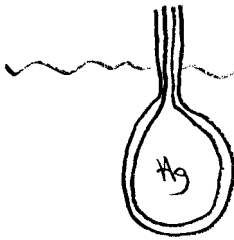


1. [Serway Chapter 19 Question 6, pg 544]
Explain why a column of mercury in a thermometer first descends slightly and then rises when placed in hot water.



The hot water expands the glass first.
 \therefore the volume of the bulb increases \therefore Hg level \downarrow .
 Then the Hg heats up and expands. \therefore Hg level \uparrow .

2. [Serway Chapter 19 Problem 18, pg 545]
A concrete walk is poured on a day when the temperature is 20°C in such a way that the ends are unable to move.
- What is the stress in the cement on a hot day of 50°C ?
 - Does the concrete fracture? Take Young's modulus for concrete to be $7.0 \times 10^6 \text{ N/m}^2$ and the tensile strength to be $2 \times 10^6 \text{ N/m}^2$.

$$\gamma \frac{\Delta L}{L} = \frac{F}{A} \quad , \quad \frac{\Delta L}{L} = \alpha \Delta T = 12 \times 10^{-6} \times 30 = 0.36 \times 10^{-3}$$

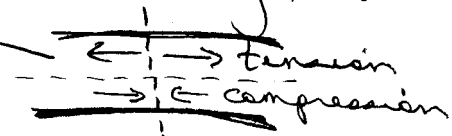
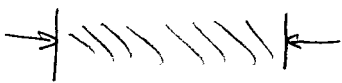
$$\therefore F/A = \text{stress} = 7 \times 10^6 \times 0.36 \times 10^{-3}$$

$$= 2.52 \times 10^3 \text{ N/m}^2 \ll \text{tensile strength of } 2 \times 10^6 \text{ N/m}^2$$

\therefore Does not fracture

Note:

The load is compression but consider the tendency to buckle:



3. [Serway Chapter 19 Problem 20, pg 545]
The New River Gorge Bridge in West Virginia is a steel arch bridge 518 m in length. How much does its length change between temperature extremes of -20.0°C and 35.0°C ?

$$\Delta L = \alpha L \Delta T = 11 \times 10^{-6} \times 518 \times 55 = \underline{\underline{0.313 \text{ m}}}$$

4. [Serway Chapter 19 Problem 22, pg 546]

A steel rod undergoes a stretching force of 500 N. Its cross sectional area is 2.00 cm^2 . Find the change in temperature that would elongate the rod by the same amount produced by the 500-N force. (Hint: Refer to Tables 12.1 and 19.2.)

$$\frac{F}{A} = \frac{500 \text{ N}}{2 \times 10^{-4} \text{ m}^2} = 2.5 \times 10^6 \text{ N/m}^2$$

$$Y = 20 \times 10^{10} \text{ N/m}^2$$

$$\therefore \frac{\Delta l}{l} = \frac{F/A}{Y} = \frac{2.5 \times 10^6}{20 \times 10^{10}} = 1.25 \times 10^{-5}$$

$$\text{Since } \frac{\Delta l}{l} = \alpha \Delta T, \Delta T = \frac{\Delta l}{l \alpha} = \frac{1.25 \times 10^{-5}}{11 \times 10^{-6}} = \underline{\underline{1.136^\circ \text{C}}}$$

5. [Serway Chapter 19 Problem 42, pg 547]

At 25.0 m below the surface of the sea (density = 1025 kg/m^3), where the temperature is 5.00°C , a diver exhales an air bubble having a volume of 1.00 cm^3 . If the surface temperature of the sea is 20.0°C , what is the volume of the bubble right before it breaks the surface?

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

$$P_1 = P_A + \rho g \times 25 \text{ m.}$$

$$P_2 = P_A$$

$$V_2 = ?$$

$$V_1 = 1 \text{ cm}^3$$

$$T_2 = 20 + 273.15 = 293.15$$

$$T_1 = 5 + 273.15 = 278.15 \text{ K}$$

$$\therefore V_2 = \frac{P_1 V_1}{T_1} \cdot \frac{T_2}{P_2} = \left\{ \frac{1.00 \text{ cm}^3 \times \left(101 \times 10^3 \text{ Pa} + 1025 \text{ kg/m}^3 \times 9.8 \frac{\text{m}}{\text{s}^2} \times 25 \right)}{101 \times 10^3 \text{ Pa}} \right\} \times \frac{293.15}{278.15} = \underline{\underline{2.62 \text{ cm}^3}}$$

6. [Serway Chapter 19 Problem 45, pg 547]

The tire on a bicycle is filled with air to a gauge pressure of 550 kPa at 20°C . What is the gauge pressure in the tire after a ride on a hot day when the tire air temperature is 40°C ? (Assume constant volume and a constant atmospheric pressure of 101 kPa.)

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

$$P_1 = 550 + 101 \text{ kPa} = 651 \text{ kPa}$$

$$P_2 = ?$$

$$T_1 = 20 + 273.15 = 293.15 \text{ K}$$

$$T_2 = 40 + 273.15 = 313.15 \text{ K}$$

$$\therefore P_2 = P_1 \frac{T_2}{T_1} = 651 \times \frac{313.15}{293.15} = 695.414 = \underline{\underline{594.4 \text{ kPa gauge}}}$$