_2$. The coefficients of linear expansion for aluminum and steel are α_a and α_s and respectively. If the length of each rod increases by the same amount when their temperature are raised by t^0C, then find the ratio $\ell_1/(\ell_1 + \ell_2)$

(a) α_s/α_a (b) α_a/α_s

(c) $\alpha_s/(\alpha_a + \alpha_s)$ (d) $\alpha_a/(\alpha_a + \alpha_s)$

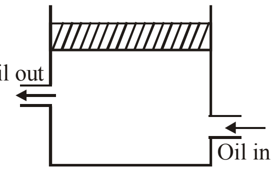
18. In a vertical U-tube containing a liquid, the two arms are maintained at different temperatures t_1 and t_2. The liquid columns in the two arms have heights l_1 and l_2 respectively. The coefficient of volume expansion of the liquid is equal to



(a) $\frac{l_1 - l_2}{l_2 t_1 - l_1 t_2}$ (b) $\frac{l_1 - l_2}{l_1 t_1 - l_2 t_2}$

(c) $\frac{l_1 + l_2}{l_2 t_1 + l_1 t_2}$ (d) $\frac{l_1 + l_2}{l_1 t_1 + l_2 t_2}$

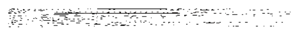
19. The top of an insulated cylindrical container is covered by a disc having emissivity 0.6 and conductivity 0.167 $WK^{-1}m^{-1}$ and thickness 1 cm. The temperature is maintained by circulating oil as shown in figure. Find the radiation loss to the surrounding in $Jm^{-2}s^{-1}$ if temperature of the upper surface of the disc is 27°C and temperature of the surrounding is 27°C.



(a) 595 $Jm^{-2}s^{-1}$ (b) 545 $Jm^{-2}s^{-1}$

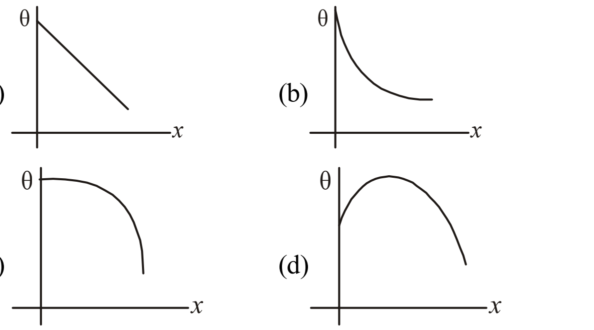
(c) 495 $Jm^{-2}s^{-1}$ (d) None of these

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

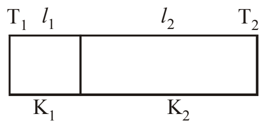


(a) 24 s (b) 13 s (c) 15 s (d) 48 s

21. 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 figures?



22. 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 sections is



(a) $\frac{(K_1 l_1 T_1 + K_2 l_2 T_2)}{(K_1 l_1 + K_2 l_2)}$ (b) $\frac{(K_2 l_2 T_1 + K_1 l_1 T_2)}{(K_1 l_1 + K_2 l_2)}$

(c) $\frac{(K_2 l_1 T_1 + K_1 l_2 T_2)}{(K_2 l_1 + K_1 l_2)}$ (d) $\frac{(K_1 l_2 T_1 + K_2 l_1 T_2)}{(K_1 l_2 + K_2 l_1)}$

RESPONSE GRID					
	16. ⓐⓑⓒⓓ	17. ⓐⓑⓒⓓ	18. ⓐⓑⓒⓓ	19. ⓐⓑⓒⓓ	20. ⓐⓑⓒⓓ
	21. ⓐⓑⓒⓓ	22. ⓐⓑⓒⓓ			

23. Two spheres of different materials one with double the radius and one-fourth wall thickness of the other are filled with ice. If the time taken for complete melting of ice in the larger sphere is 25 minute and for smaller one is 16 minute, the ratio of thermal conductivities of the materials of larger spheres to that of smaller sphere is

(a) 4 : 5 (b) 5 : 4 (c) 25 : 8 (d) 8 : 25

24. If α, β and γ are coefficient of linear, area and volume expansion respectively, then

(a) $\gamma = 3\alpha$ (b) $\alpha = 3\gamma$ (c) $\beta = 3\alpha$ (d) $\gamma = 3\beta$

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

(a) 24 g (b) 31.5 g (c) 42.5 g (d) 22.5 g

26. In a room where the temperature is 30°C, a body cools from 61°C to 59°C in 4 minutes. The time (in minutes) taken by the body to cool from 51°C to 49°C will be :

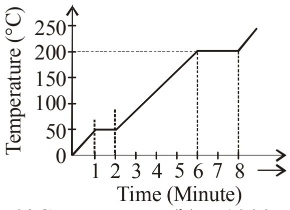
(a) 8 (b) 5 (c) 6 (d) 4

27. Two rods of same length and area of cross-section A_1 and A_2 have their ends at the same temperature. If K_1 and K_2 are their thermal conductivities, c_1 and c_2 are their specific heats and d_1 and d_2 are their densities, then the rate of flow of heat is the same in both the rods if

(a) $\frac{A_1}{A_2} = \frac{-k_1}{k_2}$ (b) $\frac{A_1}{A_2} = \frac{k_1 c_1 d_1}{k_2 c_2 d_2}$

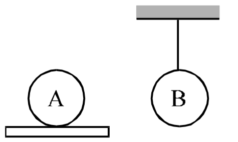
(c) $\frac{A_1}{A_2} = \frac{k_2 c_1 d_1}{c_2 d_2 k_1}$ (d) $\frac{A_1}{A_2} = \frac{k_2}{k_1}$

28. A student takes 50gm wax (specific heat = 0.6 kcal/kg°C) and heats it till it boils. The graph between temperature and time is as follows. Heat supplied to the wax per minute and boiling point are respectively



(a) 500 cal, 50°C (b) 1000 cal, 100°C
(c) 1500 cal, 200°C (d) 1000 cal, 200°C

29. Consider two identical iron spheres , one which lie on a thermally insulating plate, while the other hangs from an insulatory thread. Equal amount of heat is supplied to the two spheres, then



(a) temperature of A will be greater than B
(b) temperature of B will be greater than A
(c) their temperature will be equal
(d) can't be predicted

30. Two rods of the same length and diameter having thermal conductivities K_1 and K_2 are joined in parallel. The equivalent thermal conductivity of the combination is

(a) $\frac{K_1 K_2}{K_1 + K_2}$ (b) $K_1 + K_2$ (c) $\frac{K_1 + K_2}{2}$ (d) $\sqrt{K_1 K_2}$

RESPONSE GRID					
	23. ⓐⓑⓒⓓ	24. ⓐⓑⓒⓓ	25. ⓐⓑⓒⓓ	26. ⓐⓑⓒⓓ	27. ⓐⓑⓒⓓ
	28. ⓐⓑⓒⓓ	29. ⓐⓑⓒⓓ	30. ⓐⓑⓒⓓ		

PHYSICS CHAPTERWISE SPEED TEST-10			
Total Questions	30	Total Marks	120
Attempted		Correct	
Incorrect		Net Score	
Cut-off Score	45	Qualifying Score	60
Success Gap = Net Score – Qualifying Score			
Net Score = (Correct × 4) – (Incorrect × 1)			

HINTS & SOLUTIONS (PHYSICS – Chapter-wise Tests)

Speed Test-10

1. **(b)** Material expands outward and so x, r increases. Due to linear expansion diameter of rod will increase.

2. **(a)** $E = \dfrac{S}{S_0}\sigma T^4 = \dfrac{4\pi r^2}{4\pi R^2}\sigma T^4$

$= \sigma \dfrac{r^2}{R^2} T^4$

3. **(c)** $Q = mc\Delta T$

$Q = mc\,(T - T_0)$ ......(i)

$Q = Kt$ whereas K is heating rate

$\therefore$ from 50 to boiling temperature, T increases linearly.

At vaporization, equation is $Q = mL$

so, temperature remains constant till vaporisation is complete

After that, again Eqn (i) is followed and temperature increases linearly

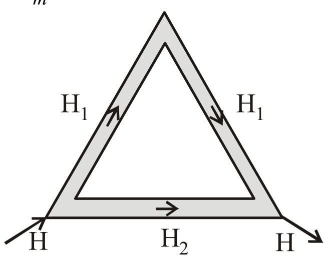
4. **(b)** When hot water temperature (T) and surrounding temparature (T_0) readings are noted, and $\log(T - T_0)$ is plotted versus time, we get a straight line having a negative slope; as a proof of Newton's law of cooling.

5. **(a)** From Wein's displacement law

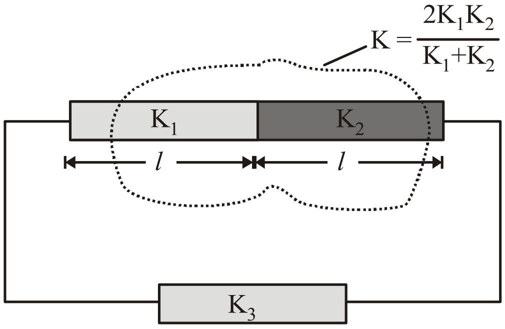
$\lambda_m T = \text{constant}$

$\Rightarrow \lambda_m \propto T^{-1}$

6. **(c)**



The given arrangement of rods can be redrawn as follows



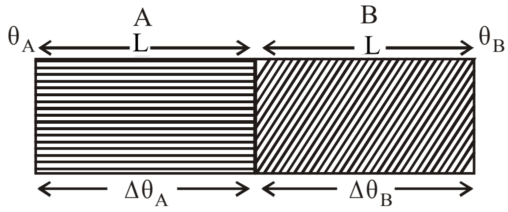
It is given that $H_1 = H_2$

$\Rightarrow \dfrac{KA(\theta_1 - \theta_2)}{2l} = \dfrac{K_3 A(\theta \;-\theta\;)}{}$ $\quad K \quad K\;K$

7. **(a)** $E = \dfrac{F/A}{\Delta l / l} = \dfrac{\text{stress}}{\text{strain}}$ where $\Delta l = (l' - l) = l\alpha t$ so $F = EA\alpha t$

8. **(b)**

9. **(b)** The wall of two layers A and B are connected in series. Then, heat flowing per second across both wall layers are same i.e



$H_1 = H_2$

$\dfrac{K_A A\Delta\theta_A}{L} = \dfrac{K_B A\Delta\theta_B}{L} \Rightarrow K_A\Delta\theta_A = K_B\Delta\theta_B$

$\Rightarrow 3K_B\Delta\theta_A = K_B\Delta\theta_B$ (as $K_A = 3K_B$)

$\Rightarrow 3\Delta\theta_A = \Delta\theta_B$ ....(i)

Also $\Delta\theta_A + \Delta\theta_B = 20°\,C$ ....(ii)

From (i) & (ii)

$\therefore\ \Delta\theta_A + 3\,\Delta\theta_A = 20°C \Rightarrow 4\,\Delta\theta_A = 20°C$

$\Rightarrow \Delta\theta_A = 5°C$

10. **(d)** $\ell = 10$ cm $= 0.1$ m, $d = 0.2$ mm,

$r = 0.1$ mm $= 1 \times 10^{-4}$ m,

$e = 0.2$, $T = 2000$ K, $\sigma = 5.67 \times 10^{-8}$ W/m^2 K^4

According to stefan's law of radiation, rate of emission of heat for an ordinary body,

$E = \sigma A e T^4 = \sigma(2\,\pi\,r\,\ell)\,eT^4$

$= 5.67 \times 10^{-8} \times 2 \times 3.14 \times 1 \times 10^{-4} \times 0.1 \times 0.2 \times (2000)^4$

$= 11.4$ W

$\therefore$ Power radiated by the filament $= 11.4$ W $[A = 2\pi r\ell]$

11. **(c)** Given $\Delta\ell / \ell = 0.10\% = 0.001$ and $\Delta T = 100°\,C$

Now $\dfrac{\Delta\ell}{\ell} = \alpha\,\Delta T$

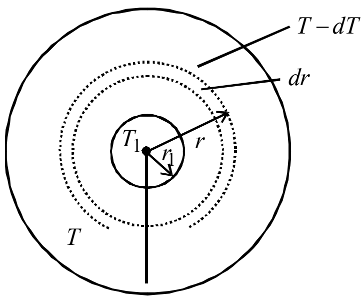
or $0.001 = \alpha \times 100$

or $\alpha = 10^{-5}$ /°C

Further $\gamma = 3\alpha = 3 \times 10^{-5}$/°C

$\therefore\ \dfrac{\Delta V}{V} \times 100 = (3 \times 10^{-3})\,(100) = 0.30\%$

12. **(d)**



Consider a shell of thickness (dr) and of radiius (r) and let the temperature of inner and outer surfaces of this shell be T and $(T - dT)$ respectively.

$\frac{dQ}{dt}$ = rate of flow of heat through it

$$= \frac{KA[(T-dT)-T]}{dr} = \frac{-KAdT}{dr}$$

$$= -4\pi K r^2 \frac{dT}{dr} \qquad (\because \ A = 4\pi r^2)$$

To measure the radial rate of heat flow, integration technique is used, since the area of the surface through which heat will flow is not constant.

$$\text{Then, } \left(\frac{dQ}{dt}\right)\int_{r_1}^{r_2}\frac{1}{r^2}dr = -4\pi K\int_{T_1}^{T_2} dT$$

$$\frac{dQ}{dt}\left[\frac{1}{r_1}-\frac{1}{r_2}\right] = -4\pi K\left[T_2 - T_1\right]$$

$$\text{or } \frac{dQ}{dt} = \frac{-4\pi K r_1 r_2 (T_2 - T_1)}{(r_2 - r_1)}$$

$$\therefore \quad \frac{dQ}{dt} \propto \frac{r_1 r_2}{(r_2 - r_1)}$$

13. **(a)** According to Newton's law of cooling if temperature difference between body & surrounding is large, then rate of cooling is also fast hence curve A shows correct behaviour.

14. **(a)** Among glass, wood and metals, metals expand more for same rise in temperature.

15. **(b)** According to Wien's law $\lambda_m \propto \frac{1}{T}$ and from the figure $(\lambda_m)_1 < (\lambda_m)_3 < (\lambda_m)_2$ therefore $T_1 > T_3 > T_2$.

16. **(a)** Moment of inertia of a rod,

$$I = \frac{1}{12}ML^2$$

Differentiating w.r.t. to ΔL, we get

$$\frac{\Delta I}{\Delta L} = \frac{1}{12}\times 2ML$$

$$\Delta I = \frac{1}{12}2ML\Delta L \qquad \therefore \ \frac{\Delta I}{I} = 2\frac{\Delta L}{L}$$

As we know, $\Delta L = L\alpha\Delta t$ or $\frac{\Delta L}{L} = \alpha\Delta t$

Substituting the value $\frac{\Delta L}{L}$, we get

$$\frac{\Delta I}{I} = 2\alpha\Delta t$$

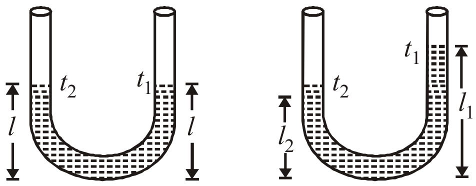
17. **(c)** The lengths of each rod increases by the same amount

$$\therefore \quad \Delta\ell_a = \Delta\ell_s \ \Rightarrow \ \ell_1\alpha_a t = \ell_2\alpha_s t$$

$$\Rightarrow \ \frac{\ell_2}{\ell_1} = \frac{\alpha_a}{\alpha_s} \Rightarrow \frac{\ell_2}{\ell_1}+1 = \frac{\alpha_a}{\alpha_s}+1$$

$$\Rightarrow \ \frac{\ell_2+\ell_1}{\ell_1} = \frac{\alpha_a+\alpha_s}{} \ \Rightarrow \ \ell_1 \ = \ \alpha_s$$

18. **(a)** Suppose, height of liquid in each arm before rising the temperature is l.



With temperature rise height of liquid in each arm increases *i.e.* $l_1 > l$ and $l_2 > l$

$$\text{Also } l = \frac{l_1}{1+\gamma t_1} = \frac{l_2}{1+\gamma t_2}$$

$$\Rightarrow \ l_1 + \gamma l_1 t_2 = l_2 + \gamma l_2 t_1 \ \Rightarrow \ \gamma = \frac{l_1 - l_2}{l_2 t_1 - l_1 t_2}.$$

19. **(a)** The rate of heat loss per unit area due to radiation $= \epsilon\sigma(T^4 - T_0^4)$
$= 0.6 \times 5.67 \times 10^{-8}\,[(400)^4 - (300)^4] = 595\ Jm^{-2}s^{-1}$.

20. **(d)** $t \propto \frac{\ell}{A} \quad t' \propto \frac{2\ell}{A/2}$

$$\frac{t'}{t} = 4\frac{\ell/A}{\ell/A}$$

$t' = 4 \times t$

$3/t' = 48s$

21. **(a)** The heat flow rate is given by

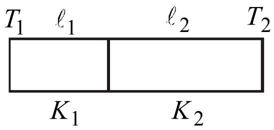
$$\frac{dQ}{dt} = \frac{kA(\theta_1 - \theta)}{x}$$

$$\Rightarrow \ \theta_1 - \theta = \frac{x}{kA}\frac{dQ}{dt} \ \Rightarrow \ \theta = \theta_1 - \frac{x}{kA}\frac{dQ}{dt}$$

where θ_1 is the temperature of hot end and θ is temperature at a distance x from hot end.

The above equation can be graphically represented by option (a).

22. **(d)** Let T be the temperature of the interface. As the two sections are in series, the rate of flow of heat in them will be equal.



$$\therefore \ \frac{K_1 A(T_1 - T)}{\ell_1} = \frac{K_2 A(T - T_2)}{\ell_2},$$

where A is the area of cross-section.

or, $\quad K_1 A(T_1 - T)\ell_2 = K_2 A(T - T_2)\ell_1$

or, $\quad K_1 T_1 \ell_2 - K_1 T \ell_2 = K_2 T \ell_1 - K_2 T_2 \ell_1$

or, $\quad (K_2\ell_1 + K_1\ell_2)T = K_1 T_1 \ell_2 + K_2 T_2 \ell_1$

$$\therefore \ T = \frac{K_1 T_1 \ell_2 + K_2 T_2 \ell_1}{K_2\ell_1 + K_1\ell_2} = \frac{K_1\ell_2 T_1 + K_2\ell_1 T_2}{K_1\ell_2 + K_2\ell_1}.$$

23. **(d)** Radius of small sphere = r

Thickness of small sphere = t

Radius of bigger sphere = 2r

Thickness of bigger sphere = t/4

Let K_1 and K_2 be the thermal conductivities of larger and smaller sphere.

For bigger sphere,

$$\frac{K_1 4\pi (2r)^2 \times 100}{t/4} = \frac{\frac{4}{3}\pi(2r)^3 \rho L}{25 \times 60}$$

For smaller sphere,

$$\frac{K_2 \times 4\pi r^2 \times 100}{t} = \frac{\frac{4}{3}\pi r^3 \rho L}{16 \times 60}$$

$$\therefore \frac{K_1}{K_2} = \frac{8}{25}$$

24. **(a)** $V + \Delta V = (L + \Delta L)^3 = (L + \alpha L\Delta T)^3$

$= L^3 + (1 + 3\alpha\Delta T + 3\alpha^2\Delta T^2 + \alpha^3\Delta T^3)$

$\Rightarrow$ α^2 and α^3 terms are neglected.

$\therefore$ $V(1 + \gamma\Delta T) = V(1 + 3\alpha\Delta T)$

$1 + \gamma\Delta T = 1 + 3\alpha\Delta T$

$\therefore \gamma = 3\alpha$.

25. **(d)** According to the principle of calorimetry.

Heat lost = Heat gained

$mL_v + ms_w\Delta\theta = m_w s_w \Delta\theta$

$\Rightarrow m \times 540 + m \times 1 \times (100 - 80)$

$= 20 \times 1 \times (80 - 10)$

$\Rightarrow m = 2.5$ g

Therefore total mass of water at 80°C

$= (20 + 2.5)$ g $= 22.5$ g

26. **(c)** From Newtwon's law of cooling

$$\frac{dQ}{dt} = -KA\frac{dT}{dx}$$

Area of cross-section A and thickness dx is the same.

Also $dQ = mCd\theta$

Thus in first case

$$\frac{m \times C \times (61° - 59°)}{4} = \frac{-KA}{dx}\left[\left(\frac{61° + 51°}{2}\right) - 30°\right] \quad \text{(i)}$$

In second case,

$$\frac{m \times C \times (51° - 49°)}{t} = \frac{-KA}{dx}\left[\left(\frac{51° + 49°}{2}\right) - 30°\right] \quad \text{(ii)}$$

Dividing equation (i) by equation (ii)

$$\frac{t}{4} = \frac{30}{20}$$

or $t = 6$ minutes.

27. **(d)** $\frac{Q}{t} = K_1A_1\frac{d\theta}{dx} = K_2A_2\frac{d\theta}{dx}$

28. **(c)** Since specific heat = 0.6 $kcal/g \times °C$ = 0.6 $cal/g \times °C$

From graph it is clear that in a minute, the temperature is raised from 0°C to 50°C.

$\Rightarrow$ Heat required for a minute $= 50 \times 0.6 \times 50 = 1500$ *cal*.

Also from graph, Boiling point of wax is 200°C.

29. **(b)** Temperature of B will be higher because, due to expansion centre of mass B will come down same heat is supplied but in B, Potential energy is decreased therefore internal energy gain will be more.

30. **(c)** In parallel combination, the equivalent thermal conductivity is given by

$$K = \frac{K_1A_1 + K_2A_2 + K_3A_3 + ... + K_nA_n}{A_1 + A_2 + A_3 + ... + A_n}$$

For two rods of equal area,

$$K = \frac{(K_1 + K_2)A}{2A} \qquad (\text{if } A_1 = A_2 = A)$$

$$\Rightarrow K = \frac{K_1 + K_2}{2}$$