ANALYSIS

The non-linear behavior of the original data set makes it very difficult to obtain a value for k. A model will be devised that will linearize the data with a slope of that line equaling k.

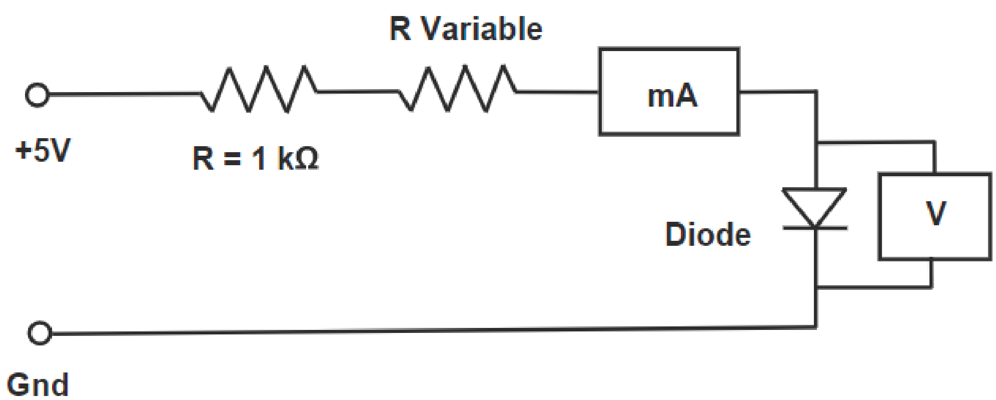

FIGURE 2: Circuit Setup (Forward Bias)

The theoretical relationship between voltage across and current though a p-n junction is

$$\frac{dI}{dV} = a(I + I_0) \tag{1}$$

Where

$$a = \frac{e}{kT} \tag{2}$$

And

$$-I_0 = I \text{ as } V \to \infty \tag{3}$$

Under no bias the number of electrons (N) able to move from the n side to the p side of the junction is proportional to,

$$Ne^{-eV_0/kt} \tag{4}$$

I_0 is proportional to the same factor. When a forward bias is applied, that number is proportional to

$$Ne^{-e(V_0-V)/kt} = Ne^{-eV_0/kt}e^{eV/kt} \tag{5}$$

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I is proportional to that number, therefore

$$I = I_0 e^{eV/kt}. \tag{6}$$

An additional current of -I_0 is present due to the motion of holes from the n side to the p side of the junction.Thus, the total current is

$$I = I_o\left(e^{eV/kT} - 1\right). \tag{7}$$

This is the Shockley diode equation, which we can see corresponds to (1) by checking the conditions $V \to -\infty, V = 0,$ and $V \to \infty$. These conditions return values of

$$I = -I_o$$

$$I = 0$$

$$I = \infty$$

respectively, for both (1) and (7).

We linearize the Shockley diode equation in the form of y = mx

$$\left(\frac{I}{I_0}\right) + 1 = e^{eV/kt} \to \ln\left(\left(\frac{I}{I_0}\right) + 1\right) = \frac{eV}{kT}$$

If we plot

$$\frac{eV}{T}\ versus\ (\mathrm{k}) \ln\left(\left(\frac{I}{I_0}\right) + 1\right)$$

we obtain a linear plot with a slope of *k.*

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