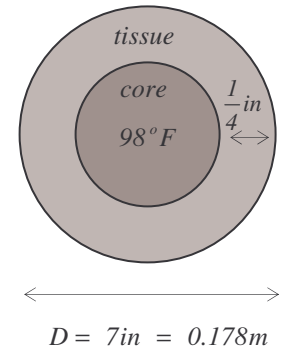
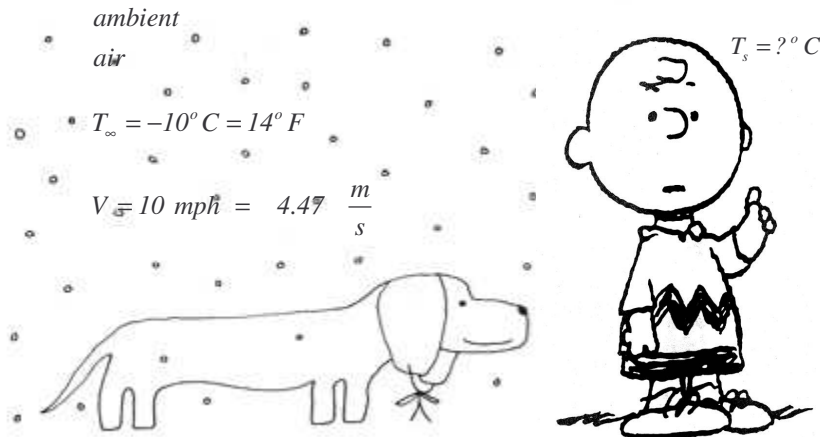
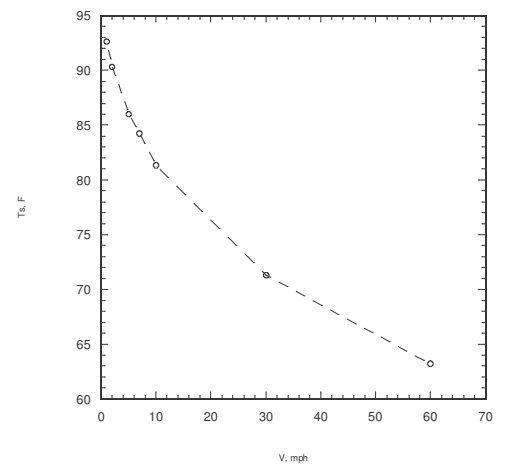


A head of a bald person can be modeled as a sphere with a core at constant temperature at $98^{\circ}\text{F} = 36.7^{\circ}\text{C}$ covered by a layer of a tissue (with the properties close to the properties of water).

What is a temperature of the surface of a head in a windy winter day (neglect radiation)?



Q-06 W09 Bald Head



$$\mu_s = 184e-7 \text{ at } T_s = 300\text{K}$$

Other properties at $T_{\infty} = 263\text{K}$:

$$\mu = 165.9e-7$$

$$k = 23.3e-3$$

$$Pr = 0.717$$

$$Re_D = \frac{VD}{\nu} = \frac{(4.47) \cdot (0.178)}{(12.61e-6)} = 63,100$$

$$\overline{Nu}_D = 2 + (0.4 Re_D^{1/2} + 0.06 Re_D^{2/3}) Pr^{0.4} \left(\frac{\mu}{\mu_s} \right)^{1/4} = 166.7$$

$$\bar{h} = \frac{\overline{Nu}_D \cdot k}{D} = 21.9$$

$$R_{cond} = \frac{T_1 - T_2}{q} = \frac{\frac{1}{r_1} - \frac{1}{r_2}}{4\pi k_w} = 0.114$$

$$R_{conv} = \frac{1}{hA} = \frac{1}{h(4\pi r^2)} = 0.459$$

$$q = \frac{T_c - T_{\infty}}{R_{cond} + R_{conv}} = 81.3$$

$$q = \frac{T_s - T_{\infty}}{R_{conv}} \Rightarrow T_s = T_{\infty} + q \cdot R_{conv} = 300.5\text{K} = 27.4^{\circ}\text{C} = 81.3^{\circ}\text{F}$$

Answer : $T_s = 300.5\text{K} = 27.4^{\circ}\text{C} = 81.3^{\circ}\text{F}$