

***Finn s Thermal Physics 3rd edition Rex Solutions
Manual***

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Chapter 2

3. The contraction from the hottest day to coldest day is

$$\Delta L = \alpha L \Delta T = (1.2 \times 10^{-5} / ^\circ\text{C})(15 \text{ m})(-60^\circ\text{C}) = -10.8 \text{ mm}$$

When added to the existing gap of 2.0 mm, this makes a net gap of 13 mm.

4. (a) From Equation 2.2, $V = \frac{\Delta V}{\beta \Delta T} = \frac{\pi r^2}{\beta} \frac{\Delta x}{\Delta T}$

for expansion by Δx in a tube of radius r . inserting the numerical values:

$$V = \frac{\pi r^2}{\beta} \frac{\Delta x}{\Delta T} = \frac{\pi (5 \times 10^{-5} \text{ m})^2}{49 \times 10^{-5} / ^\circ\text{C}} \frac{0.001 \text{ m}}{1^\circ\text{C}} = 1.60 \times 10^{-8} \text{ m}^3 = 1.6 \times 10^{-2} \text{ cm}^3$$

This is small but reasonable given the size of the tube.

(b) Using the same formula but different expansion data:

$$V = \frac{\pi r^2}{\beta} \frac{\Delta x}{\Delta T} = \frac{\pi (5 \times 10^{-5} \text{ m})^2}{49 \times 10^{-5} / ^\circ\text{C}} \frac{0.02 \text{ m}}{1^\circ\text{C}} = 3.2 \times 10^{-7} \text{ m}^3 = 0.32 \text{ cm}^3$$

(c) For ethanol the expansion coefficient is now $\beta = 75 \times 10^{-5} / ^\circ\text{C}$, which is slightly higher than for mercury. Therefore the volumes must be slightly smaller.

Ordinary thermometer: $V = \frac{\pi r^2}{\beta} \frac{\Delta x}{\Delta T} = \frac{\pi (5 \times 10^{-5} \text{ m})^2}{75 \times 10^{-5} / ^\circ\text{C}} \frac{0.001 \text{ m}}{1^\circ\text{C}} = 1.0 \times 10^{-8} \text{ m}^3 = 1.0 \times 10^{-2} \text{ cm}^3$

Medical thermometer: $V = \frac{\pi r^2}{\beta} \frac{\Delta x}{\Delta T} = \frac{\pi (5 \times 10^{-5} \text{ m})^2}{75 \times 10^{-5} / ^\circ\text{C}} \frac{0.02 \text{ m}}{1^\circ\text{C}} = 2.1 \times 10^{-7} \text{ m}^3 = 0.21 \text{ cm}^3$

6. The original gas volume is $V_0 = \frac{nRT}{P} = \frac{(2.0)(8.31 \text{ J/K})(300 \text{ K})}{101.3 \times 10^3 \text{ Pa}} = 0.04922 \text{ m}^3$

$$W_1 = -P\Delta V = -(101.3 \times 10^3 \text{ Pa})(0.04922 \text{ m}^3) = -4986 \text{ J}$$

$$W_2 = nRT \ln 2 = (2.0)(8.31 \text{ J/K})(600 \text{ K})(\ln 2) = 6912 \text{ J (note } T = 600 \text{ K after step 1)}$$

$$W_3 = 0 \text{ (because there is no work, only heat)}$$

$$W_{\text{net}} = -4986 \text{ J} + 6912 \text{ J} = 1926 \text{ J}$$

The net work is positive because the compression work is greater than that done by the gas in expansion.

7. (a) Using Equation 2.3

$$\Delta P = B \frac{\Delta V}{V} = (2.2 \times 10^9 \text{ N/m}^2)(0.01) = 2.2 \times 10^7 \text{ Pa}$$

(b) Initially the pressure is zero, and it increases gradually to the value found in part (a).

Therefore the average pressure is half the final value. The initial volume of 10 kg of water is $10 \text{ L} = 0.01 \text{ m}^3$, so $\Delta V = 10^{-4} \text{ m}^3$.

$$W = P_{\text{avg}} \Delta V = (1.1 \times 10^7 \text{ Pa})(1.0 \times 10^{-4} \text{ m}^3) = 1100 \text{ J}$$

This is equivalent to finding the area on the PV graph.