RESULTS AND CONCLUSIONS

According to Figure 3, plotting $\frac{eV}{T}$ versus $\ln(\frac{I}{I_o}+1)$ does yield a linear plot. Ideally, the slope of the plot should be equal to the Boltzmann constant, or "k". The 2 lines plotted in Figure 3 represent the full range of possible slopes that fit all of the data. Those slopes fall within the range of (2.34 ± .175) x10^{-23} J/K. Applying the usual method of rounding the final result, our experimental value for k is (2 ± .2) x10^{-23} J/K. Considering our ideality factor of 1.5, this agrees with the accepted value for k of 1.38 x10^{-23} m/s^2 to within uncertainties.

The uncertainty in the final result is on the order of 1% of the average value. This seems to imply that there is some small room for improvement. Rewriting Eq. (7) as

$$k = \frac{eV}{T} * \frac{1}{\ln(\frac{I}{I_o}+1)} \tag{9}$$

one can take the total differential to obtain

$$dk = \frac{e}{T} * \frac{1}{\ln\left(\frac{I}{I_o}+1\right)} dV - \frac{eV}{T} * \frac{1}{(\ln(\frac{I+I_o}{I_0}))^2 (I+I_0)} dI\ . \tag{10}$$

Treating infinitesimally small changes in k, V, and I (traditional calculus notation) as experimental uncertainties, Eq. (9) can be rewritten as an error equation as follows.

$$\delta k = \frac{e}{T} * \frac{1}{\ln\left(\frac{I}{I_o}+1\right)} \delta V - \frac{eV}{T} * \frac{1}{(\ln(\frac{I+I_o}{I_0}))^2 (I+I_0)} \delta I. \tag{11}$$

The first term is an expression that illustrates how small uncertainties in V translate into small uncertainties in k and the second term illustrates how small uncertainties in I translate into small uncertainties in k.

An error-analysis table can be constructed where both of the terms in Eq. (11) serve as column headings. With this table one can identify the dominant source of error.

We have reviewed this document and fully support its content.

-Greg W
-Jeremy W
-Aric M
-frank zoladz