Determining a large resistance

Metals are good conductors of electricity, because thay contain an abundance of free electrons, which due to their high mobility carry the current easily. An electric current passing through metal is proportional to the potential difference across its two ends, that is, $I \propto U$. The constant of proportionality is $1/R$, where R is the resistance of the metal. Therefore, we get that

$$I = \frac{U}{R}. \tag{1}$$

Resistance is a characteristic quantity of matter, and it reflects the ability of that particular substance to resist electrical current. Resistance can be determined, for example, with the help of a Wheatstone–bridge, where an additional resistor of known resistance is needed. If the resistance of the substance is very high, a Wheatstone–bridge cannot be used. Instead, one has to use a RC-circuit, wherein a capacitator of capacitance C is charged to a certain voltage and then let to discharge itself through the resistor being measured. Since the voltage over the plates of the capacitator is the same as the one across the resistor, one finds an equation for the voltage in the resistor:

$$U = -RC\,\frac{\mathrm{d}U}{\mathrm{d}t} \tag{2}$$

This differential equation has the solution

$$U = D\exp\left(-\frac{t}{RC}\right), \tag{3}$$

where D is a constant of integration. From this, one obtains the expression for a line

$$\ln U = -\frac{t}{RC} + K, \tag{4}$$

where K is a constant.

Let us assume that we have measured the potential difference across the plates of the capactitator U (the internal resistance of the volt-meter is taken to be zero) as a function of time t at the moments $t = 0, 1, \ldots, 10$ s, and that we have got $U = 10.04, 7.67, 5.73, 4.37, 3.23, 2.62, 1.75, 1$ We take the logarithms of the measured values of the voltage, fit a line to the data, and compute the resistance using the equation (4). The capacitance of the capacitor is $C = 0.450 \pm 0.008$ pF. Calculate an error-estimate using the total differential. The error in the slope of the fitting line can be obtained using the `Regress` command (look for standard error, SE). Note, that all the terms in the expression for the total differential must be summed positive!

As your results, give the resistance you have calculated along with its error bounds and plot the data points together with the fitted line into same figure.