Thermal Properties Of Matter

Very Short Answer Type Questions

1. Is the bulb of a thermometer made of diathermic or adiabatic wall?
2. A student records the initial length l, change in temperature ΔT and change in length Δl of a rod as follows:

S.No.	l (m)	ΔT (°C)	Δl (m)
1.	2	10	4×10^{-4}
2.	1	10	4×10^{-4}
3.	2	20	2×10^{-4}
4.	3	10	6×10^{-4}

   If the first observation is correct, what can you say about observations 2, 3 and 4.
3. Why does a metal bar appear hotter than a wooden bar at the same temperature? Equivalently it also appears cooler than wooden bar if they are both colder than room temperature.
4. Calculate the temperature which has same numeral value on celsius and Fahrenheit scale.
5. These days people use steel utensils with copper bottom. This is supposed to be good for uniform heating of food. Explain this effect using the fact that copper is the better conductor.

Short Answer Type Questions

1. Find out the increase in moment of inertia I of a uniform rod (coefficient of linear expansion α) about its perpendicular bisector when its temperature is slightly increased by ΔT.
2. During summers in India, one of the common practice to keep cool is to make ice balls of crushed ice, dip it in flavoured sugar syrup and sip it. For this a stick is inserted into crushed ice and is squeezed in the palm to make it into the ball. Equivalently in winter, in

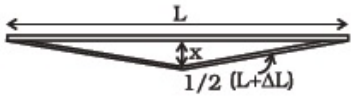
those areas where it snows, people make snow balls and throw around. Explain the formation of ball out of crushed ice or snow in the light of P–T diagram of water.

3. 100 g of water is supercooled to −10°C. At this point, due to some disturbance mechanised or otherwise some of it suddenly freezes to ice. What will be the temperature of the resultant mixture and how much mass would freeze?
   [S_w = 1cal/g/°C and L^w_{Fusion} = 80cal/g]
4. One day in the morning, Ramesh filled up 1/3 bucket of hot water from geyser, to take bath. Remaining 2/3 was to be filled by cold water (at room temperature) to bring mixture to a comfortable temperature. Suddenly Ramesh had to attend to something which would take some times, say 5-10 minutes before he could take bath. Now he had two options: (i) fill the remaining bucket completely by cold water and then attend to the work, (ii) first attend to the work and fill the remaining bucket just before taking bath.
   Which option do you think would have kept water warmer? Explain.

Long Answer Type Questions

1. We would like to prepare a scale whose length does not change with temperature. It is proposed to prepare a unit scale of this type whose length remains, say 10 cm. We can use a bimetallic strip made of brass and iron each of different length whose length (both components) would change in such a way that difference between their lengths remain constant. If $\alpha_{iron} = 1.2 \times 10^{-5}$ / K and α brass $= 1.8 \times 10^{-5}$ /K , what should we take as length of each strip?
2. We would like to make a vessel whose volume does not change with temperature (take a hint from the problem above). We can use brass and iron ($\beta_{vbrass} = 6 \times 10^{-5}$ /K and $\beta_{viron} = 3.55 \times 10^{-5}$/ K) to create a volume of 100 cc. How do you think you can achieve this.
3. Calculate the stress developed inside a tooth cavity filled with copper when hot tea at temperature of 57°C is drunk. You can take body (tooth) temperature to be 37°C and $\alpha = 1.7 \times 10^{-5}$ /°C, bulk modulus for copper = $140 \times 10^9 N/m^2$.
4. A rail track made of steel having length 10 m is clamped on a raillway line at its two ends (Fig 11.3). On a summer day due to rise in temperature by 20° C , it is deformed as

shown in figure. Find x (displacement of the centre) if α steel = 1.2×10^{-5}/°C.



5. A thin rod having length L_0 at 0°C and coefficient of linear expansion α has its two ends maintained at temperatures θ_1 and θ_2, respectively. Find its new length.
6. According to Stefan's law of radiation, a black body radiates energy σT^4 from its unit surface area every second where T is the surface temperature of the black body and $\sigma = 5.67 \times 10^{-8}$ W/m^{2}K^4 is known as Stefan's constant. A nuclear weapon may be thought of as a ball of radius 0.5 m. When detonated, it reaches temperature of 10^6 K and can be treated as a black body.
   - (a) Estimate the power it radiates.
   - (b) If surrounding has water at 30°C , how much water can 10% of the energy produced evaporate in 1 s?
     [S_w = 4186.0 J/kg K and $L_v = 22.6 \times 10_5$J/kg]
   - (c) If all this energy U is in the form of radiation, corresponding momentum is p = U/c. How much momentum per unit time does it impart on unit area at a distance of 1 km?