Introductory Exercise: Ohm's Law

PHY224H1 S — Winter 2020

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1. Introduction

The setup of the circuit was as follows:

- negative terminal of the power supply connected to the common terminal of multimeter #1
- ammeter terminal of multimeter #1 connected to one side of the resistor
- the same side of the resistor also connected to the common terminal of multimeter #2
- voltage/resistance terminal of multimeter #2 connected to other side of the resistor
- the same side of the resistor also connected to the positive terminal of the power supply

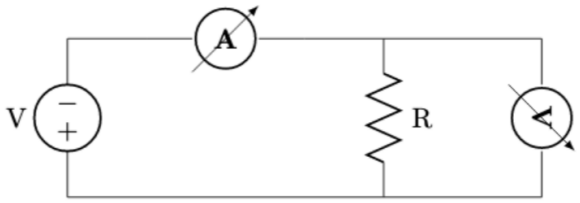

Figure 1: Circuit diagram of setup.

The steps that we followed were:

1. Connect setup to resistor.
2. Turn on power supply and both multimeters.
3. Record the voltage.
4. Change the voltage.

The lower portion of one multimeter was set to DCA (the ammeter) and the other to DCV (the voltmeter). The upper portions of the ammeter and the voltmeter were set to the lowest settings which still gave a readout (in order to get the most digits possible). In most cases, the voltmeter was at the 20V setting. We used the 2mA, 20mA, and 200mA settings on the ammeter.

We started with the resistor that had the colour bands blue-grey-brown-gold. We performed steps 1-3 with each of the seven resistors that were available to us. Then we changed the voltage, and repeated steps 1-3. We did this a total of three times. Thus, we had three data points for each of the seven resistors. At this point, we realized that we needed to have a lot of data points for a few resistors rather than a few points for a lot of resistors. So, we conducted another round of data collection.

We selected four resistors (blue-grey-brown-gold, green-orange-brown-gold, orange-orange-orange-gold, and grey-orange-red-gold), and for each of them, we repeated steps 3-4 a total of seven times. So, including the three data points collected earlier, we had a total of 10 data points for these four resistors. We decided not to include the data for the other three resistors.

Afterwards, we disassembled the setup. We took one of the multimeters, and used it to measure the resistance of the three resistors that we had 10 data points for. One side of the resistor was connected to the common terminal of the multimeter, and the other to the voltage/resistance terminal. The lower portion of the multimeter was set to read the resistance. The upper portion was again, set to the lowest setting which gave us a readable output. This was the 2 kiloohm setting for the blue-grey-brown-gold and the green-orange-brown-gold resistors, the 20 kiloohm setting for the grey-orange-red-gold resistor, and the 200 kiloohm setting for the orange-orange-orange-gold resistor.

2. Data

Table 1: Data for grey-orange-brown-gold resistor.

Current (mA)	Current Uncertainty (mA)	Voltage (V)	Voltage Uncertainty (V)
1.373 mA	0.010 mA	1.122 V	0.003 V
3.81 mA	0.03 mA	3.11 V	0.01 V
6.30 mA	0.05 mA	5.12 V	0.01 V
6.82 mA	0.05 mA	5.53 V	0.01 V
9.36 mA	0.07 mA	7.60 V	0.02 V
9.49 mA	0.07 mA	7.72 V	0.02 V
14.22 mA	0.10 mA	11.56 V	0.03 V
15.57 mA	0.11 mA	12.67 V	0.03 V
17.07 mA	0.13 mA	13.83 V	0.03 V
19.36 mA	0.15 mA	15.64 V	0.04 V

Table 2: Data for orange-orange-orange-gold resistor.

Current (mA)	Current Uncertainty (mA)	Voltage (V)	Voltage Uncertainty (V)
0.131 mA	0.001 mA	4.42 V	0.01 V
0.170 mA	0.001 mA	5.57 V	0.01 V
0.187 mA	0.001 mA	6.23 V	0.02 V
0.232 mA	0.002 mA	7.74 V	0.02 V
0.301 mA	0.002 mA	10.06 V	0.03 V
0.345 mA	0.003 mA	11.54 V	0.03 V
0.401 mA	0.003 mA	13.41 V	0.03 V
0.456 mA	0.003 mA	15.23 V	0.04 V
0.518 mA	0.004 mA	17.37 V	0.04 V
0.585 mA	0.004 mA	19.55 V	0.05 V

Table 3: Data for blue-grey-brown-gold resistor.

Current (mA)	Current Uncertainty (mA)	Voltage (V)	Voltage Uncertainty (V)
1.96 mA	0.01 mA	1.33 V	0.01 V
7.34 mA	0.06 mA	4.96 V	0.01 V
8.22 mA	0.06 mA	5.50 V	0.01 V
10.77 mA	0.08 mA	7.27 V	0.02 V
11.50 mA	0.09 mA	7.76 V	0.02 V
14.35 mA	0.11 mA	9.67 V	0.02 V
16.89 mA	0.13 mA	11.38 V	0.03 V
18.55 mA	0.14 mA	12.45 V	0.03 V
23.8 mA	0.2 mA	15.97 V	0.04 V
26.2 mA	0.2 mA	17.50 V	0.04 V

Table 4: Data for blue-grey-brown-gold resistor.

Current (mA)	Current Uncertainty (mA)	Voltage (V)	Voltage Uncertainty (V)
0.518 mA	0.004 mA	4.34 V	0.01 V
0.675 mA	0.005 mA	5.58 V	0.01 V
0.785 mA	0.006 mA	6.49 V	0.02 V
0.926 mA	0.007 mA	7.65 V	0.02 V
1.060 mA	0.008 mA	8.77 V	0.02 V
1.382 mA	0.010 mA	11.43 V	0.03 V
1.448 mA	0.011 mA	11.97 V	0.03 V
1.666 mA	0.012 mA	13.78 V	0.03 V
1.869 mA	0.015 mA	15.48 V	0.04 V
2.13 mA	0.02 mA	17.6 V	0.04 V

Table 5: Calculated, measured, and read resistances compared.

	Average Calculated Resistance	Standard Error	Measured Resistance	Measurement Uncertainty	Colour Band Resistance	Tolerance
grey-orange--brown-gold	1230.45 Ω	.42 Ω	814 Ω	2 Ω	830 Ω	42 Ω
orange-orange--black-gold	29.96 Ω	0.02 Ω	33.4 Ω	0.1 Ω	33 Ω	2 Ω
blue-grey--brown-gold	1485.7 Ω	0.7 Ω	675 Ω	1 Ω	680 Ω	34 Ω
blue-grey--brown-gold	8280.14 Ω	3.50 Ω	8270 Ω	17 Ω	8300 Ω	415 Ω