Assumed that we have a resistor with resistance we need to calculate. We can use **Ohm’s law** to calculate the resistance, given that we know both the voltage, and the current flows through the resistor under that current. It is possible to determine the value of the current and voltage, using an Amperemeter and a Voltmeter.

In theory, an ideal Voltmeter would have infinitely large inner resistance, so that the current we trying to measure does not flow through it. As oppose to that, an ideal Amperemeter would have its inner resistance as zero, so it does not consume any energy at all and the current flows through it will not drop. However, in reality, the meters are not ideal. They both will consume some of the energy carried by the current (because they both have inner resistance).

So, in order to overcome this “error” (due to the energy consumed by the meters) we will use two different configuration of circuits to measure the current and voltage of the resistor: one type of coupling that is called short coupling and another called long coupling. After gathering the information by long and short coupling, we can derive equations which take into account the internal resistances of meters and can be used to correct methodological errors.

In a short coupling (figure a below), we connect a voltmeter and the resistor parallel to each other, and then a ammeter is connected directly outside this circuit. It is clear that now, the voltmeter will measure the correct voltage of the resistor. As oppose to this fact, as the ammeter measures its own current, the ammeter in this case will show the total current that is divided between the resistor and the voltmeter.

So, in this case, we can use **Kirchhoff’s first rule** to give an equation that describes the relationship between the 3 currents: the current that flows thought the ammeter I\_a, the current flows through the resistor I and the current flows through the voltmeter I\_v:

I\_a = I + I\_v (1)

Using **Ohm’s law**, we can rewritten I\_v as a function of U and R\_v. And since the voltmeter and the resistor are parallel to each other, their voltage are going to be equal: U = U\_v

I\_v = U\_v/R\_v = U/R\_v (2)

Substitute (2) into (1) gives:

I\_a = I + U/R\_v

Which gives the current flowing through the resistor as:

I = I\_a – U/R\_v

This equation is used when the methodological error correction is calculated for the current values obtained using the short coupling.

In long coupling (figure b below), we connect an ammeter directly next to the resistor so that the ammeter measures the current flowing through the resistor. We then connect a voltmeter parallel to that (the ammeter and the resistor), which is used to measure U\_v. This U\_v is the sum of voltages across the resistor (which is U) and the ammeter (which is U\_a). Now, we can use **Kirchhoff’s second law** to make an equation that describes the relationship of these values:

U\_v – U\_r – U\_a = 0

Since the ammeter is next to the resistor, the ammeter will measure the current that flows through the resistor, so we have

I\_a = I\_R = I

Which can then be used to calculate the voltage of the ammeter:

U\_a = I\_a \* R\_a = R\_a \* I

And thus, we can get an equation for the voltage of the resistor:

U = U\_v – R\_a \* I

**ERROR EVALUATION**

\_Draw the line of best fit to measuring points using **LEAST-SQUARE REGRESSION**

\_Draw the line that **represent the resistance from the multimeter**

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**QUALITATIVE CONCLUSIONS**