# 10 Thermal Properties of Matter

## Conceptual MCQs

**1.** A beaker is completely filled with water at 4°C. It will overflow, if
(a) heated above 4°C
(b) cooled below 4°C
(c) both heated and cooled above and below 4°C respectively
(d) None of these

**2.** If a graph is plotted taking the temperature in Fahrenheit along Y-axis and the corresponding temperature in Celsius along the X-axis, it will be a straight line
(a) having a + ve intercept on Y-axis
(b) having a + ve intercept on X-axis
(c) passing through the origin
(d) having a – ve intercepts on both the axis

**3.** When a bimetallic strip is heated, it
(a) does not bend at all
(b) gets twisted in the form of an helix
(c) bend in the form of an arc with the more expandable metal outside
(d) bends in the form of an arc with the more expandable metal inside

**4.** An iron bar of length $l$ and having a cross-section A is heated from 0 to 100°C. If this bar is so held that it is not permitted to expand or bend, the force that is developed is
(a) inversely proportional to the cross-sectional area of the bar
(b) independent of the length of the bar
(c) inversely proportional to the length of the bar
(d) directly proportional to the length of the bar

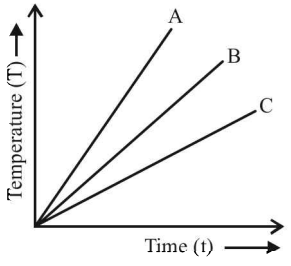
**5.** On centigrade scale the temperature of a body increases by 30 degrees. The increase in temperature on Fahrenheit scale
(a) 50° (b) 40° (c) 30° (d) 54°

**6.** A brass disc fits simply in a hole of a steel plate. The disc from the hole can be loosened if the system
(a) first heated then cooled
(b) first cooled then heated
(c) is heated
(d) is cooled

**7.** An iron bar of length 10 m is heated from 0°C to 100°C. If the coefficient of linear thermal expansion of iron is $10 \times 10^{-6}$ per °C, the increase in the length of bar is
(a) 0.5 cm (b) 1.0 cm (c) 1.5 cm (d) 2.0 cm

**8.** In order that the heat flows from one part of a solid to another part, what is required?
(a) Uniform density
(b) Temperature gradient
(c) Density gradient
(d) Uniform temperature

**9.** Which of the substances A, B or C has the highest specific heat? The temperature vs time graph is shown in figure,




(a) A
(b) B
(c) C
(d) All have equal specific heat

**10.** The ratio of the coefficient of thermal conductivity of two different materials is 5 : 3. If the thermal resistance of the two rods of these materials of same thickness is same, then the ratio of the length of these rods will be
(a) 5 : 3 (b) 3 : 5 (c) 9 : 25 (d) 25 : 9

**11.** Newton's law of cooling is a special case of
(a) Stefan's law (b) Kirchhoff's law
(c) Wien's law (d) Planck's law

**12.** Solar radiation emitted by sun resembles that emitted by a black body at a temperature of 6000 K. Maximum intensity is emitted at a wavelength of about 4800 Å. If the sun were to cool down from 6000 K to 3000K, then the peak intensity would occur at a wavelength of
(a) 4800 Å (b) 9600 Å (c) 7200 Å (d) 6400 Å

13. A metallic ball and highly stretched spring are made of the same material and have the same mass. They are heated so that they melt, the latent heat required
(a) are the same for both
(b) is greater for the ball
(c) is greater for the spring
(d) for the two may or may not be the same depending upon the metal

14. A cane is taken out from a refrigerator at 0°C. The atmospheric temperature is 25°C. If $t_1$ is the time taken to heat from 0°C to 5°C and $t_2$ is the time taken from 10°C to 15°C, then
(a) $t_1 > t_2$ (b) $t_1 < t_2$
(c) $t_1 = t_2$ (d) there is no relation

15. What temperature is the same on celsius scale as well as on Fahrenheit scale?
(a) −212°C (b) −40°C (c) −32°C (d) 32°C

## Application Based MCQs

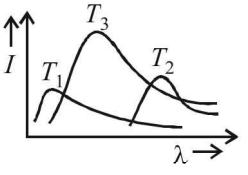
16. The length of a metallic rod is 5 m at 0°C and becomes 5.01 m, on heating upto 100°C. The coefficient of linear expansion of the metal will be
(a) $2.33 \times 10^{-5}$/°C (b) $6.0 \times 10^{-5}$/°C
(c) $4.0 \times 10^{-5}$/°C (d) $2.0 \times 10^{-5}$/°C

17. Two rods of same length and material transfer a given amount of heat in 12 seconds, when they are joined end to end. But when they are joined lengthwise, then they will transfer same heat in same conditions in
(a) 24s (b) 3 s (c) 1.5 s (d) 48 s

18. Two rods, one of aluminum and the other made of steel, having initial length $\ell_1$ and $\ell_2$ are connected together to form a single rod of length $\ell_1 + \ell_2$. The coefficients of linear expansion for aluminum and steel are $\alpha_a$ and $\alpha_s$ and respectively. If the length of each rod increases by the same amount when their temperature are raised by $t$°C, then find the ratio $\ell_1/(\ell_1 + \ell_2)$
(a) $\alpha_s/\alpha_a$ (b) $\alpha_a/\alpha_s$
(c) $\alpha_s/(\alpha_a+\alpha_s)$ (d) $\alpha_a/(\alpha_a+\alpha_s)$

19. The coefficient of apparent expansion of a liquid when determined using two different vessels A and B are $\gamma_1$ and $\gamma_2$ respectively. If the coefficient of linear expansion of the vessel A is $\alpha$, the coefficient of linear expension of the vessel B is
(a) $\frac{a\gamma_1\gamma_2}{\gamma_1+\gamma_2}$ (b) $\frac{\gamma_1-\gamma_2}{2a}$
(c) $\frac{\gamma_1-\gamma_2+a}{3}$ (d) $\frac{\gamma_1-\gamma_2}{3}+a$

20. 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) $T_3 > T_2 > T_1$

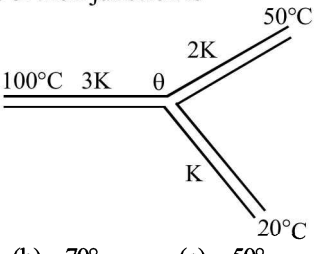



21. Three bodies of the same material and having masses m, m and 3m are at temperature 40°C, 50°C and 60°C respectively. If the bodies are brought in thermal contact, the final temperature will be
(a) 45°C (b) 54°C (c) 52°C (d) 48°C

22. A hammer of mass 1 kg having speed of 50 m/s, hit a iron nail of mass 200 g. If specific heat of iron is 0.105 cal/gm°C and half the energy is converted into heat, the raise in temperature of nail is
(a) 7.1°C (b) 9.2°C (c) 10.5°C (d) 12.1°C

23. A black metal foil is warmed by radiation from a small sphere at temperature T and at a distance d. It is found that the power recieved by the foil is 'P' . If both the temperature and the distance are doubled , the power recieved by the foil will be
(a) 16P (b) 4P (c) 2P (d) P

24. Three rods of the same dimensions have thermal conductivities 3K, 2K and K. They are arranged as shown in fig. with their ends at 100°C, 50°C and 20°C. The temperature of their junction is




(a) 60° (b) 70° (c) 50° (d) 35°

25. 50 g of copper is heated to increase its temperature by 10°C. If the same quantity of heat is given to 10 g of water, the rise in its temperature is (Specific heat of copper = 420 joule-kg$^{-1}$°C$^{-1}$)
(a) 5°C (b) 6°C (c) 7°C (d) 8°C

26. The ratio of radiant energies radiated per unit surface area by two bodies is 16 : 1, the temperature of hotter body is 1000 K, then the temperature of colder body will be
(a) 250 K (b) 500 K (c) 1000 K (d) 62.5 K

27. From what height should a piece of ice fall so that it melts completely? Only one-half of the heat produced absorbed by the ice. The latent heat of ice is $3.4 \times 10^5$ J/kg and g = 10 N/kg.
(a) 36 km (b) 40 km (c) 68 km (d) 53 km

28. The temperature of equal masses of three different liquids A, B and C are 12°C, 19°C and 28°C respectively. The temperature when A and B are mixed is 16°C and when B and C are mixed is 23°C . The temperature when A and C are mixed is
(a) 18.2°C (b) 22°C (c) 20.2°C (d) 25.2°C

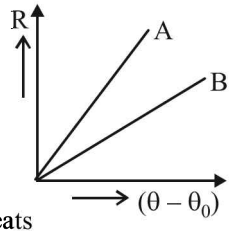
**29.** 0.1 $m^3$ of water at 80°C is mixed with 0.3 $m^3$ of water at 60°C. The final temperature of the mixture is
(a) 65°C (b) 70°C (c) 60°C (d) 75°C

**30.** A block of mass 100 g slides on a rough horizontal surface. If the speed of the block decreases from 10 m/s to 5 m/s, the thermal energy developed in the process is
(a) 3.75 J (b) 37.5 J (c) 0.375 J (d) 0.75 J

**31.** A body initially at 80°C cools to 64°C in 5 minutes and to 52°C in 10 minutes. The temperature of the body after 15 minutes will be :
(a) 42.7°C (b) 35°C (c) 47°C (d) 40°C

**32.** A body cools from 50.0°C to 49.9°C in 5s. How long will it take to cool from 40.0°C to 39.9°C? Assume the temperature of surroundings to be 30.0°C and Newton's law of cooling to be valid
(a) 2.5 s (b) 10 s (c) 20 s (d) 5 s

**33.** Two circular discs A and B with equal radii are blackened. They are heated to same temperature and are cooled under identical conditions. What inference do you draw from their cooling curves?




(a) A and B have same specific heats
(b) Specific heat of A is less
(c) Specific heat of B is less
(d) Nothing can be said

**34.** Three objects coloured black, grey and white can withstand hostile conditions up to 2800°C. These objects are thrown into a furnace where each of them attains a temperature of 2000°C. Which object will glow brightest?
(a) The white object
(b) The black object
(c) All glow with equal brightness
(d) Grey object

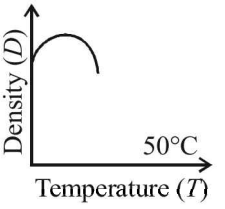
**35.** A wall has two layers *A* and *B* made of different materials. The thickness of both layers is the same. The thermal conductivity of *A* and *B* are $K_A$ and $K_B$ such that $K_A = 3K_B$. The temperature across the wall is 20°C. In thermal equilibrium
(a) the temperature difference across *A* 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*

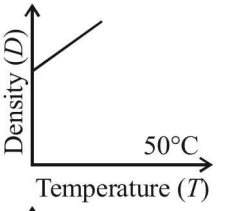
**36.** A vessel completely filled with a liquid is heated. If $\alpha$ and $\gamma$ represent coefficient of linear expansion of material of vessel and coefficient of cubical expansion of liquid respectively, then the liquid will not overflow if
(a) $\gamma = 3\alpha$ (b) $\gamma > 3\alpha$ (c) $\gamma < 3\alpha$ (d) $\gamma \leq 3\alpha$

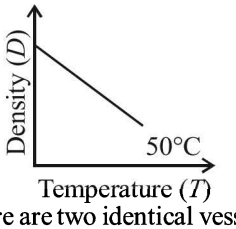
**37.** A particular star (assuming it as a black body) has a surface temperature of about $5 \times 10^4$ K. The wavelength in nanometers at which its radiation becomes maximum is (b = 0.0029 mK)
(a) 48 (b) 58 (c) 60 (d) 70

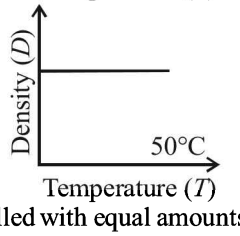
**38.** Density of substance at 0°C is 10g/cc and at 100°C, its density is 9.7g/cc. The coefficient of linear expansion in $°C^{-1}$ of the substance will be
(a) $10^2$ (b) $10^{-2}$ (c) $10^{-3}$ (d) $10^{-4}$

**39.** Which one of the figures gives the temperature dependence of density of water correctly?

(a)



(b)



(c)



(d)



**40.** There are two identical vessels filled with equal amounts of ice. The vessels are of different metals. If the ice melts in the two vessels in 20 and 35 minutes respectively, the ratio of the coefficients of thermal conductivity of the two metals is
(a) 4 : 7 (b) 7 : 4 (c) 16 : 49 (d) 49 : 16

## Skill Based MCQs

**41.** A piece of ice (heat capacity = 2100 J $kg^{-1}$ $°C^{-1}$ and latent heat = $3.36 \times 10^5$ J $kg^{-1}$) of mass m grams is at –5°C at atmospheric pressure. It is given 420 J of heat so that the ice starts melting. Finally when the ice-water mixture is in equilibrium, it is found that 1 gm of ice has melted. Assuming there is no other heat exchange in the process, the value of m is
(a) 4 (b) 8 (c) 2 (d) 5

**42.** Three very large plates of same area are kept parallel and close to each other. They are considered as ideal black surfaces and have very high thermal conductivity. The first and third plates are maintained at temperatures 2*T* and 3*T* respectively. The temperature of the middle (i.e. second) plate under steady state condition is

(a) $\left(\frac{65}{2}\right)^{1/4} T$ (b) $\left(\frac{97}{4}\right)^{1/4} T$

(c) $\left(\frac{97}{2}\right)^{1/4} T$ (d) $(97)^{1/4} T$

**43.** A clock with a metal pendulum beating seconds keeps correct time at 0°C. If it loses 12.5 s a day at 25°C, the coefficient of linear expansion of metal pendulum is

(a) $\frac{1}{86400}/°C$ (b) $\frac{1}{43200}/°C$

(c) $\frac{1}{14400}/°C$ (d) $\frac{1}{28800}/°C$

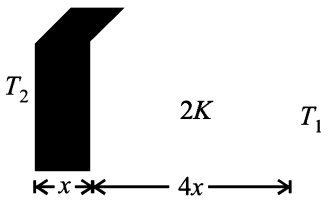
**44.** The temperature of the two outer surfaces of a composite slab, consisting of two materials having coefficients of thermal conductivity $K$ and $2K$ and thickness $x$ and $4x$, respectively are $T_2$ and $T_1$ ($T_2 > T_1$). The rate of heat transfer through the slab, in a steady state is $\left(\frac{A(T_2 - T_1)K}{x}\right)f$, with $f$ equal to

(a) 1

(b) $\frac{1}{2}$

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

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



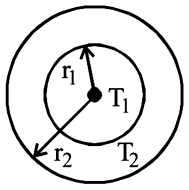

**45.** The figure shows a system of two concentric spheres of radii $r_1$ and $r_2$ are kept at temperatures $T_1$ and $T_2$, respectively. The radial rate of flow of heat in a substance between the two concentric spheres is proportional to

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

(b) $\frac{(r_2 - r_1)}{(r_1 r_2)}$

(c) $(r_2 - r_1)$

(d) $\frac{r_1 r_2}{(r_2 - r_1)}$




**46.** A bimetallic strip is formed out of two identical strips, one of copper and other of brass. The coefficients of linear expansion of the two metals are $\alpha_C$ and $\alpha_B$. On heating the temperature of the strip goes up by $\Delta T$ and the strip bends to form an arc of radius of curvature $R$. Then $R$ is

(a) proportional to $\Delta T$

(b) independent of $\Delta T$

(c) proportional to $|\alpha_B - \alpha_C|$

(d) inversely proportional to $|\alpha_B - \alpha_C|$

**47.** A 2 kg copper block is heated to 500°C and then it is placed on a large block of ice at 0°C. If the specific heat capacity of copper is 400 J/kg°C and latent heat of fusion of water is $3.5 \times 10^5$ J/kg, the amount of ice that can melt is

(a) (7/8) kg (b) (7/5) kg

(c) (8/7) kg (d) (5/7) kg

**48.** 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) 2αΔt (b) αΔt (c) $\frac{\alpha \Delta t}{2}$ (d) $\frac{\Delta t}{\alpha}$

**49.** An iron tyre is to be fitted on to a wooden wheel 1m in diameter. The diameter of tyre is 6 mm smaller than that of wheel. The tyre should be heated so that its temperature increases by a minimum of (the coefficient of cubical expansion of iron is $3.6 \times 10^{-5}$/°C)

(a) 167°C (b) 334°C (c) 500°C (d) 1000°C

**50.** 19 g of water at 30°C and 5 g of ice at –20°C are mixed together in a calorimeter. What is the final temperature of the mixture? Given specific heat of ice = 0.5 cal $g^{-1}$ $°C^{-1}$ and latent heat of fusion of ice = 80 cal $g^{-1}$

(a) 0°C (b) –5°C (c) 5°C (d) 10°C

## ANSWER KEY

**Conceptual MCQs**

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | (c) | **3** | (c) | **5** | (d) | **7** | (b) | **9** | (c) | **11** | (a) | **13** | (a) | **15** | (b) | | | | |
| **2** | (a) | **4** | (b) | **6** | (d) | **8** | (b) | **10** | (a) | **12** | (b) | **14** | (b) | | | | | | |

**Application Based MCQs**

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **16** | (d) | **19** | (d) | **22** | (a) | **25** | (a) | **28** | (c) | **31** | (a) | **34** | (b) | **37** | (b) | **40** | (b) | | |
| **17** | (b) | **20** | (b) | **23** | (b) | **26** | (b) | **29** | (a) | **32** | (b) | **35** | (b) | **38** | (d) | | | | |
| **18** | (c) | **21** | (b) | **24** | (b) | **27** | (c) | **30** | (a) | **33** | (b) | **36** | (d) | **39** | (a) | | | | |

**Skill Based MCQs**

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **41** | (b) | **42** | (c) | **43** | (a) | **44** | (d) | **45** | (d) | **46** | (d) | **47** | (c) | **48** | (a) | **49** | (c) | **50** | (c) |