

Problem 1.48

[Difficulty: 3]

1.48 From Appendix A, the viscosity μ ($\text{N} \cdot \text{s}/\text{m}^2$) of water at temperature T (K) can be computed from $\mu = A10^{B/(T-C)}$, where $A = 2.414 \times 10^{-5} \text{ N} \cdot \text{s}/\text{m}^2$, $B = 247.8 \text{ K}$, and $C = 140 \text{ K}$. Determine the viscosity of water at 30°C , and estimate its uncertainty if the uncertainty in temperature measurement is $\pm 0.5^\circ\text{C}$.

Given: Data on water

Find: Viscosity; Uncertainty in viscosity

Solution:

The data is: $A = 2.414 \times 10^{-5} \cdot \frac{\text{N} \cdot \text{s}}{\text{m}^2}$ $B = 247.8 \text{ K}$ $C = 140 \cdot \text{K}$ $T = 303 \cdot \text{K}$

The uncertainty in temperature is $u_T = \frac{0.5 \cdot \text{K}}{293 \cdot \text{K}}$ $u_T = 0.171 \cdot \%$

Also $\mu(T) = A \cdot 10^{\frac{B}{(T-C)}}$ Evaluating $\mu(293 \cdot \text{K}) = 1.005 \times 10^{-3} \cdot \frac{\text{N} \cdot \text{s}}{\text{m}^2}$

For the uncertainty $\frac{d}{dT} \mu(T) = - \frac{A \cdot B \cdot \ln(10)}{10^{\frac{B}{C-T}} \cdot (C-T)^2}$

Hence $u_{\mu(T)} = \left| \frac{T}{\mu(T)} \cdot \frac{d}{dT} \mu(T) \cdot u_T \right| = \frac{\ln(10) \cdot |B \cdot T \cdot u_T|}{(|C-T|)^2}$ Evaluating $u_{\mu(T)} = 1.11 \cdot \%$