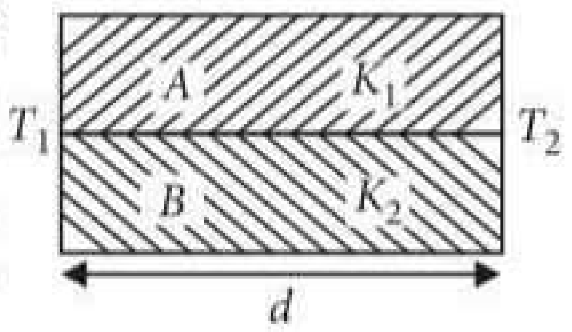
Chapter 8. Properties of Matter

1. Two rods A and B of different materials are welded together as shown in figure. Their thermal conductivities are K_1 and K_2. The thermal conductivity of the composite rod will be



(a) $\dfrac{3(K_1+K_2)}{2}$ (b) K_1+K_2

(c) $2(K_1+K_2)$ (d) $\dfrac{K_1+K_2}{2}$

(NEET 2017)

2. A spherical black body with a radius of 12 cm radiates 450 watt power at 500 K. If the radius were halved and the temperature doubled, the power radiated in watt would be

(a) 450 (b) 1000 (c) 1800 (d) 225

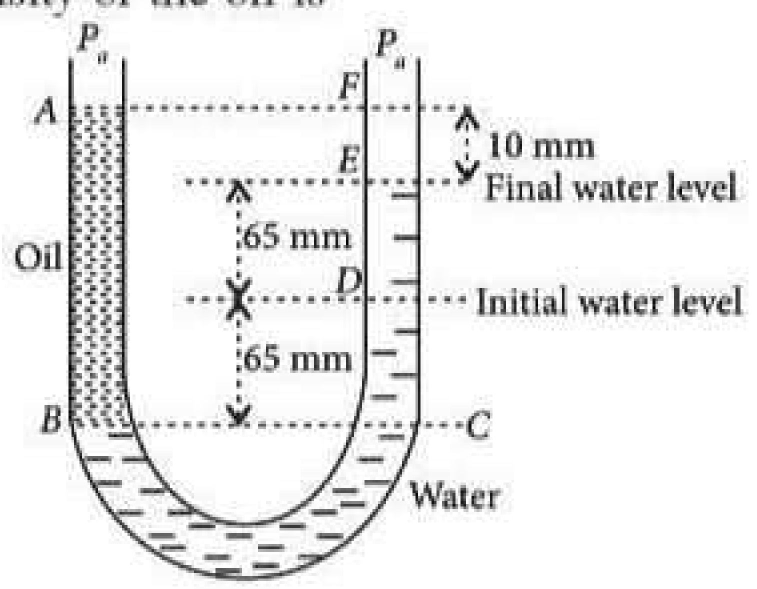
(NEET 2017)

3. The bulk modulus of a spherical object is 'B'. If it is subjected to uniform pressure 'p', the fractional decrease in radius is

(a) $\dfrac{B}{3p}$ (b) $\dfrac{3p}{B}$ (c) $\dfrac{p}{3B}$ (d) $\dfrac{p}{B}$

(NEET 2017)

4. A U tube with both ends open to the atmosphere, is partially filled with water. Oil, which is immiscible with water, is poured into one side until it stands at a distance of 10 mm above the water level on the other side. Meanwhile the water rises by 65 mm from its original level (see diagram). The density of the oil is



(a) 425 kg m^{-3} (b) 800 kg m^{-3}

(c) 928 kg m^{-3} (d) 650 kg m^{-3}

(NEET 2017)

5. A rectangular film of liquid is extended from (4 cm × 2 cm) to (5 cm × 4 cm). If the work done is 3×10^{-4} J, the value of the surface tension of the liquid is

(a) 0.250 N m^{-1} (b) 0.125 N m^{-1}

(c) 0.2 N m^{-1} (d) 8.0 N m^{-1}

(NEET-II 2016)

6. Three liquids of densities ρ_1, ρ_2 and ρ_3 (with $\rho_1 > \rho_2 > \rho_3$), having the same value of surface tension T, rise to the same height in three identical capillaries. The angles of contact θ_1, θ_2 and θ_3 obey

(a) $\dfrac{\pi}{2} > \theta_1 > \theta_2 > \theta_3 \geq 0$

(b) $0 \leq \theta_1 < \theta_2 < \theta_3 < \dfrac{\pi}{2}$

(c) $\dfrac{\pi}{2} < \theta_1 < \theta_2 < \theta_3 < \pi$

(d) $\pi > \theta_1 > \theta_2 > \theta_3 > \dfrac{\pi}{2}$ *(NEET-II 2016)*

7. Two identical bodies are made of a material for which the heat capacity increases with temperature. One of these is at 100 °C, while the other one is at 0 °C. If the two bodies are brought into contact, then, assuming no heat loss, the final common temperature is

(a) 50 °C

(b) more than 50 °C

(c) less than 50 °C but greater than 0 °C

(d) 0 °C *(NEET-II 2016)*

8. A body cools from a temperature $3T$ to $2T$ in 10 minutes. The room temperature is T. Assume that Newton's law of cooling is applicable. The temperature of the body at the end of next 10 minutes will be

(a) $\dfrac{7}{4}T$ (b) $\dfrac{3}{2}T$ (c) $\dfrac{4}{3}T$ (d) T

(NEET-II 2016)

9. Coefficient of linear expansion of brass and steel rods are α_1 and α_2. Lengths of brass and steel rods are l_1 and l_2 respectively. If $(l_2 - l_1)$ is maintained same at all temperatures, which one of the following relations holds good?

(a) $\alpha_1^2 l_2 = \alpha_2^2 l_1$ (b) $\alpha_1 l_1 = \alpha_2 l_2$
(c) $\alpha_1 l_2 = \alpha_2 l_1$ (d) $\alpha_1 l_2^2 = \alpha_2 l_1^2$

(NEET-I 2016, 1999)

10. A piece of ice falls from a height h so that it melts completely. Only one-quarter of the heat produced is absorbed by the ice and all energy of ice gets converted into heat during its fall. The value of h is [Latent heat of ice is 3.4×10^5 J/ kg and $g = 10$ N/kg]

(a) 136 km (b) 68 km
(c) 34 km (d) 544 km

(NEET-I 2016)

11. A black body is at a temperature of 5760 K. The energy of radiation emitted by the body at wavelength 250 nm is U_1, at wavelength 500 nm is U_2 and that at 1000 nm is U_3. Wien's constant, $b = 2.88 \times 10^6$ nm K. Which of the following is correct?

(a) $U_1 > U_2$ (b) $U_2 > U_1$
(c) $U_1 = 0$ (d) $U_3 = 0$

(NEET-I 2016)

12. Two non-mixing liquids of densities ρ and $n\rho$ $(n > 1)$ are put in a container. The height of each liquid is h. A solid cylinder of length L and density d is put in this container. The cylinder floats with its axis vertical and length pL $(p < 1)$ in the denser liquid. The density d is equal to

(a) $\{2 + (n - 1)p\}\rho$ (b) $\{1 + (n - 1)p\}\rho$
(c) $\{1 + (n + 1)p\}\rho$ (d) $\{2 + (n + 1)p\}\rho$

(NEET-I 2016)

13. The cylindrical tube of a spray pump has radius R, one end of which has n fine holes, each of radius r. If the speed of the liquid in the tube is V, the speed of the ejection of the liquid through the holes is

(a) $\dfrac{VR^2}{n^3 r^2}$ (b) $\dfrac{V^2 R}{nr}$ (c) $\dfrac{VR^2}{n^2 r^2}$ (d) $\dfrac{VR^2}{nr^2}$

(2015)

14. Water rises to a height h in capillary tube. If the length of capillary tube above the surface of water is made less than h, then

(a) water rises upto a point a little below the top and stays there.
(b) water does not rise at all.
(c) water rises upto the tip of capillary tube and then starts overflowing like a fountain.
(d) water rises upto the top of capillary tube and stays there without overflowing.

(2015)

15. The value of coefficient of volume expansion of glycerin is 5×10^{-4} K^{-1}. The fractional change in the density of glycerin for a rise of 40°C in its temperature, is

(a) 0.025 (b) 0.010 (c) 0.015 (d) 0.020

(2015)

16. The Young's modulus of steel is twice that of brass. Two wires of same length and of same area of cross section, one of steel and another of brass are suspended from the same roof. If we want the lower ends of the wires to be at the same level, then the weights added to the steel and brass wires must be in the ratio of

(a) 4 : 1 (b) 1 : 1 (c) 1 : 2 (d) 2 : 1

(2015)

17. The two ends of a metal rod are maintained at temperatures 100°C and 110°C. The rate of heat flow in the rod is found to be 4.0 J/s. If the ends are maintained at temperatures 200°C and 210°C, the rate of heat flow will be

(a) 8.0 J/s (b) 4.0 J/s
(c) 44.0 J/s (d) 16.8 J/s

(2015 Cancelled)

18. A wind with speed 40 m/s blows parallel to the roof of a house. The area of the roof is 250 m^2. Assuming that the pressure inside the house is atmospheric pressure, the force exerted by the wind on the roof and the direction of the force will be $(\rho_{air} = 1.2$ kg/m$^3)$

(a) 2.4×10^5 N, upwards
(b) 2.4×10^5 N, downwards
(c) 4.8×10^5 N, downwards
(d) 4.8×10^5 N, upwards *(2015 Cancelled)*

19. 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 temperatures of P, Q and R, then it can be concluded from the above observations that

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

(2015 Cancelled)

20. The approximate depth of an ocean is 2700 m. The compressibility of water is 45.4×10^{-11} Pa^{-1} and density of water is 10^3 kg/m^3. What fractional compression of water will be obtained at the bottom of the ocean?
(a) 1.2×10^{-2} (b) 1.4×10^{-2}
(c) 0.8×10^{-2} (d) 1.0×10^{-2}
(2015 Cancelled)

21. Copper of fixed volume V is drawn into wire of length l. When this wire is subjected to a constant force F, the extension produced in the wire is Δl. Which of the following graphs is a straight line?
(a) Δl versus $1/l$ (b) Δl versus l^2
(c) Δl versus $1/l^2$ (d) Δl versus l *(2014)*

22. A certain number of spherical drops of a liquid of radius r coalesce to form a single drop of radius R and volume V. If T is the surface tension of the liquid, then
(a) energy $= 4VT\left(\frac{1}{r}-\frac{1}{R}\right)$ is released.
(b) energy $= 3VT\left(\frac{1}{r}+\frac{1}{R}\right)$ is absorbed.
(c) energy $= 3VT\left(\frac{1}{r}-\frac{1}{R}\right)$ is released.
(d) energy is neither released nor absorbed.
(2014)

23. 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
(2014)

24. Certain quantity of water cools from 70°C to 60°C in the first 5 minutes and to 54°C in the next 5 minutes. The temperature of the surroundings is
(a) 45°C (b) 20°C (c) 42°C (d) 10°C
(2014)

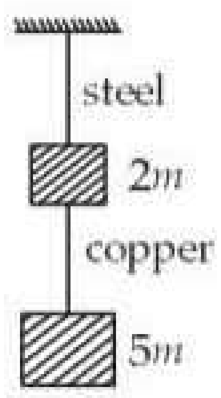
25. A piece of iron is heated in a flame. It first becomes dull red then becomes reddish yellow and finally turns to white hot. The correct explanation for the above observation is possible by using
(a) Kirchhoff's Law
(b) Newton's Law of cooling
(c) Stefan's Law
(d) Wien's displacement Law *(NEET 2013)*

26. The wettability of a surface by a liquid depends primarily on
(a) density
(b) angle of contact between the surface and the liquid
(c) viscosity
(d) surface tension *(NEET 2013)*

27. The following four wires are made of the same material. Which of these will have the largest extension when the same tension is applied?
(a) length = 200 cm, diameter = 2 mm
(b) length = 300 cm, diameter = 3 mm
(c) length = 50 cm, diameter = 0.5 mm
(d) length = 100 cm, diameter = 1 mm
(NEET 2013)

28. The molar specific heats of an ideal gas at constant pressure and volume are denoted by C_p and C_v respectively. If $\gamma = \frac{C_p}{C_v}$ and R is the universal gas constant, then C_v is equal to
(a) $\frac{(\gamma-1)}{R}$ (b) γR
(c) $\frac{1+\gamma}{1-\gamma}$ (d) $\frac{R}{(\gamma-1)}$ *(NEET 2013)*

29. If the ratio of diameters, lengths and Young's modulus of steel and copper wires shown in the figure are p, q and s respectively, then the corresponding ratio of increase in their lengths would be



(a) $\frac{5q}{(7sp^2)}$ (b) $\frac{7q}{(5sp^2)}$
(c) $\frac{2q}{(5sp)}$ (d) $\frac{7q}{(5sp)}$
(Karnataka NEET 2013)

30. Two metal rods 1 and 2 of same lengths have same temperature difference between their ends. Their thermal conductivities are K_1 and K_2 and cross sectional areas A_1 and A_2, respectively. If the rate of heat conduction in 1 is four times that in 2, then
(a) $K_1A_1 = 4K_2A_2$ (b) $K_1A_1 = 2K_2A_2$
(c) $4K_1A_1 = K_2A_2$ (d) $K_1A_1 = K_2A_2$
(Karnataka NEET 2013)

31. A fluid is in streamline flow across a horizontal pipe of variable area of cross section. For this which of the following statements is correct?

(a) The velocity is maximum at the narrowest part of the pipe and pressure is maximum at the widest part of the pipe.
(b) Velocity and pressure both are maximum at the narrowest part of the pipe.
(c) Velocity and pressure both are maximum at the widest part of the pipe.
(d) The velocity is minimum at the narrowest part of the pipe and the pressure is minimum at the widest part of the pipe.

(Karnataka NEET 2013)

32. The density of water at 20°C is 998 kg/m^3 and at 40°C is 992 kg/m^3. The coefficient of volume expansion of water is

(a) 3×10^{-4}/°C (b) 2×10^{-4}/°C
(c) 6×10^{-4}/°C (d) 10^{-4}/°C

(Karnataka NEET 2013)

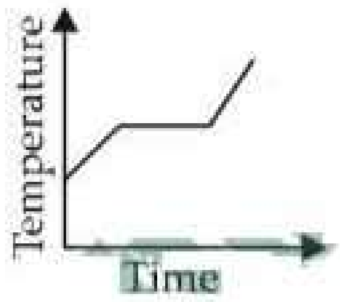
33. If the radius of a star is R and it acts as a black body, what would be the temperature of the star, in which the rate of energy production is Q?

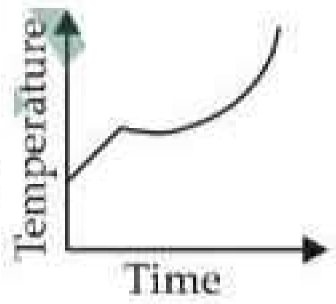
(a) $\dfrac{Q}{4\pi R^2\sigma}$ (b) $\left(\dfrac{Q}{4\pi R^2\sigma}\right)^{-1/2}$

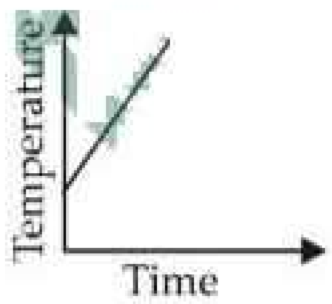
(c) $\left(\dfrac{4\pi R^2 Q}{\sigma}\right)^{1/4}$ (d) $\left(\dfrac{Q}{4\pi R^2\sigma}\right)^{1/4}$

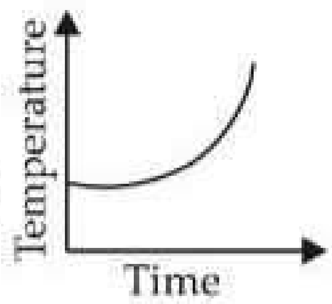
(σ stands for Stefan's constant) *(2012)*

34. Liquid oxygen at 50 K is heated to 300 K at constant pressure of 1 atm. The rate of heating is constant. Which one of the following graphs represents the variation of temperature with time?

(a)


(b)


(c)


(d)


(2012)

35. A slab of stone of area 0.36 m^2 and thickness 0.1 m is exposed on the lower surface to steam at 100°C. A block of ice at 0°C rests on the upper surface of the slab. In one hour 4.8 kg of ice is melted. The thermal conductivity of slab is

(Given latent heat of fusion of ice $= 3.36 \times 10^5$ J kg^{-1})

(a) 1.24 J/m/s/°C (b) 1.29 J/m/s/°C
(c) 2.05 J/m/s/°C (d) 1.02 J/m/s/°C

(Mains 2012)

36. 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) $\dfrac{Q}{4}$ (b) $\dfrac{Q}{16}$ (c) $2Q$ (d) $\dfrac{Q}{2}$

(2010)

37. 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

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

(where σ is Stefan's constant) *(2010)*

38. Assuming the sun to have a spherical outer surface of radius r, radiating like a black body at temperature t°C, the power received by a unit surface, (normal to the incident rays) at a distance R from the centre of the sun is

(a) $\dfrac{r^2\sigma(t+273)^4}{4\pi R^2}$ (b) $\dfrac{16\pi^2 r^2 \sigma t^4}{R^2}$

(c) $\dfrac{r^2\sigma(t+273)^4}{R^2}$ (d) $\dfrac{4\pi r^2 \sigma t^4}{R^2}$

where σ is the Stefan's constant.

(2010, 2007)

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

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

(2009)

40. 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, $\dfrac{dQ}{dt}$, through the rod in a steady state is given by

(a) $\dfrac{dQ}{dt} = \dfrac{k\,(T_1 - T_2)}{LA}$

(b) $\frac{dQ}{dt} = kLA(T_1 - T_2)$

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

(d) $\frac{dQ}{dt} = \frac{kL(T_1 - T_2)}{A}$ *(2009)*

41. On a new scale of temperature (which is linear) and called the *W* scale, the freezing and boiling points of water are 39°W and 239°W respectively. What will be the temperature on the new scale, corresponding to a temperature of 39°C on the Celsius scale ?

(a) 200°W (b) 139°W
(c) 78°W (d) 117°W *(2008)*

42. A black body is at 727°C. It emits energy at a rate which is proportional to

(a) $(1000)^4$ (b) $(1000)^2$
(c) $(727)^4$ (d) $(727)^2$. *(2007)*

43. A black body at 1227°C emits radiations with maximum intensity at a wavelength of 5000 Å. If the temperature of the body is increased by 1000°C, the maximum intensity will be observed at

(a) 3000 Å (b) 4000 Å
(c) 5000 Å (d) 6000 Å. *(2006)*

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

(a) $r = r_0,\ l = l_0$ (b) $r = 2r_0,\ l = l_0$
(c) $r = r_0,\ l = 2l_0$ (d) $r = 2r_0,\ l = 2l_0$. *(2005)*

45. If λ_m denotes the wavelength at which the radiative emission from a black body at a temperature *T* K is maximum, then

(a) $\lambda_m \propto T^4$ (b) λ_m is independent of *T*
(c) $\lambda_m \propto T$ (d) $\lambda_m \propto T^{-1}$ *(2004)*

46. Consider a compound slab consisting of two different materials having equal thicknesses and thermal conductivities *K* and 2*K*, respectively. The equivalent thermal conductivity of the slab is

(a) $\frac{2}{3}K$ (b) $\sqrt{2}\,K$ (c) $3K$ (d) $\frac{4}{3}K$ *(2003)*

47. 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^2K^4. *(2002)*

48. Consider two rods of same length and different specific heats (S_1, S_2), conductivities (K_1, K_2) and area of cross-sections (A_1, A_2) and both having temperatures T_1 and T_2 at their ends. If rate of loss of heat due to conduction is equal, then

(a) $K_1A_1 = K_2A_2$ (b) $\frac{K_1A_1}{S_1} = \frac{K_2A_2}{S_2}$
(c) $K_2A_1 = K_1A_2$ (d) $\frac{K_2A_1}{S_2} = \frac{K_1A_2}{S_1}$. *(2002)*

49. For a black body at temperature 727°C, its radiating power is 60 watt and temperature of surrounding is 227°C. If temperature of black body is changed to 1227°C then its radiating power will be

(a) 304 W (b) 320 W
(c) 240 W (d) 120 W. *(2002)*

50. Which of the following is best close to an ideal black body?

(a) black lamp
(b) cavity maintained at constant temperature
(c) platinum black
(d) a lump of charcoal heated to high temperature. *(2002)*

51. The Wien's displacement law express relation between

(a) wavelength corresponding to maximum energy and temperature
(b) radiation energy and wavelength
(c) temperature and wavelength
(d) colour of light and temperature. *(2002)*

52. A cylindrical rod having temperature T_1 and T_2 at its end. The rate of flow of heat Q_1 cal/sec. If all the linear dimension are doubled keeping temperature constant, then rate of flow of heat Q_2 will be

(a) $4Q_1$ (b) $2Q_1$ (c) $\frac{Q_1}{4}$ (d) $\frac{Q_1}{2}$. *(2001)*

53. A black body has maximum wavelength λ_m at 2000 K. Its corresponding wavelength at 3000 K will be

(a) $\frac{3}{2}\lambda_m$ (b) $\frac{2}{3}\lambda_m$
(c) $\frac{16}{81}\lambda_m$ (d) $\frac{81}{16}\lambda_m$. *(2000)*

54. If 1 g of steam is mixed with 1 g of ice, then resultant temperature of the mixture is
(a) 100°C (b) 230°C
(c) 270°C (d) 50°C *(1999)*

55. The radiant energy from the sun, incident normally at the surface of earth is 20 kcal/m^2 min. What would have been the radiant energy, incident normally on the earth, if the sun had a temperature, twice of the present one?
(a) 320 kcal/m^2 min (b) 40 kcal/m^2 min
(c) 160 kcal/m^2 min (d) 80 kcal/m^2 min
(1998)

56. A black body is at a temperature of 500 K. It emits energy at a rate which is proportional to
(a) $(500)^3$ (b) $(500)^4$ (c) 500 (d) $(500)^2$.
(1997)

57. A beaker full of hot water is kept in a room. If 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) $t_1 < t_2 = t_3$.
(1995)

58. Heat is flowing through two cylindrical rods of the same material. The diameters of the rods are in the ratio 1 : 2 and the lengths in the ratio 2 : 1. If the temperature difference between the ends is same, then ratio of the rate of flow of heat through them will be
(a) 2 : 1 (b) 8 : 1 (c) 1 : 1 (d) 1 : 8.
(1995)

59. If the temperature of the sun is doubled, the rate of energy recieved on earth will be increased by a factor of
(a) 2 (b) 4
(c) 8 (d) 16 *(1993)*

60. Mercury thermometer can be used to measure temperature upto
(a) 260°C (b) 100°C
(c) 360°C (d) 500°C *(1992)*

61. A Centigrade and a Fahrenheit thermometer are dipped in boiling water. The water temperature is lowered until the Fahrenheit thermometer registers 140°F. What is the fall in temperature as registered by the centigrade thermometer ?
(a) 80°C (b) 60°C
(c) 40°C (d) 30°C *(1990)*

62. Thermal capacity of 40 g of aluminum ($s = 0.2$ cal/g K) is
(a) 168 J/K (b) 672 J/K
(c) 840 J/K (d) 33.6 J/K *(1990)*

63. 10 gm of ice cubes at 0° C are released in a tumbler (water equivalent 55 g) at 40° C. Assuming that negligible heat is taken from the surroundings, the temperature of water in the tumbler becomes nearely (L = 80 cal/g)
(a) 31 °C
(b) 22 °C
(c) 19 °C
(d) 15 °C *(1988)*

Answer Key

1.	(d)	**2.**	(c)	**3.**	(c)	**4.**	(c)	**5.**	(b)	**6.**	(b)	**7.**	(b)	**8.**	(b)	**9.**	(b)	**10.**	(a)
11.	(b)	**12.**	(b)	**13.**	(d)	**14.**	(d)	**15.**	(d)	**16.**	(d)	**17.**	(b)	**18.**	(a)	**19.**	(d)	**20.**	(a)
21.	(b)	**22.**	(c)	**23.**	(d)	**24.**	(a)	**25.**	(d)	**26.**	(b)	**27.**	(c)	**28.**	(d)	**29.**	(b)	**30.**	(a)
31.	(a)	**32.**	(a)	**33.**	(d)	**34.**	(a)	**35.**	(a)	**36.**	(b)	**37.**	(a)	**38.**	(c)	**39.**	(b)	**40.**	(c)
41.	(d)	**42.**	(a)	**43.**	(a)	**44.**	(b)	**45.**	(d)	**46.**	(a)	**47.**	(d)	**48.**	(a)	**49.**	(b)	**50.**	(b)
51.	(a)	**52.**	(b)	**53.**	(b)	**54.**	(a)	**55.**	(a)	**56.**	(b)	**57.**	(a)	**58.**	(d)	**59.**	(d)	**60.**	(c)
61.	(c)	**62.**	(d)	**63.**	(b)														

EXPLANATIONS

1. **(d)** : Equivalent thermal conductivity of the composite rod in parallel combination will be,

$$K = \frac{K_1A_1 + K_2A_2}{A_1 + A_2} = \frac{K_1 + K_2}{2}$$

2. **(c)** : According to Stefan-Boltzman law, rate of energy radiated by a black body is given as

$E = \sigma AT^4 = \sigma 4\pi R^2T^4$

Given $E_1 = 450$ W, $T_1 = 500$ K, $R_1 = 12$ cm

$$R_2 = \frac{R_1}{2}, T_2 = 2T_1, E_2 = ?$$

$$\frac{E_2}{E_1} = \frac{\sigma 4\pi R_2^2 T_2^4}{\sigma 4\pi R_1^2 T_1^4} = \left(\frac{R_2}{R_1}\right)^2\left(\frac{T_2}{T_1}\right)^4$$

$$\frac{E_2}{E_1} = \frac{1}{4}\times 16 = 4$$

$$E_2 = E_1 \times 4 = 450 \times 4 = 1800 \text{ W}$$

3. **(c)** : Bulk modulus B is given as

$$B = \frac{-pV}{\Delta V} \quad ...(i)$$

The volume of a spherical object of radius r is given as

$$V = \frac{-pV}{\Delta V}, \Delta V = \frac{4}{3}\pi(3r^2)\Delta r$$

$$\therefore \quad -\frac{V}{\Delta V} = \frac{\frac{4}{3}\pi r^3}{\frac{4}{3}\pi 3r^2\Delta r} \text{ or } -\frac{V}{\Delta V} = -\frac{r}{3\Delta r}$$

Put this value in eqn. (i), we get

$$B = -\frac{pr}{3\Delta r}$$

Fractional decrease in radius is

$$-\frac{\Delta r}{r} = \frac{p}{3B}$$

4. **(c)** : Pressure at point C,

$P_C = P_a + \rho_{water}gh_{water}$,

where $h_{water} = CE = (65 + 65)$ mm $= 130$ mm

Pressure at point B, $P_B = P_a + \rho_{oil}gh_{oil}$

where $h_{oil} = AB = (65 + 65 + 10)$ mm $= 140$ mm

In liquid, pressure is same at same liquid level,

$P_B = P_C \Rightarrow \rho_{oil}gh_{oil} = \rho_{water}gh_{water}$

$$\rho_{oil} = \frac{130\times 10^3}{140} = \frac{13}{14}\times 10^3 = 928.57 \text{ kg m}^{-3}$$

5. **(b)** : Work done = Surface tension of film × Change in area of the film

or, $W = T \times \Delta A$

Here, $A_1 = 4$ cm × 2 cm = 8 cm²

$A_2 = 5$ cm × 4 cm = 20 cm²

$\Delta A = 2(A_2 - A_1) = 24$ cm² $= 24 \times 10^{-4}$ m²

$W = 3 \times 10^{-4}$ J, $T = ?$

$$\therefore \quad T = \frac{W}{\Delta A} = \frac{3\times 10^{-4}}{24\times 10^{-4}} = \frac{1}{8} = 0.125 \text{ N m}^{-1}$$

6. **(b)** : Capillary rise, $h = \dfrac{2T\cos\theta}{r\rho g}$

For given value of T and r, $h \propto \dfrac{\cos\theta}{\rho}$

Also, $h_1 = h_2 = h_3$ or $\dfrac{\cos\theta_1}{\rho_1} = \dfrac{\cos\theta_2}{\rho_2} = \dfrac{\cos\theta_3}{\rho_3}$

Since, $\rho_1 > \rho_2 > \rho_3$, so $\cos\theta_1 > \cos\theta_2 > \cos\theta_3$

For $0 \le \theta < \dfrac{\pi}{2}$, $\theta_1 < \theta_2 < \theta_3$

Hence, $0 \le \theta_1 < \theta_2 < \theta_3 < \dfrac{\pi}{2}$

7. **(b)** : Since, heat capacity of material increases with increase in temperature so, body at 100 °C has more heat capacity than body at 0 °C. Hence, final common temperature of the system will be closer to 100 °C.

$\therefore \quad T_c > 50$ °C

8. **(b)** : According to Newton's law of cooling,

$$\frac{dT}{dt} = K(T - T_s)$$

For two cases,

$$\frac{dT_1}{dt} = K(T_1 - T_s) \text{ and } \frac{dT_2}{dt} = K(T_2 - T_s)$$

Here, $T_s = T$, $T_1 = \dfrac{3T + 2T}{2} = 2.5\,T$

and $\dfrac{dT_1}{dt} = \dfrac{3T - 2T}{10} = \dfrac{T}{10}$

$$T_2 = \frac{2T + T'}{2} \text{ and } \frac{dT_2}{dt} = \frac{2T - T'}{10}$$

So, $$\frac{T}{10} = K(2.5T - T) \quad ...(i)$$

$$\frac{2T - T'}{10} = K\left(\frac{2T + T'}{2} - T\right) \quad ...(ii)$$

Dividing eqn. (i) by eqn. (ii), we get

$$\frac{T}{2T - T'} = \frac{(2.5T - T)}{\left(\frac{2T + T'}{2} - T\right)}$$

$$\frac{2T+T'}{2}-T=(2T-T')\times\frac{3}{2}$$

$$T'=3(2T-T') \text{ or, } 4T'=6T \quad \therefore \quad T'=\frac{3}{2}T$$

9. (b) : Linear expansion of brass = α_1
Linear expansion of steel = α_2
Length of brass rod = l_1
Length of steel rod = l_2
On increasing the temperature of the rods by ΔT, new lengths would be

$$l_1'=l_1(1+\alpha_1\Delta T) \quad ...(i) \quad l_2'=l_2(1+\alpha_2\Delta T) \quad ...(ii)$$

Subtracting eqn. (i) from eqn. (ii), we get

$$l_2'-l_1'=(l_2-l_1)+(l_2\alpha_2-l_1\alpha_1)\Delta T$$

According to question,

$$l_2'-l_1'=l_2-l_1 \quad \text{(for all temperatures)}$$

$\therefore \quad l_2\alpha_2-l_1\alpha_1=0$ or $l_1\alpha_1=l_2\alpha_2$

10. (a) : Gravitational potential energy of a piece of ice at a height $(h)=mgh$
Heat absorbed by the ice to melt completely

$$\Delta Q=\frac{1}{4}mgh \quad ...(i)$$

Also, $\Delta Q=mL$ ...(ii)

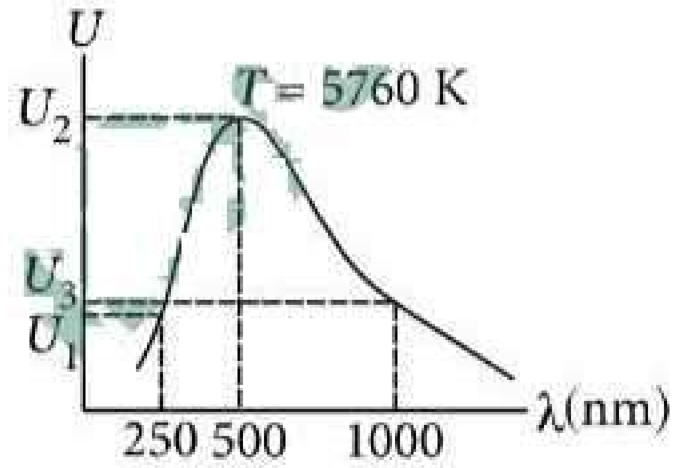
From eqns. (i) and (ii), $mL=\frac{1}{4}mgh$ or, $h=\frac{4L}{g}$

Here $L=3.4\times10^5\ \text{J kg}^{-1}$, $g=10\ \text{N kg}^{-1}$

$$\therefore \quad h=\frac{4\times3.4\times10^5}{10}=4\times34\times10^3=136\ \text{km}$$

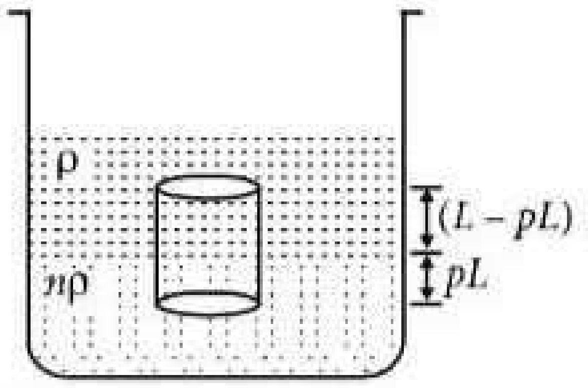
11. (b) : According to Wein's displacement law

$$\lambda_m=\frac{b}{T}=\frac{2.88\times10^6\ \text{nm K}}{5760\ \text{K}}=500\ \text{nm}$$



Clearly from graph, $U_1<U_2>U_3$

12. (b) :



d = density of cylinder
A = area of cross-section of cylinder

Using law of floatation,
Weight of cylinder = Upthrust by two liquids

$$L\times A\times d\times g=n\rho\times(pL\times A)g+\rho(L-pL)Ag$$

$$d=np\rho+\rho(1-p)=(np+1-p)\rho$$

$$d=\{1+(n-1)p\}\ \rho$$

13. (d) : Let the speed of the ejection of the liquid through the holes be v. Then according to the equation of continuity,

$$\pi R^2V=n\pi r^2v \text{ or } v=\frac{\pi R^2V}{n\pi r^2}=\frac{VR^2}{nr^2}$$

14. (d) : Water will not overflow but will change its radius of curvature.

15. (d) : Let r_0 and r_T be densities of glycerin at 0°C and T°C respectively. Then,

$$\rho_T=\rho_0(1-\gamma\Delta T)$$

where γ is the coefficient of volume expansion of glycerine and ΔT is rise in temperature.

$$\frac{\rho_T}{\rho_0}=1-\gamma\Delta T \text{ or } \gamma\Delta T=1-\frac{\rho_T}{\rho_0}$$

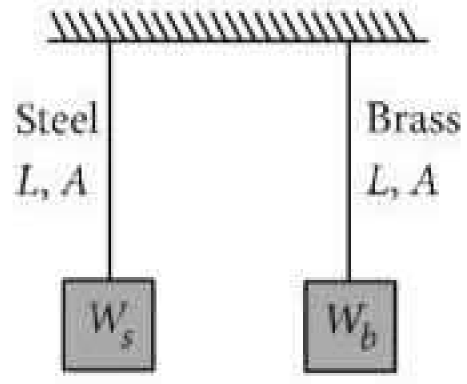
Thus, $\frac{\rho_0-\rho_T}{\rho_0}=\gamma\Delta T$

Here, $\gamma=5\times10^{-4}\ \text{K}^{-1}$ and $\Delta T=40°\text{C}=40\ \text{K}$

$\therefore$ The fractional change in the density of glycerin

$$=\frac{\rho_0-\rho_T}{\rho_0}=\gamma\Delta T=(5\times10^{-4}\text{K}^{-1})(40\ \text{K})=0.020$$

16. (d) : Let L and A be length and area of cross section of each wire. In order to have the lower ends of the wires to be at the same level (*i.e.* same elongation is produced in both wires), let weights W_s and W_b are added to steel and brass wires respectively. Then



By definition of Young's modulus, the elongation produced in the steel wire is

$$\Delta L_s=\frac{W_sL}{Y_sA} \quad \left(\text{as } Y=\frac{W/A}{\Delta L/L}\right)$$

and that in the brass wire is $\Delta L_b=\frac{W_bL}{Y_bA}$

But $\Delta L_s=\Delta L_b$ (given)

$$\therefore \quad \frac{W_sL}{Y_sA}=\frac{W_bL}{Y_bA} \text{ or } \frac{W_s}{W_b}=\frac{Y_s}{Y_b}$$

As $\frac{Y_s}{Y_b}=2$ (given)

$$\therefore \quad \frac{W_s}{W_b}=\frac{2}{1}$$

17. (b) **18. (a)**

19. (d) : According to Wein's displacement law

$\lambda_m T$ = constant ...(i)

For star P, intensity of violet colour is maximum

For star Q, intensity of red colour is maximum.

For star R, intensity of green colour is maximum.

Also, $\lambda_r > \lambda_g > \lambda_v$

Using equation (i), $T_r < T_g < T_v$

$T_Q < T_R < T_P$

20. (a) : Depth of ocean d = 2700 m

Density of water, $\rho = 10^3$ kg m^{-3}

Compressibility of water, $K = 45.4 \times 10^{-11}$ Pa^{-1}

$\frac{\Delta V}{V} = ?$

Excess pressure at the bottom, $\Delta P = \rho g d$

$= 10^3 \times 10 \times 2700 = 27 \times 10^6$ Pa

We know, $B = \frac{\Delta P}{(\Delta V/V)}$

$\left(\frac{\Delta V}{V}\right) = \frac{\Delta P}{B} = K.\Delta P \qquad \left(\because K = \frac{1}{B}\right)$

$= 45.4 \times 10^{-11} \times 27 \times 10^6 = 1.2 \times 10^{-2}$

21. (b) : As $V = Al$ ...(i)

where A is the area of cross-section of the wire.

Young's modulus, $Y = \frac{(F/A)}{(\Delta l/l)} = \frac{Fl}{A\Delta l}$

$\Delta l = \frac{Fl}{YA} = \frac{Fl^2}{YV}$ (Using (i))

$\Delta l \propto l^2$

Hence, the graph between Δl and l^2 is a straight line.

22. (c) : Let n droplets each of radius r coalesce to form a big drop of radius R.

∴ Volume of n droplets = Volume of big drop

$n \times \frac{4}{3}\pi r^3 = \frac{4}{3}\pi R^3 \Rightarrow n = \frac{R^3}{r^3}$ ...(i)

Volume of big drop, $V = \frac{4}{3}\pi R^3$ ...(ii)

Initial surface area of n droplets,

$A_i = n \times 4\pi r^2 = \frac{R^3}{r^3} \times 4\pi r^2$ (Using (i))

$= 4\pi \frac{R^3}{r} = \left(\frac{4}{3}\pi R^3\right)\frac{3}{r} = \frac{3V}{r}$ (Using (ii))

Final surface area of big drop

$A_f = 4\pi R^2 = \left(\frac{4}{3}\pi R^3\right)\frac{3}{R} = \frac{3V}{R}$ (Using (ii))

Decrease in surface area

$\Delta A = A_i - A_f = \frac{3V}{r} - \frac{3V}{R} = 3V\left(\frac{1}{r} - \frac{1}{R}\right)$

∴ Energy released = Surface tension × Decrease in surface area

$= T \times \Delta A = 3VT\left(\frac{1}{r} - \frac{1}{R}\right)$

23. (d) : Here,

Specific heat of water, $s_w = 1$ cal g^{-1} °C^{-1}

Latent heat of steam, $L_s = 540$ cal g^{-1}

Heat lost by m g of steam at 100°C to change into water at 80°C is

$Q_1 = mL_s + ms_w\Delta T_w = m \times 540 + m \times 1 \times (100 - 80)$

$= 540m + 20m = 560m$

Heat gained by 20 g of water to change its temperature from 10°C to 80°C is

$Q_2 = m_w s_w \Delta T_w = 20 \times 1 \times (80 - 10) = 1400$

According to principle of calorimetry, $Q_1 = Q_2$

∴ $560m = 1400$ or $m = 2.5$ g

Total mass of water present

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

24. (a) : Let T_s be the temperature of the surroundings.

According to Newton's law of cooling

$\frac{T_1 - T_2}{t} = K\left(\frac{T_1 + T_2}{2} - T_s\right)$

For first 5 minutes,

$T_1 = 70°C, T_2 = 60°C, t = 5$ minutes

∴ $\frac{70 - 60}{5} = K\left(\frac{70 + 60}{2} - T_s\right)$

$\frac{10}{5} = K(65 - T_s)$ ... (i)

For next 5 minutes,

$T_1 = 60°C, T_2 = 54°C, t = 5$ minutes

∴ $\frac{60 - 54}{5} = K\left(\frac{60 + 54}{2} - T_s\right)$

$\frac{6}{5} = K(57 - T_s)$ ... (ii)

Divide eqn. (i) by eqn. (ii), we get

$\frac{5}{3} = \frac{65 - T_s}{57 - T_s}$

$285 - 5T_s = 195 - 3T_s$

$2T_s = 90$ or $T_s = 45°C$

25. (d) : According to Wien's displacement law

$\lambda_m T$ = constant

$\lambda_m = \frac{\text{constant}}{T}$

So when a piece of iron is heated, λ_m decreases *i.e.* with rise in temperature the maximum intensity of radiation emitted gets shifted towards the shorter wavelengths. So the colour of the heated object will change that of longer wavelength (red) to that of shorter (reddish yellow) and when the temperature is sufficiently high and all wavelengths are emitted, the colour will become white.

26. (b) : The wettability of a surface by a liquid depends primarily on angle of contact between the surface and the liquid.

27. (c) : Young's modulus,

$$Y = \frac{FL}{A\Delta L} = \frac{4FL}{\pi D^2 \Delta L} \text{ or } \Delta L = \frac{4FL}{\pi D^2 Y}$$

where F is the force applied, L is the length, D is the diameter and ΔL is the extension of the wire respectively. As each wire is made up of same material therefore their Young's modulus is same for each wire.

For all the four wires, Y, F (= tension) are the same.

$$\therefore \quad \Delta L \propto \frac{L}{D^2}$$

In (a) $\frac{L}{D^2} = \frac{200 \text{ cm}}{(0.2 \text{ cm})^2} = 5 \times 10^3 \text{ cm}^{-1}$

In (b) $\frac{L}{D^2} = \frac{300 \text{ cm}}{(0.3 \text{ cm})^2} = 3.3 \times 10^3 \text{ cm}^{-1}$

In (c) $\frac{L}{D^2} = \frac{50 \text{ cm}}{(0.05 \text{ cm})^2} = 20 \times 10^3 \text{ cm}^{-1}$

In (d) $\frac{L}{D^2} = \frac{100 \text{ cm}}{(0.1 \text{ cm})^2} = 10 \times 10^3 \text{ cm}^{-1}$

Hence, ΔL is maximum in (c).

28. (d) : For an ideal gas

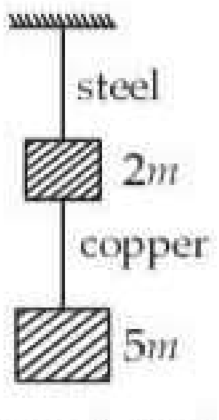
$$C_p - C_v = R \quad \text{...(i)}$$

Divide C_v on both sides, we get

$$\frac{C_p}{C_v} - 1 = \frac{R}{C_v}$$

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

29. (b) : As $Y = \frac{FL}{A\Delta L} = \frac{4FL}{\pi D^2 \Delta L}$



$$\Delta L = \frac{4FL}{\pi D^2 Y}$$

$$\therefore \quad \frac{\Delta L_S}{\Delta L_C} = \frac{F_S}{F_C}\frac{L_S}{L_C}\frac{D_C^2}{D_S^2}\frac{Y_C}{Y_S}$$

where subscripts S and C refer to copper and steel respectively.

Here, $F_s = (5m + 2m)g = 7mg$

$F_c = 5mg$

$$\frac{L_S}{L_C} = q, \frac{D_S}{D_C} = p, \frac{Y_S}{Y_C} = s$$

$$\therefore \quad \frac{\Delta L_S}{\Delta L_C} = \left(\frac{7mg}{5mg}\right)(q)\left(\frac{1}{p}\right)^2\left(\frac{1}{s}\right) = \frac{7q}{5p^2 s}$$

30. (a) : Let L be length of each rod.

Rate of heat flow in rod 1 for the temperature difference ΔT is

$$H_1 = \frac{K_1 A_1 \Delta T}{L}$$

Rate of heat flow in rod 2 for the same difference ΔT is

$$H_2 = \frac{K_2 A_2 \Delta T}{L}$$

As per questionm, $H_1 = 4H_2$

$$\frac{K_1 A_1 \Delta T}{L} = 4\frac{K_2 A_2 \Delta T}{L}; \quad K_1 A_1 = 4K_2 A_2$$

31. (a) : According to equation of continuity,

Av = constant

Therefore, velocity is maximum at the narrowest part and minimum at the widest part of the pipe.

According to Bernoulli's theorem for a horizontal pipe,

$$P + \frac{1}{2}\rho v^2 = \text{constant}$$

Hence, when a fluid flow across a horizontal pipe of variable area of cross-section its velocity is maximum and pressure is minimum at the narrowest part and vice versa.

32. (a) : As $\rho_{T_2} = \frac{\rho_{T_1}}{(1 + \gamma\Delta T)} = \frac{\rho_{T_1}}{1 + \gamma(T_2 - T_1)}$

Here, $T_1 = 20°C$, $T_2 = 40°C$

$\rho_{20} = 998 \text{ kg/m}^3$, $\rho_{40} = 992 \text{ kg/m}^3$

$$\therefore \quad 992 = \frac{998}{1 + \gamma(40 - 20)}$$

$$992 = \frac{998}{1 + 20\gamma}$$

$$992(1 + 20\gamma) = 998$$

$$1 + 20\gamma = \frac{998}{992} \text{ or } 20\gamma = \frac{998}{992} - 1 = \frac{6}{992}$$

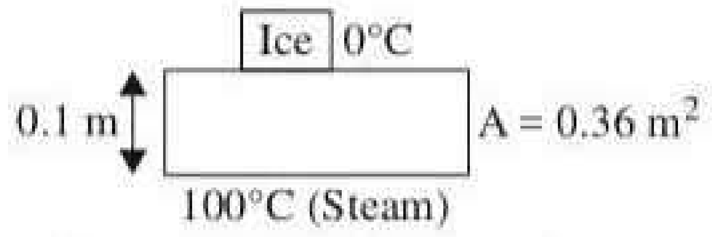
$$\gamma = \frac{6}{992} \times \frac{1}{20} = 3 \times 10^{-4}/°C$$

33. (d) : According to Stefan's law, $Q = \sigma A T^4$

$$\text{or} \quad T = \left(\frac{Q}{\sigma A}\right)^{1/4} = \left(\frac{Q}{\sigma 4\pi R^2}\right)^{1/4}$$

34. (a) : Temperature of liquid oxygen will first increase in the same phase. Then, the liquid oxygen will change to gaseous phase during which temperature will remain constant. After that temperature of oxygen in gaseous state will increase. Hence option (a) represents corresponding temperature-time graph.

35. (a) :



Heat flows through the slab in t s is

$$Q = \frac{KA(T_1 - T_2)t}{L} = \frac{K \times 0.36 \times (100-0) \times 3600}{0.1}$$

$$= \frac{K \times 0.36 \times 100 \times 3600}{0.1} \quad \text{...(i)}$$

So ice melted by this heat is

$$m_{ice} = \frac{Q}{L_f} \quad \text{...(ii)}$$

or $Q = m_{ice} L_f = 4.8 \times 3.36 \times 10^5$

From (i) and (ii), we get

$$\frac{K \times 0.36 \times (100-0) \times 3600}{0.1} = 4.8 \times 3.36 \times 10^5$$

$$K = \frac{4.8 \times 3.36 \times 10^5 \times 0.1}{0.36 \times 100 \times 3600} = 1.24 \text{ J/m/s/°C}$$

36. (b) : The amount of heat flows in time t through a cylindrical metallic rod of length L and uniform area of cross-section $A(= \pi R^2)$ with its ends maintained at temperatures T_1 and T_2 $(T_1 > T_2)$ is given by

$$Q = \frac{KA(T_1 - T_2)t}{L} \quad \text{...(i)}$$

where K is the thermal conductivity of the material of the rod.

Area of cross-section of new rod

$$A' = \pi\left(\frac{R}{2}\right)^2 = \frac{\pi R^2}{4} = \frac{A}{4} \quad \text{...(ii)}$$

As the volume of the rod remains unchanged

$\therefore \quad AL = A'L'$

where L' is the length the new rod

or $\quad L' = L\frac{A}{A'} \quad \text{...(iii)}$

$= 4L$ (Using (ii))

Now, the amount of heat flows in same time t in the new rod with its ends maintained at the same temperatures T_1 and T_2 is given by

$$Q' = \frac{KA'(T_1 - T_2)t}{L'} \quad \text{...(iv)}$$

Substituting the values of A' and L' from equations (ii) and (iii) in the above equation, we get

$$Q' = \frac{K(A/4)(T_1 - T_2)t}{4L} = \frac{1}{16}\frac{KA(T_1 - T_2)t}{L} = \frac{1}{16}Q$$

(Using (i))

37. (a) : According to the Stefan Boltzmann law, the power radiated by the star whose outer surface radiates as a black body at temperature T K is given by

$P = \sigma 4\pi r^2 T^4$

where, r = radius of the star

σ = Stefan's constant

The radiant power per unit area received at a distance R from the centre of a star is

$$S = \frac{P}{4\pi R^2} = \frac{\sigma 4\pi r^2 T^4}{4\pi R^2} = \frac{\sigma r^2 T^4}{R^2}$$

38. (c) : Power P radiated by the sun with its surface temperature $(t + 273)$ K is given by Stefan's Boltzmann law.

$P = \sigma e\, 4\pi r^2 (t + 273)^4$

where r is the radius of the sun and the sun is treated as a black body where $e = 1$.

The radiant power per unit area received by the surface at a distance R from the centre of the sun is given by

$$S = \frac{P}{4\pi R^2} = \frac{\sigma 4\pi r^2 (t+273)^4}{4\pi R^2} = \frac{r^2 \sigma (t+273)^4}{R^2}.$$

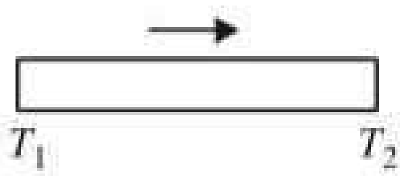
39. (b) : Rate of heat radiated at (227 + 273) K = 7 cals/(cm²s)

Let rate of heat radiated at (727 + 273) K = x cals/(cm²s)

By Stefan's law, $7 \propto (500)^4$ and $x \propto (1000)^4$

$$\therefore \frac{x}{7} = 2^4 \Rightarrow x = 7 \times 2^4 = 112 \text{ cals/(cm}^2\text{ s)}.$$

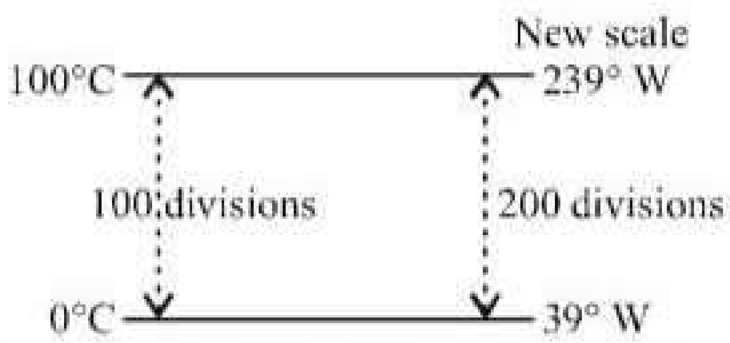
40. (c) : Similar to $I = V/R$



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

k = conductivity of the rod.

41. (d) :



$\therefore \quad 39°C = 39 \times 2 + 39 = (78 + 39)° W = 117° W.$

42. (a) : According to Stefan's law, rate of energy radiated $E \propto T^4$

where T is the absolute temperature of a black body.

$\therefore \quad E \propto (727 + 273)^4 \quad$ or $\quad E \propto [1000]^4$.

43. (a) : According to Wein's displacement law, $\lambda_{max} T$ = constant

$$\therefore \quad \frac{\lambda_{max_1}}{\lambda_{max_2}} = \frac{T_2}{T_1}$$

$$\text{or, } \lambda_{max_2} = \frac{\lambda_{max_1} \times T_1}{T_2} = \frac{5000 \times 1500}{2500} = 3000 \text{ Å}.$$

44. (b) : Heat conducted

$$= \frac{KA(T_1 - T_2)t}{l} = \frac{K\pi r^2 (T_1 - T_2)t}{l}$$

The rod with the maximum ratio of A/l will conduct most. Here the rod with $r = 2r_0$ and $l = l_0$ will conduct most.

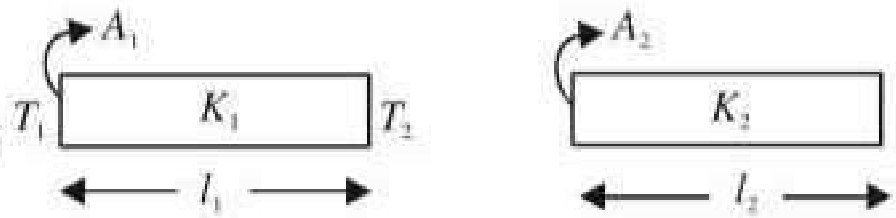
45. (d) : Wein's displacement law
$\lambda_m T = \text{constant}, \lambda_m \propto T^{-1}$

46. (a) : The slabs are in series.
Total resistance $R = R_1 + R_2$

$$\Rightarrow \frac{l}{AK_{\text{effective}}} = \frac{l}{A.K} + \frac{l}{A2K}$$

$$\Rightarrow \frac{1}{K_{\text{effective}}} = \frac{1}{K} + \frac{1}{2K} = \frac{3}{2K} \quad \therefore K_{\text{effective}} = \frac{2K}{3}$$

47. (d) : Unit of Stefan's constant is watt/m^{2}K^4.

48. (a) : 

Rate of heat loss in rod 1 = $Q_1 = \frac{K_1A_1(T_1 - T_2)}{l_1}$

Rate of heat loss in rod 2 = $Q_2 = \frac{K_2A_2(T_1 - T_2)}{l_2}$

By problem, $Q_1 = Q_2$.

$$\therefore \frac{K_1A_1(T_1 - T_2)}{l_1} = \frac{K_2A_2(T_1 - T_2)}{l_2}.$$

$\therefore K_1A_1 = K_2A_2.$ $[\because l_1 = l_2]$

49. (b) : Radiating power of a black body
$= E_0 = \sigma(T^4 - T_0^4)A$
where σ is known as the Stefan-Boltzmann constant, A is the surface area of a black body, T is the temperature of the black body and T_0 is the temperature of the surrounding.

$\therefore$ $60 = \sigma(1000^4 - 500^4)$ ...(i)
$[T = 727°C = 727 + 273 = 1000$ K,
$T_0 = 227°C = 500$ K$]$.

In the second case, $T = 1227°C = 1500$ K and let E' be the radiating power.

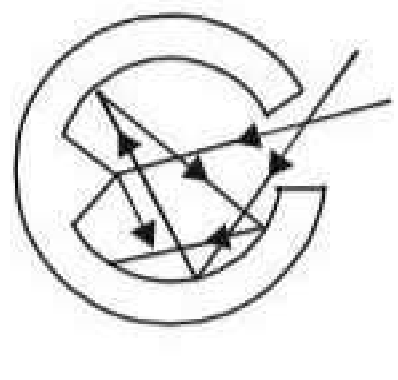
$\therefore$ $E' = \sigma(1500^4 - 500^4)$ ...(ii)

From (i) and (ii) we have

$$\frac{E'}{60} = \frac{1500^4 - 500^4}{1000^4 - 500^4} = \frac{15^4 - 5^4}{10^4 - 5^4} = \frac{50000}{9375}$$

$$\therefore E' = \frac{50000}{9375} \times 60 = 320 \text{ W}.$$

50. (b) : An ideal black body is one which absorbs all the incident radiation without reflecting or transmitting any part of it. Black lamp absorbs approximately 96% of incident radiation.



An ideal black body can be realized in practice by a small hole in the wall of a hollow body (as shown in figure) which is at uniform temperature. Any radiation entering the hollow body through the holes suffers a number of reflections and ultimately gets completely absorbed. This can be facilitated by coating the interior surface with black so that about 96% of the radiation is absorbed at each reflection. The portion of the interior surface opposite to the hole is made conical to avoid the escape of the reflected ray after one reflection.

51. (a) : Wien's displacement law states that the product of absolute temperature and the wavelength at which the emissive power is maximum is constant *i.e.* $\lambda_{\text{max}} T = \text{constant}$. Therefore it expresses relation between wavelength corresponding to maximum energy and temperature.

52. (b) : Heat flow rate $\frac{dQ}{dt} = \frac{KA(T_1 - T_2)}{L} = Q$

When linear dimensions are double.
$A_1 \propto r_1^2, L_1 = L$
$A_2 \propto 4r_1^2, L_2 = 2L$ so $Q_2 = 2Q_1$.

53. (b) : According to Wein's law,
$\lambda_m T = \text{constant}. \therefore \lambda' = (2/3)\lambda_m$

54. (a)

55. (a) : $E = \sigma T^4 = 20. \; T' = 2T$
$\therefore E' = \sigma(2T)^4 = 16\,\sigma T^4$
$= 16 \times 20 = 320$ kcal/m^2 min

56. (b) : Temperature of black body $(T) = 500$ K. Therefore total energy emitted by the black body $(E) \propto T^4 \propto (500)^4$.

57. (a) : The rate of cooling is directly proportional to the temperature difference of the body and the surroundings. So, cooling will be fastest in the first case and slowest in the third case.

58. (d) : Ratio of diameters of rod = 1 : 2 and ratio of their lengths 2 : 1.

The rate of flow of heat, $(R) = \frac{KA\Delta T}{l} \propto \frac{A}{l}$.

Therefore $\frac{R_1}{R_2} = \frac{A_1}{A_2} \times \frac{l_2}{l_1} = \left(\frac{1}{2}\right)^2 \times \frac{1}{2} = \frac{1}{8}$

or $R_1 : R_2 = 1 : 8$

59. (d) : Amount of energy radiated $\propto T^4$.

60. (c) : Mercury thermometer is based on the principle of change of volume with rise of temperature and can measure temperatures ranging from −30°C to 357°C

61. (c) : Here, F = 140°

Using $\frac{F-32}{180}=\frac{C}{100}$,

$\therefore \quad \frac{140-32}{180}=\frac{C}{100} \Rightarrow C=60°C$

we get, fall in temperature = 40°C

62. (d) : Thermal capacity = $ms = 40 \times 0.2 = 8$ cal/K = 33.6 joule/K.

63. (b) : Let the final temperature be T

Heat required by ice $= mL + m \times s \times (T-0)$
$= 10 \times 80 + 10 \times 1 \times T$

Heat lost by water = $55 \times (40 - T)$

By using law of calorimetry,

heat gained = heat lost

$800 + 10T = 55 \times (40 - T)$

$\Rightarrow \quad T = 21.54°C = 22°C$