1.26

1.29

1.29 An open, rigid-walled, cylindrical tank contains 4 ft³ of water at 40 °F. Over a 24-hour period of time the water temperature varies from 40 °F to 90 °F. Make use of the data in Appendix B to determine how much the volume of water will change. For a tank diameter of 2 ft, would the corresponding change in water depth be very noticeable? Explain.

mass of water $= \forall \times \rho$

where $\forall$ is the volume and ρ the density. Since the mass must remain constant as the temperature changes

$$\forall_{40^\circ} \times \rho_{40^\circ} = \forall_{90^\circ} \times \rho_{90^\circ} \qquad (1)$$

From Table B.1 $\rho_{H_2O\,@\,40^\circ F} = 1.940 \frac{slugs}{ft^3}$

$$\rho_{H_2O\,@\,90^\circ F} = 1.931 \frac{slugs}{ft^3}$$

Therefore, from Eq. (1)

$$\forall_{90^\circ} = \frac{(4\,ft^3)(1.940 \frac{slugs}{ft^3})}{1.931 \frac{slugs}{ft^3}} = 4.0186\ ft^3$$

Thus, the increase in volume is

$$4.0186 - 4.000 = \underline{\underline{0.0186\ ft^3}}$$

The change in water depth, Δl, is equal to

$$\Delta l = \frac{\Delta \forall}{area} = \frac{0.0186\ ft^3}{\frac{\pi}{4}(2ft)^2} = 5.92 \times 10^{-3} ft = 0.0710\ in.$$

This small change in depth would not be very noticeable. $\underline{\underline{No}}$.

Note: A slightly different value for Δl will be obtained if specific weight of water is used rather than density. This is due to the fact that there is some uncertainty in the fourth significant figure of these two values, and the solution is sensitive to this uncertainty.