The Heat Equation, generalized:

$$-k\nabla^2 T = \rho C \frac{\partial T}{\partial t} \tag{1}$$

The exact solution to the heat equation with an infinite line source with constant heat flux:

$$T(r,t) = -\frac{q}{4\pi k}\mathrm{Ei}\left(-\frac{r^2}{4kt}\right) \tag{2}$$

Note that q is the heat flux per linear distance.

The "long-time" solution to the same problem:

$$T(r,t) = \frac{q}{4\pi k}\ln\left(\frac{4kt}{r^2} - \frac{\gamma q}{4\pi k}\right) \tag{3}$$

Note that γ is the "Euler-Masceroni constant."

Using this solution to solve for k:

$$k = \frac{q}{4\pi}\left(\frac{dT}{d\left(\ln(t)\right)}\right)^{-1} \tag{4}$$

$\frac{dT}{d(\ln(t))}$ may be found using a linear curve fit.

An Analogous Approach applied to the Cooling Curve:

$$k = -\frac{q}{4\pi}\left(\frac{dT}{d\left(\ln(t_{\mathrm{cool}})\right)}\right)^{-1} \tag{5}$$

$t_{\mathrm{cool}} = t - t_{\mathrm{heated}}$, where t_{heated} is the length of time the sample was heated. In other words, for the cooling curve, reset t_0.

Calculating q, heat flux per linear distance (W/m) from the given voltage:

$$\left(\frac{V^2}{R}\right)\Big/ l \tag{6}$$

The "voltage" column is given in millivolts. $R = 0.7902\Omega$, and $l = 0.120\mathrm{m}$. V should be averaged over the heating curve portion of the experiment.