

Problem 2.39

[Difficulty: 3]

2.39 Some experimental data for the viscosity of helium at 1 atm are

$T, ^\circ\text{C}$	0	100	200	300	400
$\mu, \text{N} \cdot \text{s}/\text{m}^2 (\times 10^5)$	1.86	2.31	2.72	3.11	3.46

Using the approach described in Appendix A.3, correlate these data to the empirical Sutherland equation

$$\mu = \frac{bT^{1/2}}{1 + S/T}$$

(where T is in kelvin) and obtain values for constants b and S .

Given: Viscosity data

Find: Obtain values for coefficients in Sutherland equation

Solution:

Data:

Using procedure of Appendix A.3:

$T (^{\circ}\text{C})$	$T (\text{K})$	$\mu (\times 10^5)$
0	273	1.86E-05
100	373	2.31E-05
200	473	2.72E-05
300	573	3.11E-05
400	673	3.46E-05

$T (\text{K})$	$T^{3/2}/\mu$
273	2.43E+08
373	3.12E+08
473	3.78E+08
573	4.41E+08
673	5.05E+08

The equation to solve for coefficients S and b is

$$\frac{T^{3/2}}{\mu} = \left(\frac{1}{b} \right) T + \frac{S}{b}$$

From the built-in *Excel* *Linear Regression* functions:

$$\begin{aligned} \text{Slope} &= 6.534\text{E}+05 \\ \text{Intercept} &= 6.660\text{E}+07 \\ R^2 &= 0.9996 \end{aligned}$$

Hence:

$$\begin{aligned} b &= 1.531\text{E}-06 \quad \text{kg/m} \cdot \text{s} \cdot \text{K}^{1/2} \\ S &= 101.9 \quad \text{K} \end{aligned}$$

