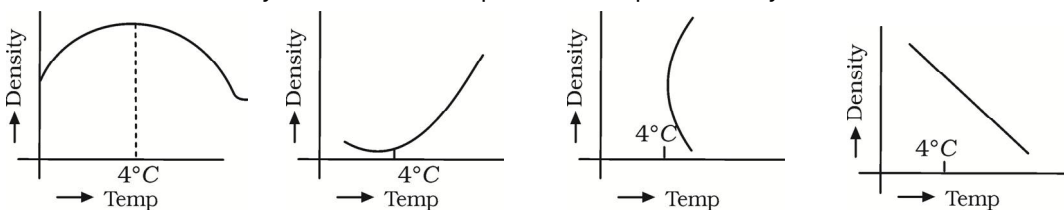


Properties of Matter

Miscellaneous Question Bank

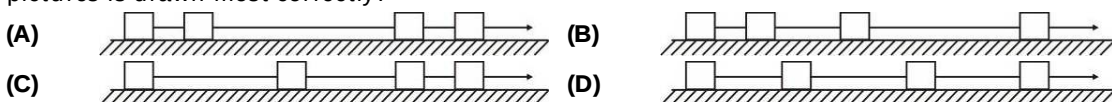
Level – 1, 2, 3

- The variation of density of water with temperature is represented by the curve in :


(A) (B) (C) (D)
- 500 gm of ice at -5°C is mixed with 100 gm of water at 20°C , when equilibrium is reached, amount of ice in the mixture is:

(A) 93.75 gm (B) 421.75 gm (C) 406.25 gm (D) zero
- A steel wire is stretched by 1.2 kg wt and the extension is 0.3 mm. How many times does its Young's modulus change if the radius of the wire is doubled and length halved?

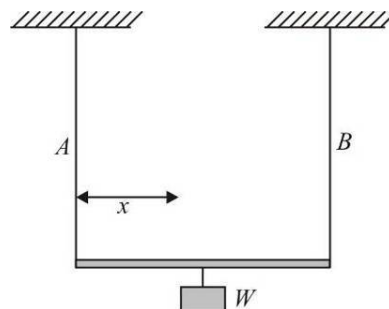
(A) 0.4 (B) 3.6 (C) 0.8 (D) No change
- The compressibility of water is 4×10^{-5} per unit atmospheric pressure. The decrease in volume of 100 cm^3 of water under a pressure of 100 atmospheres will be :

(A) 0.4 cm^3 (B) $4 \times 10^{-5} \text{ cm}^3$ (C) 0.025 cm^3 (D) 0.04 cm^3
- Each of the pictures shows four objects tied together with rubber bands being pulled to the right across a horizontal frictionless surface by a horizontal force F . All the objects have the same mass; all the rubber bands obey Hooke's law and have the same equilibrium length and the same force constant. Which of these pictures is drawn most correctly?


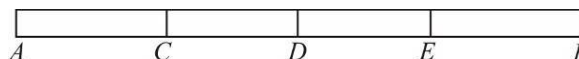
(A) (B) (C) (D)

PARAGRAPH FOR QUESTIONS 6 - 7

A light rod of length $L = 2 \text{ m}$ is suspended horizontally from the ceiling by two wires A and B of equal lengths. The wire A is made of steel with the area of cross section $A_s = 1 \times 10^{-5} \text{ m}^2$ while the wire B is made of brass of cross-sectional area $A_b = 2 \times 10^{-5} \text{ m}^2$. A weight W is suspended at a distance x from the wire A as shown in the figure. Take, Young's modulus of steel and brass as $Y_s = 2 \times 10^{11} \text{ Nm}^{-2}$ and $Y_b = 1 \times 10^{11} \text{ Nm}^{-2}$.



6. Determine the value of x so that equal stresses are produced in each wire.
(A) 1.33 m (B) 2.5 m (C) 3.6 m (D) 2.1 m
7. Determine the value of x so that equal strains are produced in each wire.
(A) 1 m (B) 2 m (C) 3 m (D) 2.2 m
8. A rod AB of uniform cross section consists of four sections AC , CD , DE and EB of different metals with thermal conductivities K , $(0.8) K$, $(1.2) K$ and $(1.50) K$ respectively. Their lengths are respectively L , $(1.2) L$, $(1.5) L$ and $(0.6) L$. They are joined rigidly in succession at C , D and E to form the rod AB . The end A is maintained at 100°C and the end B is maintained at 0°C . The steady state temperatures of the joints C , D and E are respectively T_C , T_D and T_E . Column I list the temperature differences $(T_A - T_C)$, $(T_C - T_D)$, $(T_D - T_E)$ and $(T_E - T_B)$ in the four sections and Column II their values jumbled up. Match each item in Column I with its correct value in Column II.



Column I

Column II

- | | |
|-------------------|----------|
| (A) $(T_A - T_C)$ | (P) 9.6 |
| (B) $(T_C - T_D)$ | (Q) 30.1 |
| (C) $(T_D - T_E)$ | (R) 24.1 |
| (D) $(T_E - T_B)$ | (S) 36.2 |

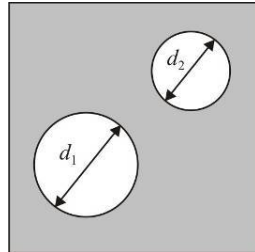
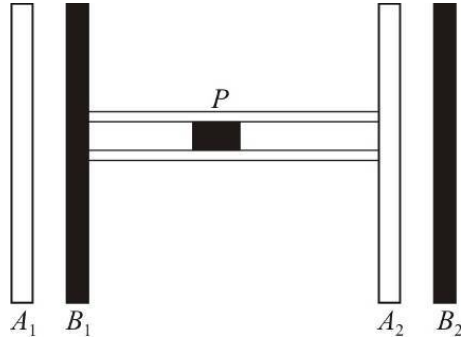
- *9. A clock is calibrated at a temperature of 20°C . Assume that the pendulum is a thin brass rod of negligible mass with a heavy bob attached to the end ($\alpha_{\text{brass}} = 19 \times 10^{-6} / \text{K}$).
- (A) On a hot day at 30°C the clock gains 8.2 s
(B) On a hot day at 30°C the clock loses 8.2 s
(C) On a cold day at 10°C the clock gains 8.2 s
(D) On a cold day at 10°C the clock loses 8.2 s
- *10. Choose the correct statements from the following:
- (A) Steel is more elastic than rubber
(B) The stretching of a coil spring is determined by the Young's modulus of the wire of the spring
(C) The frequency of a tuning fork is determined by the shear modulus of the material of the fork
(D) When a material is subjected to a tensile (stretching) stress the restoring forces are caused by interatomic attraction
11. A body is cooled in 2 min in a room at temperature of 30°C from 75°C to 65°C . If the same body is cooled from 55°C to 45°C in the same room, find the time taken (in minute).
12. When the temperature of a body increases from t to $t + \Delta t$, its moment of inertia increases from I to $I + \Delta I$. The coefficient of linear expansion of the body is α . The ratio $\frac{\Delta I}{I}$ is equal to:
- (A) $\frac{\Delta t}{I}$ (B) $\frac{2\Delta t}{I}$ (C) $\alpha \Delta t$ (D) $2\alpha \Delta t$

13. The specific heat of a substance varies with temperature t ($^{\circ}\text{C}$) as $c = 0.20 + 0.14t + 0.023t^2$ ($\text{cal} / \text{g} / ^{\circ}\text{C}$). The heat required to raise the temperature of 2 g of substance from 5°C to 15°C will be:
(A) 24 cal (B) 56 cal (C) 82 cal (D) 100 cal
14. When the temperature of a black body increases, it is observed that the wavelength corresponding to maximum energy changes from $0.26\mu\text{m}$ to $0.13\mu\text{m}$. The ratio of the emissive powers of the body at the initial temperature to the final temperature is :
(A) 16/1 (B) 4/1 (C) 1/4 (D) 1/16
15. A mass m of lead shot is placed at the bottom of a vertical cardboard cylinder that is 1.5 m long and closed at both ends. The cylinder is suddenly inverted so that the shot fall 1.5 m. If this process is repeated quickly 100 times, assuming no heat is dissipated or lost, the temperature of the shot will increase by: (Specific heat of lead = $0.03 \text{ cal/g}^{\circ}\text{C}$)
(A) 0 (B) 5°C (C) 7.3°C (D) 11.9°C
16. What amount of work is done in increasing the length of a wire through unity?
(A) $\frac{YL}{2A}$ (B) $\frac{YL^2}{2A}$ (C) $\frac{YA}{2L}$ (D) $\frac{YL}{A}$

PARAGRAPH FOR QUESTIONS 17 - 19

A copper collar is to fit tightly about a steel shaft that has a diameter of 6 cm at 20°C . The inside diameter of the copper collar at that temperature is 5.98 cm.

17. To what temperature must the copper collar be raised so that it will just slip on the steel shaft, assuming the steel shaft remains at 20°C ? ($\alpha_{\text{copper}} = 17 \times 10^{-6} / \text{K}$)
(A) 324°C (B) 21.70°C (C) 217°C (D) 32.4°C
18. The tensile stress in the copper collar when its temperature returns to 20°C is : ($Y = 11 \times 10^{10} \text{ N} / \text{m}^2$)
(A) $1.34 \times 10^5 \text{ N/m}^2$ (B) $3.68 \times 10^{-12} \text{ N/m}^2$
(C) $3.68 \times 10^8 \text{ N/m}^2$ (D) $1.34 \times 10^{-12} \text{ N/m}^2$
19. If the breaking stress of copper is 230 N/m^2 , at what temperature will the copper collar break as it cools?
(A) 20°C (B) 47°C (C) 94°C (D) 217°C
20. Match the following two columns.
- | Column I | Column II |
|-------------------|-----------------------------------|
| (A) Specific heat | (P) watt |
| (B) Heat capacity | (Q) $\text{J/kg}^{\circ}\text{C}$ |
| (C) Heat current | (R) J/s |
| (D) Latent heat | (S) None of these |

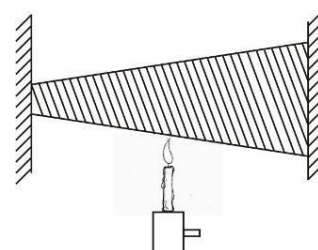
21. A clock with a metallic pendulum at 15°C runs faster by 5 s each day and at 30°C , runs slow by 10 s. Find the coefficient of linear expansion of the metal. (Nearly in $10^{-5}/^{\circ}\text{C}$)
22. Two rods of length L_2 and coefficient of linear expansion α_2 are connected freely to a third rod of length L_1 and coefficient of linear expansion α_1 to form an isosceles triangle. The arrangement is supported on the knife edge at the midpoint of L_1 which is horizontal. The apex of the isosceles triangle will remain at a constant distance from the knife edge if :
- (A) $\frac{L_1}{L_2} = \frac{\alpha_2}{\alpha_1}$ (B) $\frac{L_1}{L_2} = \sqrt{\frac{\alpha_2}{\alpha_1}}$ (C) $\frac{L_1}{L_2} = 2 \frac{\alpha_2}{\alpha_1}$ (D) $\frac{L_1}{L_2} = 2 \sqrt{\frac{\alpha_2}{\alpha_1}}$
23. Two holes of unequal diameters d_1 and d_2 ($d_1 > d_2$) are cut in a metal sheet. If the sheet is heated :
- (A) Both d_1 and d_2 will decrease
(B) Both d_1 and d_2 will increase
(C) d_1 will increase, d_2 will decrease
(D) d_1 will decrease, d_2 will increase
- 
24. Hot water cools from 60°C to 50°C in the first 10 min and to 42°C in the next 10 min. The temperature of the surrounding is : (Assuming radiation)
- (A) 5°C (B) 10°C (C) 15°C (D) 20°C
25. Two plates identical in size, one of black and rough surface (B_1) and the other smooth and polished (A_2) are interconnected by a thin horizontal pipe with a mercury pellet at the centre. Two more plates A_1 (identical to A_2) and B_2 (identical to B_1) are heated to the same temperature and placed closed to the plates B_1 , and A_2 as shown in the figure. The mercury pellet :
- 
- (A) Moves to the right
(B) Moves to the left
(C) Remains stationary
(D) Starts oscillating left and right
26. A body cools from 50°C to 49°C in 5s. How long will it take to cool from 40°C to 39.5°C ? {Assume the temperature of surrounding to be 30°C and Newton's law of cooling to be valid.}
- (A) 2.5 s (B) 10 s (C) 20 s (D) 5 s

PARAGRAPH FOR QUESTIONS 27 - 29

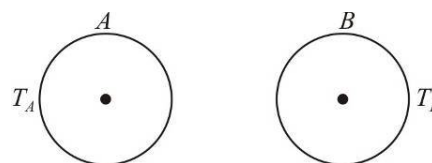
When a solid is heated, its length changes according to the relation $l = l_0(1 + \alpha\Delta T)$ where l = final length, l_0 = initial length, ΔT = change in temperature and α = coefficient of linear expansion.

The change in area of solid upon heating is called superficial expansion. The area changes according to the following relation $A = A_0(1 + \beta\Delta T)$ where A = final area, A_0 = initial area and β = coefficient of superficial expansion.

27. A metal disc having circular hole at its centre is heated. If the metal expands on heating, the diameter of the hole will :
- (A) Increase (B) decrease
(C) remain unchanged (D) Increases or decreases depending upon the metal
28. On heating a liquid of coefficient of cubical expansion γ in a container having coefficient of linear expansion $\gamma/3$, the level of liquid in the container will :
- (A) rise (B) fall
(C) remain almost stationary (D) None of these
29. The coefficient of linear expansion of brass and steel are α_1 and α_2 . If we take a brass rod of length l_1 and a steel rod of length l_2 at 0°C , their difference in length will remain the same at any temperature if :
- (A) $\alpha_1 l_2 = \alpha_2 l_1$ (B) $\alpha_1 l_2^2 = \alpha_2 l_1^2$ (C) $\alpha_1^2 l_2 = \alpha_2^2 l_1$ (D) $\alpha_1 l_1 = \alpha_2 l_2$
- *30. A rod is made of uniform material and has non-uniform cross section. It is fixed at both the ends as shown and heated at mid-section. Which of the following statements are not correct?
- (A) Force of compression in the rod will be maximum at mid-section
(B) Compressive stress in the rod will be maximum at left end
(C) Since rod is fixed at both the ends, its length will remain unchanged. Hence, no strain will be induced in it
(D) None of the above
31. Two spherical bodies A (radius 6 cm) and B (radius 18 cm) are at temperature T_1 and T_2 respectively. The maximum intensity in the emission spectrum of A is at 500 nm and in that of B is at 1500 nm. Considering them to be black bodies, what will be the ratio of the rate of total energy radiated by A to that of B? .
32. A planet radiates heat at a rate proportional to the fourth power of its surface temperature T . If such a steady temperature of the planet is due to an exactly equal amount of heat received from the sun then which of the following statements is true?
- (A) The planet's surface temperature varies inversely as the distance of the sun
(B) The planet's surface temperature varies directly as the square of its distance from the sun
(C) The planet's surface temperature varies inversely as the square root of its distance from the sun
(D) The planet's surface temperature is proportional to the fourth power of distance from the sun



33. A and B are two isolated spheres kept in close proximity so that they can exchange energy by radiation. The two spheres have identical physical dimensions but the surface of A behaves like a perfectly black body while the surface of B reflects 20% of all radiations it receives. They are isolated from all other sources of radiation. Which of the following is true?



- (A) If they are in thermal equilibrium and exchange equal amounts of radiation per second, then they will be at same absolute temperature, $T_A = T_B$
- (B) If they are in thermal equilibrium and exchange equal amounts of radiation per second, then $T_A = (0.8)^{1/4} T_B$
- (C) If they are not in thermal equilibrium and are each at $t = 0$ at the same temperature $T_A = T_B = T$, then the sphere A will lose thermal energy and B will gain thermal energy
- (D) If they are not in thermal equilibrium and are each at $t = 0$ at the same temperature $T_A = T_B = T$, then the sphere A will gain thermal energy and B will lose thermal energy
34. The length of a steel rod exceeds that of a brass rod by 5 cm. If the difference in their lengths remains same at all temperatures, then the length of brass rod will be: (α for steel and brass are $12 \times 10^{-6}/^\circ\text{C}$ and $18 \times 10^{-6}/^\circ\text{C}$, respectively.)
- (A) 15 cm (B) 5 cm (C) 10 cm (D) 2 cm
35. A system receives heat continuously at the rate of 10 W. The temperature of the system becomes constant at 70°C when the temperature of the surroundings is 30°C . After the heater is switched off, the system cools from 50°C to 49.9°C in 1 min. The heat capacity of the system is :
- (A) 1000 J/ $^\circ\text{C}$ (B) 1500 J/ $^\circ\text{C}$ (C) 3000 J/ $^\circ\text{C}$ (D) None of these
36. A cube is shifted to a depth of 100 m in a lake. The change in volume is 0.1%. The bulk modulus of the material is nearly :
- (A) 10 Pa (B) 10^4 Pa (C) 10^7 Pa (D) 10^9 Pa
37. **Statement I:** From the relation $Y = \frac{Fl}{A\Delta l}$, we can say that, if length of a wire is doubled, its Young's modulus of elasticity will also becomes two times.
- Statement II:** Modulus of elasticity is a material property.
- (A) Statement-I is True, Statement-II is True and Statement-II is a correct explanation for Statement-I
- (B) Statement-I is True, Statement-II is True and Statement-II is NOT a correct explanation for Statement-I
- (C) Statement-I is True, Statement-II is False
- (D) Statement-I is False, Statement-II is True

- *38.** A light rod of length $2m$ is suspended from a ceiling horizontally by means of two vertical wires of equal length tied to its ends. One of the wires is made of steel and is of cross-section $10^{-3}m^2$ and the other is of brass of cross-section $2 \times 10^{-3}m^2$. x is the distance from steel wire end, at which a weight may be hung. $Y_{steel} = 2 \times 10^{11}Pa$ and $Y_{brass} = 10^{11}Pa$. Which of the following statement(s) is/are correct?

- (A) $x = 1.2m$, if the strains of both the wires are to be equal
(B) $x = 1.42m$ if the stresses of both the wires are to be equal
(C) $x = 1m$, if the strains of both the wires are to be equal
(D) $x = 1.33m$, if the stresses of both the wires are to be equal

- *39.** Two conducting rods when connected between two point at constant but different temperatures separately, the rate of heat flow through them is q_1 and q_2 . Choose the correct options.

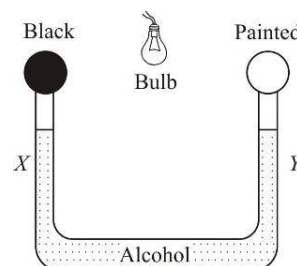
- (A) When they are connected in series, the net rate of heat flow will be $q_1 + q_2$
(B) When they are connected in series, the net rate of heat flow is $\frac{q_1 q_2}{q_1 + q_2}$
(C) When they are connected in parallel, the net rate of heat flow is $q_1 + q_2$
(D) When they are connected in parallel, the net rate of heat flow is $\frac{q_1 q_2}{q_1 + q_2}$

- 40.** Three liquids A, B and C having same specific heats have masses m , $2m$ and $3m$ respectively. Their temperatures are θ , 2θ and 3θ respectively. For temperature of mixture, match the following two columns.

Column I	Column II
(A) When A and B are mixed	(P) $\frac{5}{2}\theta$
(B) When A and C are mixed	(Q) $\frac{5}{3}\theta$
(C) When B and C are mixed	(R) $\frac{7}{3}\theta$
(D) When A, B and C all are mixed	(S) $\frac{13}{5}\theta$

- 41.** A solid sphere of radius R made of a material of bulk modulus B is surrounded by a liquid in a cylindrical container. A massless piston of area A (the area of container is also A) floats on the surface of the liquid. When a mass M is placed, fractional change in radius of the sphere is $\frac{3Mg}{nAB}$. Find the value of n .

- 42.** Figure shows two air-filled bulbs connected by a U-tube partly filled with alcohol. What happens to the levels of alcohol in the limbs X and Y when an electric bulb placed midway between the bulbs is lighted?
- (A) The level of alcohol in limb X falls while that in limb Y rises
(B) The level of alcohol in limb X rises while that in limb Y falls
(C) The level of alcohol falls in both limbs
(D) There is no change in the levels of alcohol in either of the two limbs



43. The molar heat capacity of a certain substance varies with temperature according to the given equation

$$C = 27.2 + (4 \times 10^{-3})T$$

The heat necessary to change the temperature of 2 mol of the substance from 300 K to 700 K is :

- (A) $3.46 \times 10^4 \text{ J}$ (B) $2.33 \times 10^3 \text{ J}$ (C) $3.46 \times 10^3 \text{ J}$ (D) $2.33 \times 10^4 \text{ J}$

44. The coefficient of linear expansion for a certain metal varies with temperature as $\alpha(T)$. If L_0 is the initial length of the metal and the temperature of metal is changed from T_0 to T ($T_0 > T$), then :

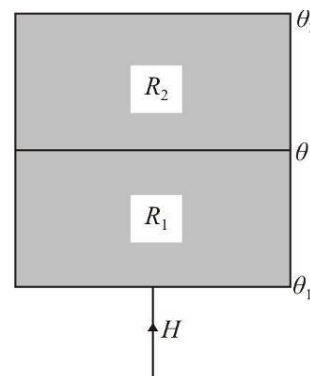
- (A) $L = L_0 \int_{T_0}^T \alpha(T) dT$ (B) $L = L_0 \left[1 + \int_{T_0}^T \alpha(T) dT \right]$
(C) $L = L_0 \left[1 - \int_{T_0}^T \alpha(T) dT \right]$ (D) $L > L_0$

45. The ratio of diameters of two wires of same material is $n : 1$. The length of each wire is 4 m. On applying the same load, the increases in the length of thin wire will be : ($n > 1$)

- (A) n^2 times (B) n times (C) $2n$ times (D) $(2n + 1)$ times

46. Consider the two conducting sheets with thermal resistance R_1 and R_2 as shown in figure. The temperature θ is :

- (A) $\frac{\theta_1 \theta_2 R_1 R_2}{(\theta_1 + \theta_2)(R_1 + R_2)}$
(B) $\frac{\theta_1 R_1 + \theta_2 R_2}{R_1 + R_2}$
(C) $\frac{(\theta_1 + \theta_2) R_1 R_2}{R_1^2 + R_2^2}$
(D) $\frac{\theta_1 R_2 + \theta_2 R_1}{R_1 + R_2}$

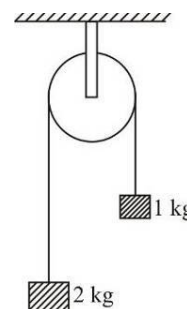


47. When an elastic material with Young's modulus Y is subjected to a stretching stress s , the elastic energy store per unit volume of the material is :

- (A) $s.Y / 2$ (B) $s^2 Y / 2$ (C) $s^2 / 2Y$ (D) $s / 2Y$

48. Two blocks of masses 1 kg and 2 kg are connected by a metal wire going over a smooth pulley as shown in the figure. The breaking stress of the metal is $(40 / 3\pi) \times 10^6 \text{ N / m}^2$. If $g = 10 \text{ m/s}^2$, then what should be the minimum radius of the wire used if it is not to break?

- (A) 0.5 mm (B) 1 mm
(C) 1.5 mm (D) 2 mm



PARAGRAPH FOR QUESTIONS 49 - 51

A hot body placed in air is cooled down according to Newton's law of cooling, the rate of decrease of temperature being k times the temperature difference from the surrounding. Assume that cooling starts at $t = 0$.

49. If T_0 and T_1 be the temperature of the surrounding and the initial temperature of the body respectively, then the temperature of the body at any time t is given by :

(A) $T_0 + (T_1 - T_0)e^{-kt}$ (B) T_0e^{-kt} (C) $T_1(T_0 - T_1)e^{-kt}$ (D) $T_1 + (T_0 - T_1)e^{-kt}$

50. The time in which the body will lose half the maximum heat it can lose is:

(A) $\ln 2$ (B) $\frac{\ln 2}{k}$ (C) $k \ln 2$ (D) $k + \ln 2$

51. If $k = \ln 2$, then the time (in proper unit) in which the body will lose half the maximum heat it can lose is:

(A) 2 (B) 1 (C) 4 (D) 3

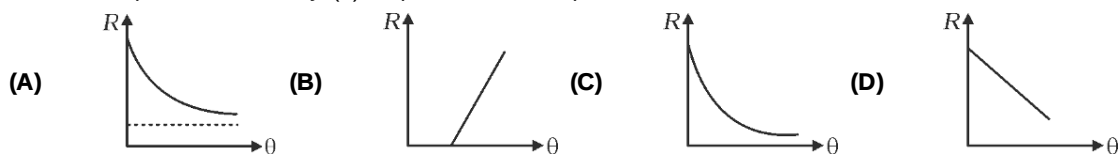
52. Calculate the compression force required to prevent the metallic rod of length l cm and cross-sectional area A cm^2 when heated through $t^\circ\text{C}$, from expanding lengthwise. Young's modulus of elasticity of the metal is E and mean coefficient of linear expansion is α per degree Celsius.

(A) $EA\alpha t$ (B) $EA\alpha t / (1 + \alpha t)$ (C) $EA\alpha t / (1 - \alpha t)$ (D) $El\alpha t$

53. One end of uniform wire of length L and of weight W is attached rigidly to a point in the roof and a weight W_1 is suspended from its lower end. If s is the area of cross section of the wire, the stress in the wire at a height $(3L/4)$ from its lower end is :

(A) $\frac{W_1}{s}$ (B) $\left[W_1 + \frac{W}{4}\right]s$ (C) $\left[W_1 + \frac{3W}{4}\right] / s$ (D) $\frac{W_1 + W}{s}$

54. Temperature of a body θ is slightly more than the temperature of the surrounding θ_0 . Its rate of cooling (R) versus temperature of body (θ) is plotted. Its shape would be :

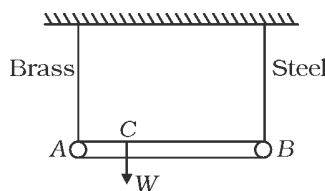


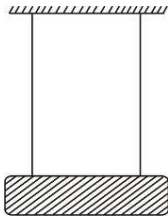
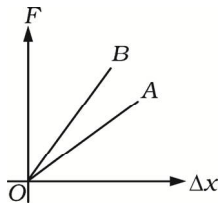
55. A wire of length L and radius r is fixed at one end. A force F applied to the other end produced an extension l . The extension produced in another wire of same material of length $2L$ and radius $2r$ by a force $2F$ is :

(A) l (B) $2l$ (C) $l/2$ (D) $4l$

56. Bulk modulus of water is $2 \times 10^9 \text{ N/m}^2$. The change in pressure required to increase the density of water by 0.1% is :

(A) $2 \times 10^9 \text{ N/m}^2$ (B) $2 \times 10^8 \text{ N/m}^2$ (C) $2 \times 10^6 \text{ N/m}^2$ (D) $2 \times 10^4 \text{ N/m}^2$

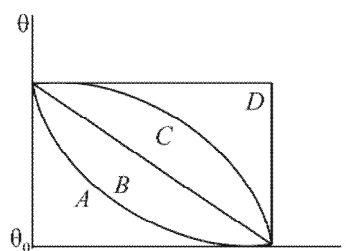
57. A black body at a high temperature T K radiates energy at the rate of E watt $/m^2$. When the temperature falls to $T/2$ K the radiated energy in watt $/m^2$ will be:
(A) $E/4$ (B) $E/2$ (C) $2E$ (D) $E/16$
- *58. The emissive power of a black body at $T = 300$ K is 100 Watt $/m^2$. Consider a body B of area $A = 10m^2$, coefficient of reflection $r = 0.3$ and coefficient of transmission $t = 0.5$. Its temperature is 300 K. Then which of the following are correct?
(A) The emissive power of B is 20 W $/m^2$ (B) The emissive power of B is 200 W $/m^2$
(C) The power emitted by B is 200 Watts (D) The emissivity of B is 0.2
59. A rubber eraser $3\text{ cm} \times 1\text{ cm} \times 8\text{ cm}$ is clamped at one end with 8 cm edge as vertical. A horizontal force $F = 2.1\text{ N}$ is applied on the free surface. Shear modulus of rubber $= 1.4 \times 10^5 \text{ Nm}^{-2}$. The horizontal displacement (in mm) of the top face is x . Find x .
60. A 2 m long light metal rod AB is suspended from the ceiling horizontally by means of two vertical wires of equal length tied to its ends. One wire is of brass and has cross-sectional area of $0.2 \times 10^{-4} m^2$ and the other is of steel with $0.1 \times 10^{-4} m^2$ cross-sectional area. In order to have equal stresses in the two wires, a weight W is hung from the rod. The position of the weight along the rod from end A should be :
(A) 66.6 cm (B) 133 cm (C) 44.4 cm (D) 155.6 cm
- 
61. **Statement I:** Bulk modulus of elasticity can be defined for all three states of matter, solid liquid and gas.
Statement II: Young's modulus is not defined for liquids and gases.
(A) Statement-I is True, Statement-II is True and Statement-II is a correct explanation for Statement-I
(B) Statement-I is True, Statement-II is True and Statement-II is NOT a correct explanation for Statement-I
(C) Statement-I is True, Statement-II is False
(D) Statement-I is False, Statement-II is True
62. A piece of metal weighs 46 g in air. When immersed in a liquid of specific gravity 1.24 at 27°C it weighs 30 g . When the temperature of liquid is raised to 42°C the metal piece weighs 30.5 g . Specific gravity of liquid at 42°C is 1.20 . Find the coefficient of linear expansion of metal.
(A) $2.23 \times 10^{-5} / ^\circ\text{C}$ (B) $6.7 \times 10^{-5} / ^\circ\text{C}$ (C) $4.46 \times 10^{-5} / ^\circ\text{C}$ (D) None of these
63. The dimensions of four wires of the same material are given below. In which wire the increase in the length will be maximum for equal force applied?
(A) Length 100 cm , diameter 1 mm (B) Length 200 cm , diameter 2 mm
(C) Length 300 cm , diameter 3 mm (D) Length 50 cm , diameter 0.5 mm

64. A steel wire with cross section 3 cm^2 has elastic limit $2.4 \times 10^8 \text{ pa}$. The maximum upward acceleration that can be given to 1200 kg elevator supported by this cable if the stress is not to exceed $1/3^{\text{rd}}$ of the elastic limit is: ($g = 10 \text{ m/s}^2$)
- (A) 9ms^{-2} (B) 10ms^{-2} (C) 11ms^{-2} (D) 12ms^{-2}
65. Two wires of equal length and cross-section are suspended as shown. Their Young's moduli are Y_1 and Y_2 respectively. The equivalent Young's modulus will be :
- (A) $Y_1 + Y_2$ (B) $\frac{Y_1 + Y_2}{2}$
(C) $\frac{Y_1 Y_2}{Y_1 + Y_2}$ (D) $\sqrt{Y_1 Y_2}$
- 
66. A bucket full of hot water is kept in a room and it cools from 75°C to 70°C in t_1 min, from 70°C to 65°C in t_2 min and from 65°C to 60°C in t_3 min; then :
- (A) $t_1 = t_2 = t_3$ (B) $t_1 < t_2 < t_3$ (C) $t_1 > t_2 > t_3$ (D) $t_1 < t_2 > t_3$
67. The mechanical equivalent of heat:
- (A) Has the same dimension as heat (B) Has the same dimension as work
(C) Has the same dimension as energy (D) Is dimensionless
68. A wire of length L_0 is supplied heat to raise its temperature by T . If γ is the coefficient of volume expansion of the wire and Y is Young's modulus of the wire then the energy density stored in the wire is :
- (A) $\frac{1}{2} \gamma^2 T^2 Y$ (B) $\frac{1}{3} \gamma^2 T^2 Y^3$ (C) $\frac{1}{18} \frac{\gamma^2 T^2}{Y}$ (D) $\frac{1}{18} \gamma^2 T^2 Y$
- *69. Two liquids of specific heat ratio $1 : 2$ are at temperatures 2θ and θ :
- (A) if equal amounts of them are mixed, then temperature of mixture is 1.5θ
(B) if equal amounts of them are mixed, then temperature of mixture is $\frac{4}{3}\theta$
(C) for their equal amounts, the ratio of heat capacities is $1 : 1$
(D) for their equal amounts, the ratio of their heat capacities is $1 : 2$
70. Two wires A and B of same length are made of same material. The figure represents the load F versus extension Δx graph for the two wires. Then :
- (A) The cross sectional area of A is greater than that of B
(B) The elasticity of B is greater than that of A
(C) The cross-sectional area of B is greater than that of A
(D) The elasticity of A is greater than that of B
- 
- *71. If the temperature of the body is raised to a higher temperature T' , then choose the correct statement(s).
- (A) The intensity of radiation for every wavelength increases
(B) The maximum intensity occurs at a shorter wavelength
(C) The area under the graph increases
(D) The area under the graph is proportional to the fourth power of temperature

72. Two wires of the same material and length but diameters in the ratio 1 : 2 are stretched by the same force. The potential energy per unit volume for the two wires when stretched will be in the ratio :
(A) 16 : 1 (B) 4 : 1 (C) 2 : 1 (D) 1 : 1
73. When a weight of 5 kg is suspended from a copper wire of length 30 m and diameter 0.5 mm, the length of the wire increases by 2.4 cm. If the diameter is doubled, the extension produced is :
(A) 1.2 cm (B) 0.6 cm (C) 0.3 cm (D) 0.15 cm
74. Young's modulus of brass and steel are $10 \times 10^{10} \text{ N/m}^2$ and $2 \times 10^{11} \text{ N/m}^2$, respectively. A brass wire and a steel wire of the same length are extended by 1 mm under the same force. The radii of the brass and steel wires are R_B and R_S , respectively. Then :
(A) $R_S = \sqrt{2} R_B$ (B) $R_S = \frac{R_B}{\sqrt{2}}$ (C) $R_S = 4 R_B$ (D) $R_S = \frac{R_B}{4}$
75. The densities of wood and benzene at 0°C are 880 kg/m^3 and 900 kg/m^3 respectively. The coefficients of volume expansion of wood is $1.2 \times 10^{-3}/^\circ\text{C}$ and of benzene is $1.5 \times 10^{-3}/^\circ\text{C}$. The temperature at which a piece of this wood would just sink in benzene at the same temperature is :
(A) 53°C (B) 63°C (C) 73°C (D) 83°C
76. A rod of length 2m at 0°C and having expansion coefficient $\alpha = (3x + 2) \times 10^{-6} \text{ }^\circ\text{C}^{-1}$ where x is the distance (in cm) from one end of rod. The length of rod at 20°C is:
(A) 2.124 m (B) 3.24 m (C) 2.0002 m (D) 3.0124 m
77. The magnitude of the force developed by raising the temperature from 0°C to 100°C of the iron bar 1.00 m long and 1 cm^2 cross-section when it is held so that it is not permitted to expand or bend is : ($\alpha = 10^{-5}/^\circ\text{C}$ and $Y = 10^{11} \text{ N/m}^2$)
(A) 10^3 N (B) 10^4 N (C) 10^5 N (D) 10^9 N
78. An object is cooled from 75°C to 65°C in 2 minutes in a room at 30°C . The time taken to cool the same object from 55°C to 45°C in the same room in minutes is:
(A) 4 (B) 5 (C) 6 (D) 7
79. Water equivalent of a body is measured in :
(A) Kg (B) Calorie (C) Kelvin (D) m^3
80. A heavy uniform rod is hanging vertically from a fixed support. It is stretched by its own weight. The diameter of the rod is :
(A) Smallest at the top and gradually increases down the rod
(B) Largest at the top and gradually decreases down the rod
(C) Uniform everywhere
(D) Maximum in the middle

81. A hot liquid is kept in a big room. Its temperature is plotted as a function of time. Which of the following curves may represent the plot?

(A) A
(B) B
(C) C
(D) D



82. If the work done in stretching a wire by 1 mm is 2 J, the work necessary for stretching another wire of the same material but with half radius of cross section and half the length by 1 mm is :

(A) $\frac{1}{4}$ J (B) 4 J (C) 8 J (D) 1 J

83. Two bars A and B of circular cross section, same volume and made of the same material, are subjected to tension. If the diameter of A is half that of B and if the force applied to both the rod is the same and it is in the elastic limit, the ratio of extension of A to that of B will be :

(A) 16 (B) 8 (C) 4 (D) 2

84. A hot liquid is kept in a big room. The logarithm of the numerical value of the temperature difference between the liquid and the room is plotted against time. The plot will be very nearly :

(A) A straight line (B) A circular arc (C) A parabola (D) An ellipse

85. When a metal wire is stretched by a load, the fractional change in its volume $\Delta V/V$ is proportional to :

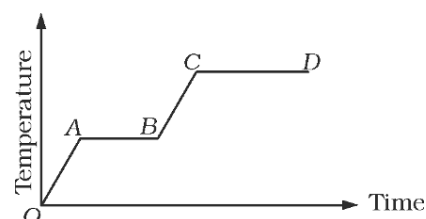
(A) $\frac{\Delta l}{l}$ (B) $\left(\frac{\Delta l}{l}\right)^2$ (C) $\sqrt{\Delta l / l}$ (D) None of these

86. Two rods A and B of the same material and length have radii r_1 and r_2 respectively. When they are rigidly fixed at one end and twisted by the same couple supplied at the other end, the ratio $\frac{(\text{angle of twist at end of A})}{(\text{angle of twist at end of B})}$ is:

(A) r_1^2 / r_2^2 (B) r_2^3 / r_1^3 (C) r_2^4 / r_1^4 (D) r_1^4 / r_2^4

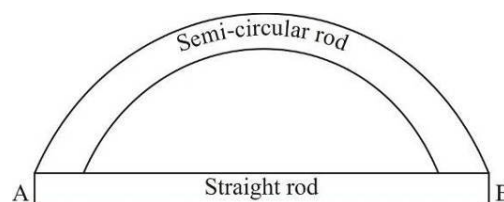
- *87. Heat is supplied to a certain homogeneous sample of matter, at a uniform rate. Its temperature is plotted against time, as shown. Which of the following conclusions can be drawn? (Slope of OA is greater than slope of BC)

(A) Its specific heat capacity is greater in the solid state than in the liquid state
(B) Its specific heat capacity is greater in the liquid state than in the solid state
(C) Its latent heat of vaporisation is greater than its latent heat of fusion
(D) Its latent heat of vaporisation is smaller than its latent heat of fusion



- *88.** A heated body emits radiations which has maximum intensity at frequency ν_m . If the temperature of the body is double, then:
- (A) The maximum intensity radiation will be at frequency $2\nu_m$
 (B) The maximum intensity radiation will be at frequency $(1/2)\nu_m$
 (C) The total emitted energy will increase by a factor of 16
 (D) The total emitted energy will increase by a factor of 2.
- 89.** The breaking stress for a metal is $9 \times 10^{10} \text{ Nm}^{-2}$. The density of the metal is 9000 kg m^{-3} . If $g = 10 \text{ N kg}^{-1}$, the maximum length of the wire made of this metal which may be suspended without breaking is 10^k m . Find the value of k .
- 90.** A wire of length ℓ , area of cross section A and Young's modulus of elasticity Y is stretched by a longitudinal force F . The change in length is $\Delta\ell$. Match the following two columns.
Note : In column I, corresponding to every option, other factors remain constant.
- | Column I | Column II |
|-------------------------|--------------------------------|
| (A) F is increased | (P) $\Delta\ell$ will increase |
| (B) ℓ is increased | (Q) Stress will increase |
| (C) A is increased | (R) $\Delta\ell$ will decrease |
| (D) Y is increased | (S) Stress will decrease |
- *91.** Two metallic spheres A and B are made of same material and have got identical surface finish. The mass of sphere A is four times that of B . Both the spheres are heated to the same temperature and placed in a room having lower temperature but thermally insulated from each other.
- (A) The ratio of heat loss of A to that of B is $2^{2/3}$
 (B) The ratio of heat loss of A to that of B is $2^{1/3}$
 (C) The ratio of the initial rate of cooling of A to that of B is $2^{-2/3}$
 (D) The ratio of the initial rate of cooling of A to that of B is $2^{-4/3}$
- 92.** If a bar is made of copper whose coefficient of linear expansion is $3/2$ times that of iron, then ratio of the force developed in the copper bar to the iron bar of identical lengths and cross-sections, when heated through the same temperature difference (Young's modulus for copper may be taken to be that of iron) is :
- (A) $3/2$ (B) $2/3$ (C) $9/4$ (D) $4/9$
- 93.** A steel ring of radius r and cross-sectional area A is fitted on to a wooden disc of radius R ($R > r$). If Young's modulus of steel is Y , then the force with which the steel ring is expanded is :
- (A) $A Y \frac{R}{r}$ (B) $A Y \left(\frac{R-r}{r} \right)$ (C) $\frac{Y}{A} \left(\frac{R-r}{r} \right)$ (D) $\frac{Yr}{AR}$

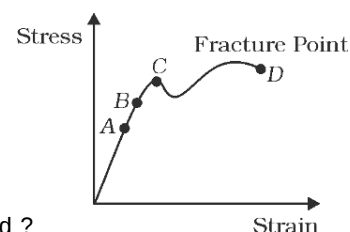
94. Two rods (one semi-circular and other straight) of same material and of same cross-sectional area are joined as shown in the figure. The points A and B are maintained at different temperatures. The ratio of the heat transferred through a cross section of a semi-circular rod to the heat transferred through a cross section of the straight rod in a given time is :



- (A) $2 : \pi$ (B) $1 : 2$ (C) $\pi : 2$ (D) $3 : 2$
95. A clock with an iron pendulum and periodic time 1 sec keeps correct time at 10°C . The error in seconds per day if the temperature is 20°C is: (Take $\alpha = 10 \times 10^{-6}/^\circ\text{C}$)
- (A) 4.32 sec (B) 8.64 sec (C) 2 sec (D) 1 sec
96. The length of an elastic spring is 'a' metre when tension is 4 N and 'b' metre when tension is 5 N. Then length in metre when the tension is 9 N is :
- (A) $4a - 5b$ (B) $5b - 4a$ (C) $5b + 4a$ (D) $9(b - a)$
- *97. Four rods A, B, C and D of the same length and material but of different radii $r, r\sqrt{2}, r\sqrt{3}$, and $2r$, respectively, are held between two rigid walls. The temperature of all rods is increased through the same range. If the rods do not bend, then :
- (A) the stress in the rods A, B, C and D is in the ratio $1 : 2 : 3 : 4$
 (B) the forces on them exerted by the wall are in the ratio $1 : 2 : 3 : 4$
 (C) the energy stored in the rods due to elasticity is in the ratio $1 : 2 : 3 : 4$
 (D) the energy is independent of area
98. A metal ball of surface area 200 cm^2 and temperature 527°C is surrounded by a vessel at 27°C . If the emissivity of the metal is 0.4, then the rate of loss of heat from the ball is approximately.
 ($\sigma = 5.27 \times 10^{-8}\text{ J/m}^2\text{-s-K}^4$)
- (A) 108 J (B) 168 J (C) 182 J (D) 192 J

PARAGRAPH FOR QUESTIONS 99 - 101

The graph shown below shows qualitatively the relation between the stress and the strain as the deformation gradually increases. Within Hooke's limit for a certain region stress and strain relation is linear. Beyond that up to a certain value of strain the body is still elastic and if deforming forces are removed the body recovers its original shape.



99. If deforming forces are removed up to which point the curve will be retraced ?
- (A) up to OA only (B) up to OB (C) up to C (D) Never retraced its path
100. In the above question, during loading and unloading the force exerted by the material are conservative up to :
- (A) OA only (B) OB only (C) OC only (D) OD only
101. During unloading beyond B, say C, the length at zero stress is now equal to :
- (A) less than original length (B) greater than original length
 (C) original length (D) can't be predicted