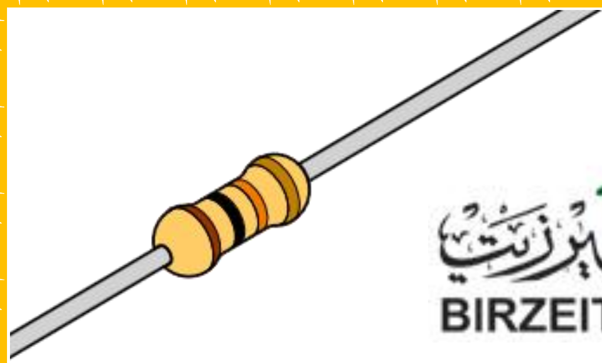

BIRZEIT UNIVERSITY

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Physics Department

Physics 111

Experiment No. 4

D.C. Circuit

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– Abstract:

1) The aim of the experiment:

(A) To test the material and find out if the material is Ohmic or non-Ohmic.

(B) To find the value of R_s , R_p practically

where:

R_s is equivalent resistance for two resistors connected in series

R_p is the equivalent resistance for two resistors connected in parallel

2) The method used:

A)By plotting a graph of the potential difference V across the material against the current through it and keeping the temperature of the material constant. If the graph is linear then the material is Ohmic.

B) by connecting two resistors at first In series and one more time in parallel and measure(V_s, I_s),(V_p, I_p)

3) The main results are:

$R = 75 \pm 8\ \Omega$

$R_s = 214 \pm 20\Omega$

$R_p = 49 \pm 4\Omega$

Theory:

(*) One of the fundamental laws describing how electrical circuits behave is Ohm’s law. According to Ohm’s law, there is a linear relationship between the voltage drop across a circuit element and the current flowing through it. Therefore the resistance R is viewed as a constant independent of the voltage and the current. In equation form, Ohm’s law is:

V = IR.

Here, V is the voltage applied across the circuit in volts (V), I is the current flowing through the circuit in units of amperes (A), and R is the resistance of the circuit with units of ohms (Ω).

$$R = \frac{V(Voltage)}{I(Current)}$$ R : resistance. R doesn't depend on (I) or (V).

(*) Materials that obey Ohm's law are called Ohmic materials. Materials that don't obey Ohm's law are called non-Ohmic materials. Testing the material to decide if it's Ohmic or non-Ohmic could be done by plotting the graph of the voltage (V) on the x-axis vs. the current (I) on the y-axis and if the graph is linear then the material is Ohmic, and if it's not linear then the material is non-Ohmic.

(*)Two or more resistors can be connected in series, connected one after another (Fig. (a)), or in parallel, typically shown connected so that they are parallel to one another (Fig. (b)). As long as the current must split, go through the resistors and then coalesce, they are in parallel. When two resistors R1 and R2 are connected in series, the equivalent resistance RS is given by RS = R1 + R2. Thus, the circuit in Fig. (a) behaves as if it contained a single resistor with resistance RS — that is, it draws current from a given applied voltage like such a resistor. When those resistors are connected in parallel instead, we use a different formula for finding the equivalent resistance.

Fig.(a)

R_1,R_2 on Series :

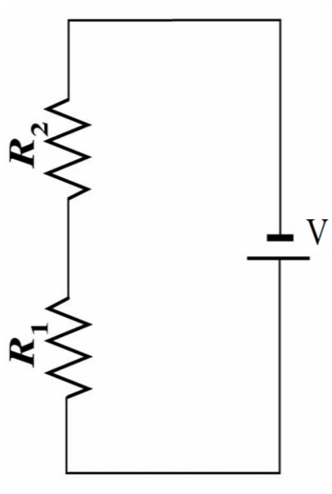
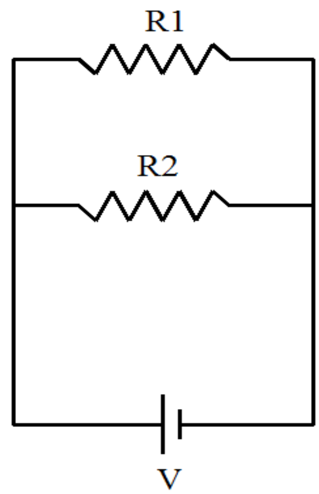


Fig.(b)

R_1,R_2 on Parallel :



Series	Parallel
$V_S = V_1 + V_2$	$V_P = V_1 = V_2$
$I_S = I_1 = I_2$	$I_P = I_1 + I_2$
$R_S = R_1 + R_2$	$\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2}$ or $R_P = \frac{R_1 R_2}{R_1 + R_2}$

Equations for two resistors in series and parallel.

– Procedure:

At first, a resistance was connected with another variable resistance to a circuit with a 3 volt power supply and. Then the uncertainty in the current ΔI and the uncertainty in the voltage ΔV was estimated. Then we measured the current (I) and the potential difference (V) across the resistance. After that the current and the potential difference were measured, but after adjusting the variable resistance and this was repeated six times. Then we disconnected the variable resistance and connected another resistance (R_2) in series instead. And after estimating

ΔI and ΔV we wrote down the reading of I_s and V_s. Then the second resistance was connected in parallel and ΔI and ΔV were estimated and the I_p and V_p were written down. Finally the values of R_1 and R_2 were written down using the color codes on the back of the resistances.

–Data:

Part A (one resistance used in the circuit, either R_1 or R_2):

ΔV =0.1 ΔI= 1mA

No	1	2	3	4	5	6	Average
I(mA)	**7**	**13**	**20**	**26**	**34**	**41**	**23.5**
V(volt)	**0.5**	**1**	**1.5**	**2**	**2.5**	**3**	**1.75**

Part B (R_1 and R_2 in series):

V_s = 3 volt ΔV_s = 0.1 volt

I_s = 14 mA ΔI_s =1mA

Part C (R_1 and R_2 in parallel):

V_p = 2 volt ΔV_p = 0.1 volt

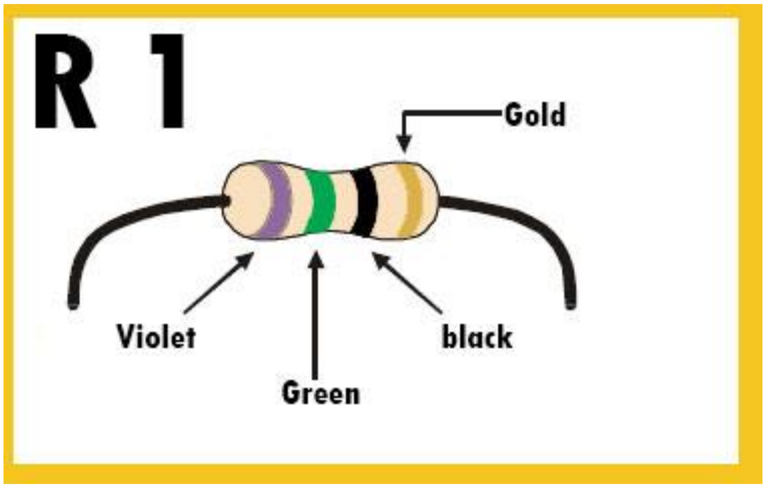
I_p = 41 mA ΔI_p= 1mA

–Calculations:

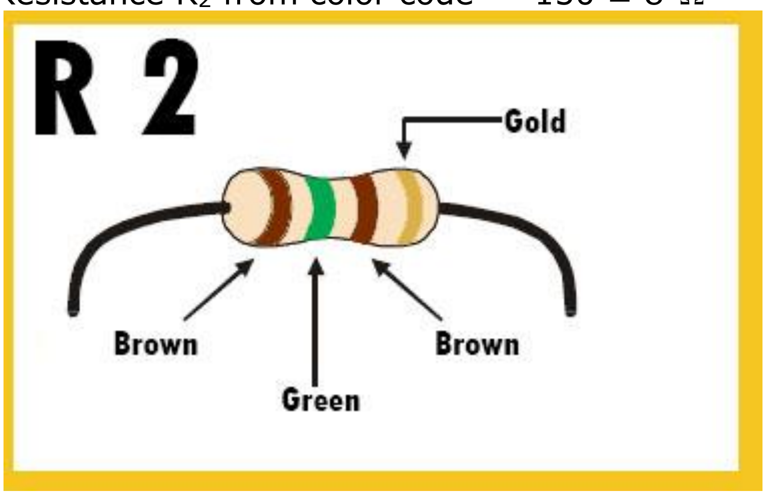
R = from the slope = $\frac{\Delta V}{\Delta I} = \frac{0.75-0}{10-0} = 0.075K\Omega = 75\Omega$

ΔR = $R(\frac{\Delta V}{V} + \frac{\Delta I}{I}) = 75(\frac{0.1}{1.75} + \frac{1\times10^{-3}}{23.5\times10^{-3}}) = 8\Omega$

Resistance R_1 from color code = 75 ± 4 Ω



Resistance R_2 from color code = 150 ± 8 Ω



R_1 and R_2 in series:

A)Practically(By experiment):

R_s = $\frac{V_S}{I_S} = \frac{3}{14\times10^{-3}} = 214\Omega$

ΔR_s = $R_S(\frac{\Delta V_S}{V_S} + \frac{\Delta I_S}{I_S}) = 214(\frac{0.1}{3} + \frac{1\times10^{-3}}{14\times10^{-3}}) = 20\Omega$

B) theoretically:

R_1 from color code = 75 ± 4 Ω

R_2 from color code = 150 ± 8 Ω

$R_S = R_1 + R_2 = 75+150=225$

$$\Delta R_s = \Delta R_1 + \Delta R_2 = 4+8=12$$

Rs= 225 ± 12 Ω

R_1 and R_2 in parallel:

A)Practically(By experiment):

R_p = $$\frac{V_P}{I_P} = \frac{2}{41\times 10^{-3}} = 49\Omega$$

ΔR_p = $$R_P(\frac{\Delta V_P}{V_P} + \frac{\Delta I_P}{I_P}) = 49(\frac{0.1}{2} + \frac{1\times 10^{-3}}{41\times 10^{-3}}) = 4\Omega$$

B) theoretically:

R_1 from color code = 75 ± 4 Ω

R_2 from color code = 150 ± 8 Ω

$$R_p = \frac{R_1 R_2}{R_1 + R_2} = \frac{75X150}{75+150} = 50\Omega$$

To find ΔR_p Assume that

$$R_p = \frac{A}{B} \rightarrow then \rightarrow \Delta R_p = (\frac{\Delta A}{A} + \frac{\Delta B}{B})R_p$$

Where A= $R_1 R_2$= 75× 150=11250

$$\Delta A = \frac{\Delta R_1}{R_1} + \frac{\Delta R_2}{R_2} = \frac{4}{75} + \frac{8}{150} = 0.11\Omega$$

B= R1+R2=75+150=225

$$\Delta B = \Delta R_1 + \Delta R_2 = 12$$

So

$$\Delta R_p = (\frac{\Delta A}{A} + \frac{\Delta B}{B})R_p = (\frac{0.11}{11250} + \frac{12}{225})50 = 3\Omega$$

$\Delta R_p = 3\Omega$

– Results and Conclusion:

❖ **Part A** (one resistance used in the circuit, either R_1 or R_2):

- My result from the slope of the graph is
  $R_1 = 75 \pm 8\ \Omega$
- The true value of the resistor R1 from color code is
  $R_1 = 75 \pm 4\ \Omega$

Discrepancy : | true value – result| = | 75 – 75 | = 0
$0 < 2\times 8 \rightarrow 0<16$
My result is accepted because $D < 2\times \Delta R$.

❖ **Part B** (R_1 and R_2 in series):

My result is
$R_s = 214 \pm 20\ \Omega$

The true value of the equivalent resistance for two resistors connected in series theoretical is :
$R_s = 225 \pm 12\ \Omega$

- **Discrepancy :** | true value – result| = | 225– 214 | = 11

$11 < 2\times 20 \rightarrow 11<40$
My result is accepted because $D < 2\times \Delta R_s$.

Part C (R_1 and R_2 in parallel)**:**

My result is

$R_p = 49 \pm 4\ \Omega$

The true value of the equivalent resistance for two resistors connected in parallel theoretical is :

$R_p = 50 \pm 3\Omega$

- **Discrepancy :** | true value – result| = | 50– 49 | = 1

$1 < 2\times4 \rightarrow 1<8$

My result is accepted because $D < 2\times \Delta R_p$.

systematic errors

A wire is actually a resistor with very low resistance compared to the resistors we typically use in class. Therefore, we neglected (ignored) any resistance that it has. Also the ammeter and the voltmeter have a resistance that we neglected.

When we take the measurements we must look straight at the pointer to have a correct reading and if we don't our reading will not be accurate.

The answer of the Question:

My measured values of R_1, R_s , and R_p are consistent with the values that I obtained from color codes.