Arnika Vishwakarma

Student Id-@01367603

Lab partners- Pravalika, Lena

LAB REPORT-1

TITLE

Study of the components, building and analyzing the simple circuits.

PURPOSE

1. The purpose of the lab is to become acquainted with the basic components and devices.
2. Learn to analyze and verify by measurements the characteristics of LED-Resistor circuits.

EQUIPMENTS

Resistors

LEDs

Digital Multimeter

Connecting wires

Breadboard

DESCRIPTION

Resistor: Resistors are the device which are used to control the direction of current flowing to a circuit by applying resistance**.**

LEDs (Light emiting diode): It’s a semiconductor device which allows current to pass through in result emits light.

Digital Multimeter: It’s an electrical tool which is used to measure the current (amp), Voltage (Volt), Resistance (Ohms Ω)

Breadboard: It’s a board which helps in building the electrical circuits.

Problem 1

Select several 100Ω and 1000Ω resistors and measure their resistance using the multimeter. Record the resistances in a table.

Observation:

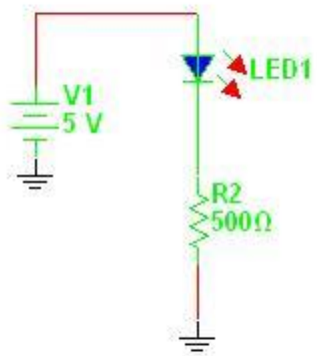
The below table represents the various measured resistance value for the different resistor of 100Ω.

Resistors	**Resistance Value(ohms)**	**Measured Resistance(ohms)**
R1	100Ω	97.8Ω
R2	100Ω	97.9Ω
R3	100Ω	97.7Ω

The below table represents the various measured resistance value for the given resistors of 1000Ω.

Resistors	**Resistance(ohms)**	**Measured Resistance(ohms)**
R1	1000Ω	999Ω
R2	1000Ω	990Ω
R3	1000Ω	983Ω

Problem 2:



Build the circuit shown, using the breadboard and (one after another) both the 500Ω resistor shown and a 1000Ω resistor.

Measure and record the voltage at every point in the circuit. The voltage across a component is called a voltage drop

Since we know the resistance of the resistor (must be near its marked value) we can compute the current flowing through the resistor. By Kirchoff's current law, the same current must be flowing in the entire circuit.

Switch resistors and repeat the measurements.

What difference does it make to re-order the components in the circuit?

Try putting two resistors into the circuit, both in series and in parallel, and record your results.

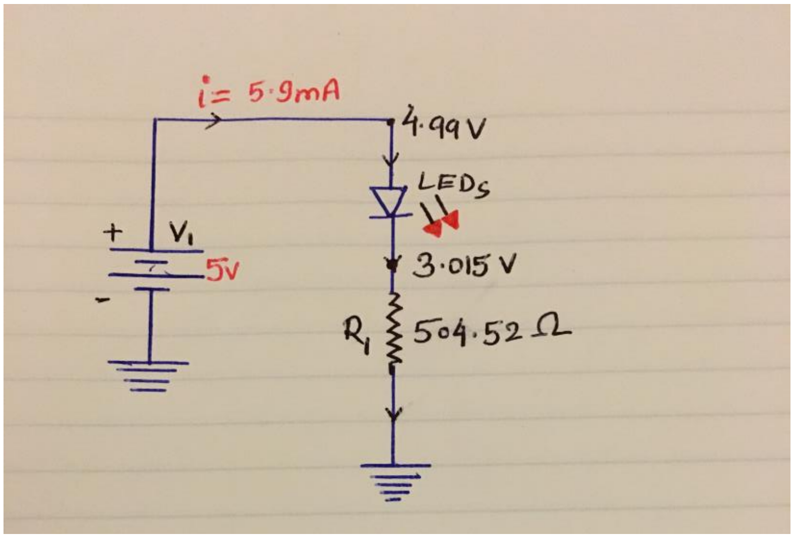
Observation:

The voltage values measured and recorded after building the circuit as shown below:

Resistor R1= 504.52Ω

Resistor R2= 1000Ω

A. With resistor R1 (504.52 Ω)



Voltage across LEDs = 4.99 V

Voltage across R1 = 3.015 V

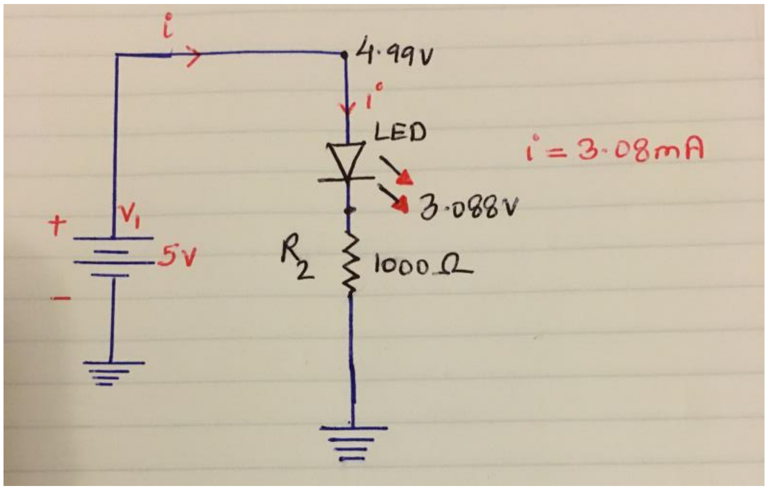
Since, we know the resistor value (R1) and the voltage across the resistor. So, we can easily calculate the value of the current flowing through the resistor by ohm's law formula:

$E = IR$

$3.015\ V = I \times 504.52\ \Omega$

$I = 5.9mA$

B. With resistor R2 (1000Ω)



Voltage across LEDs = 4.99 V

Voltage across R2 = 3.088 V

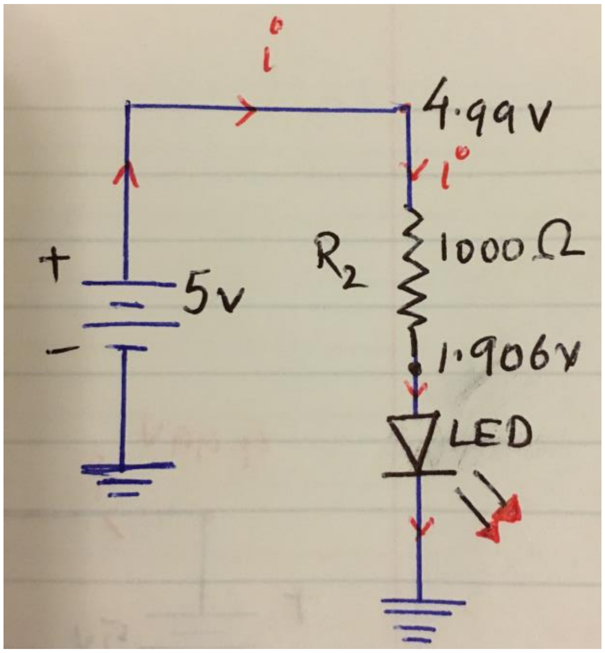
Calculating current flowing through the resistor (R2) in the circuit by ohm's law:

E = IR

3.088 V = I × 1000 Ω

I = 3.08mA

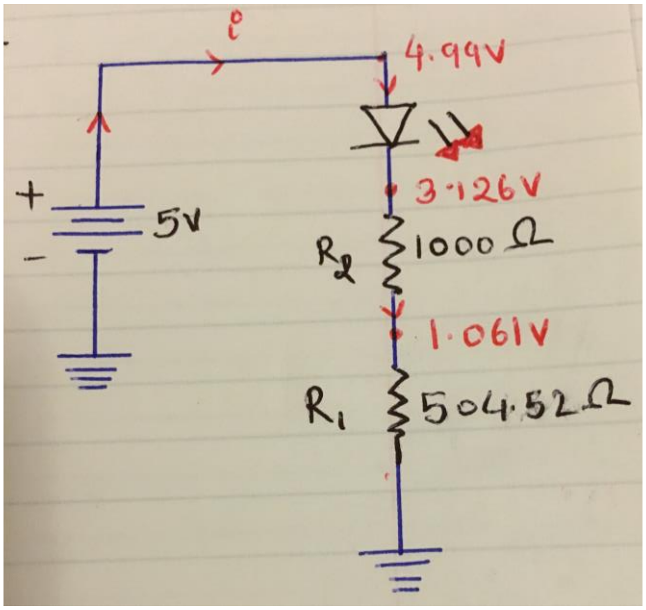
C. When we rearranged the order of the components resistor R2 (1000Ω) and LEDs in the circuit the voltage dropped



The voltage across the LEDs = 1.906 V

The voltage across R2 = 4.99 V

D. When the resistors are arranged in the series the voltage value recorded are as follows:

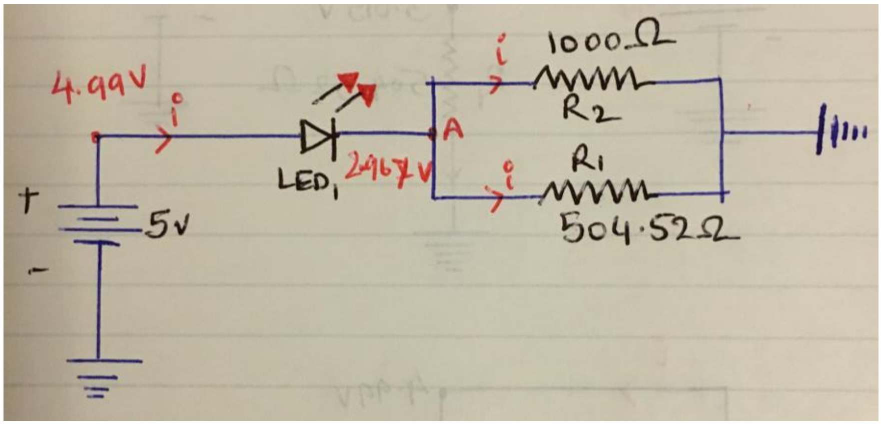


Voltage between the resistor R1 and R2 = 1.061 V

Voltage across the resistor R2 (1000 Ω) = 3.126 V

Voltage across the LEDs = 4.99 V

E. When the resistors are arranged in parallel the value of voltage recorded:

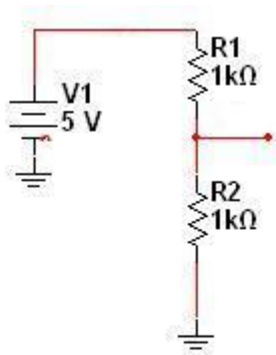


Voltage at point A = 2.967 V

Voltage across LEDs = 4.99 V

Problem 3:

Given a fixed voltage input, one can use resistors to produce a fixed fraction output voltage. You can use the circuit below to "divide" a voltage by two.



Measured at the Test point at the right, the voltage should be about 2.5 Volts.

Now, choose different resistors to have a 3.6 Volt potential at the test point.

As usual, provide a table of several of your attempts.

Observation:

After measuring at the test point the value of the voltage is 2.49 V.

Different values of voltage at the test point recorded with different resistors

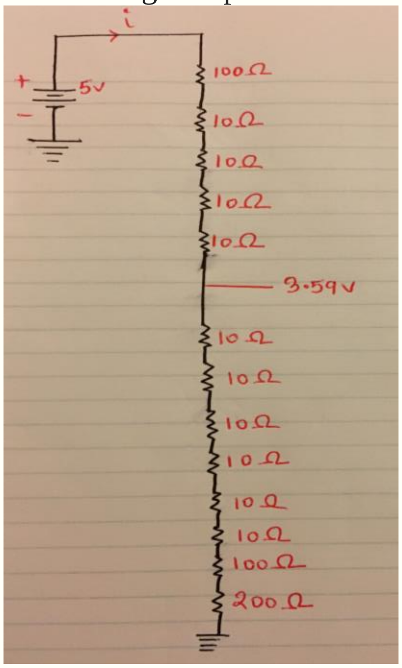
Resistance(Ω)	**Measured Voltage(Volt)**
R1=360Ω R2=640Ω	3.23V
R1= 400Ω R2= 320Ω	2.87V
R1 = 140Ω R2 = 220Ω	3.06V
R1 = 140Ω R2 = 360Ω	**3.59V**

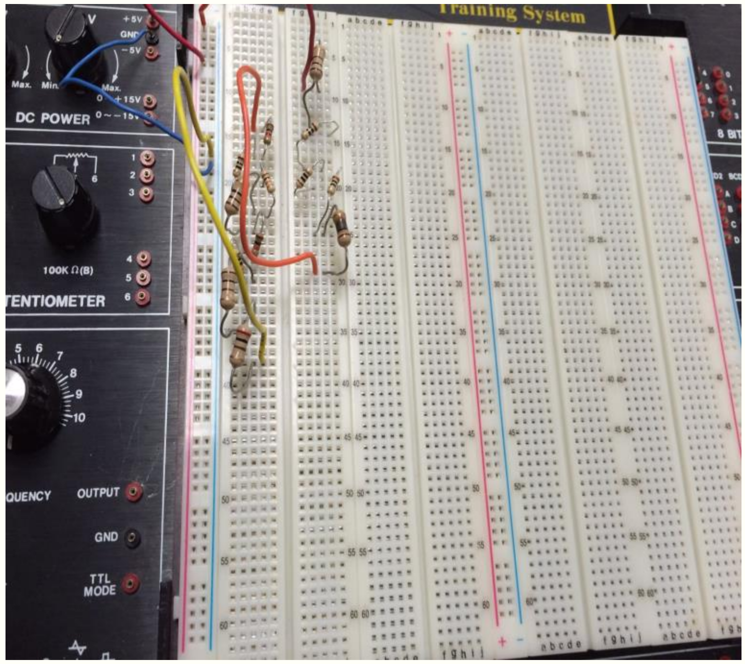
Therefore, when the resistor R1 (140Ω) and R2 (360Ω) are connected to the circuit the voltage at the test point measured is **3.59 V**.

According to the voltage divider law we can calculate the value of the voltage at the divider by using the following formula:

$$V_i = R_i \times \frac{V_t}{R_1 + R_2 + R_3\ldots}$$

Vi - Voltage drop in resistor Ri in Volts





The circuit diagram above constructed in the lab

V_T - The voltage drop in Volts
Ri - Resistance of resistor Ri in Ohms
R_1 - Resistance of resistor R1 in Ohms
R_2 - Resistance of resistor R2 in Ohms
R_3 - Resistance of resistor R3 in Ohms
Hence, The value of the voltage calculated at the test point is shown below:

$$V1 = R1 \times \frac{Vt}{R1 + R2}$$

$$V1 = 140\Omega \times \frac{5\ V}{140\Omega + 360\Omega}$$

Voltage V1 across the resistor R1 = 1.4 V

$$V2 = R2 \times \frac{Vt}{R1 + R2}$$

$$V2 = 360\ \Omega \times \frac{5V}{140\ \Omega + 360\ \Omega}$$

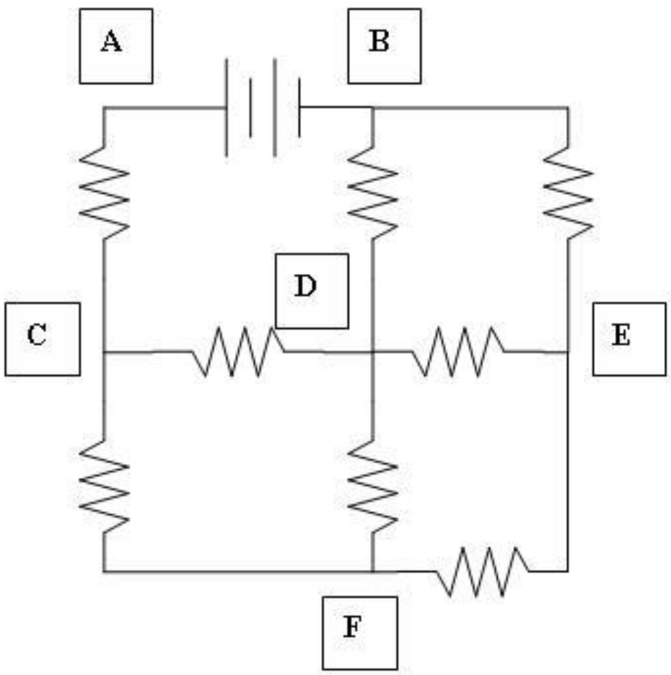
Voltage V2 at the test point = 3.6 V

Problem 4:

Consider the following circuit:

If you build it with all resistor values as 1KΩ, what are the voltages at each of the points in the circuit?

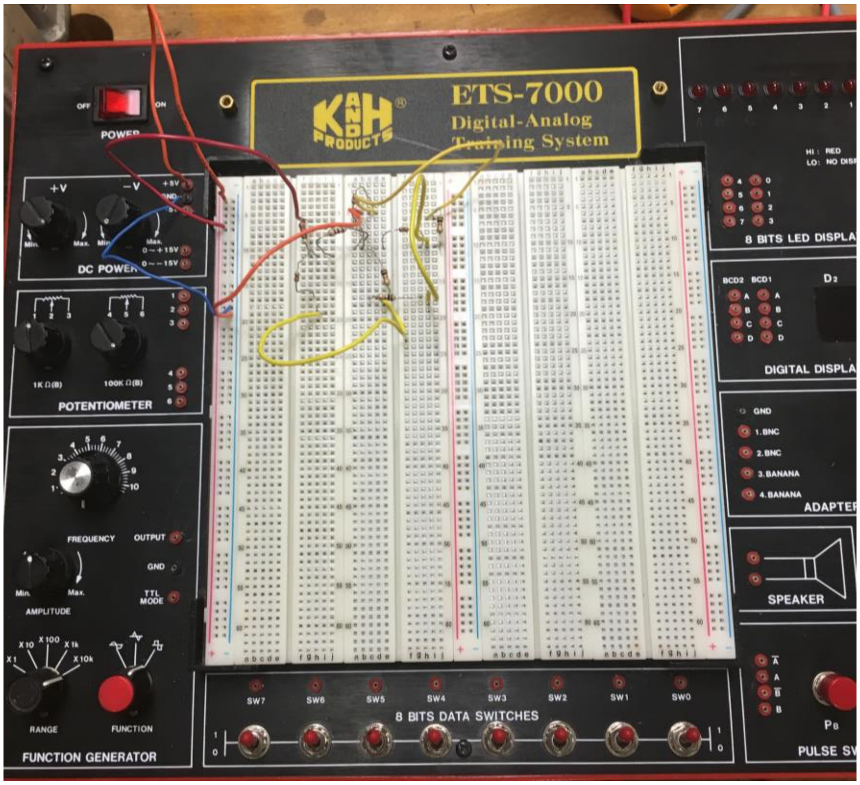
Using Kirchoff's laws, etc. can you provide a theoretical value for the voltages? Does it differ from your measurements?



Observation:

With the given value of resistors (1KΩ) the value of the voltages measured at various given points is listed below in the table:

Circuit points	Measured Voltage(Volts)
A	4.99 V
B	0.001 V
C	2.687 V
D	1.333 V
E	1.002 V
F	1.675 V

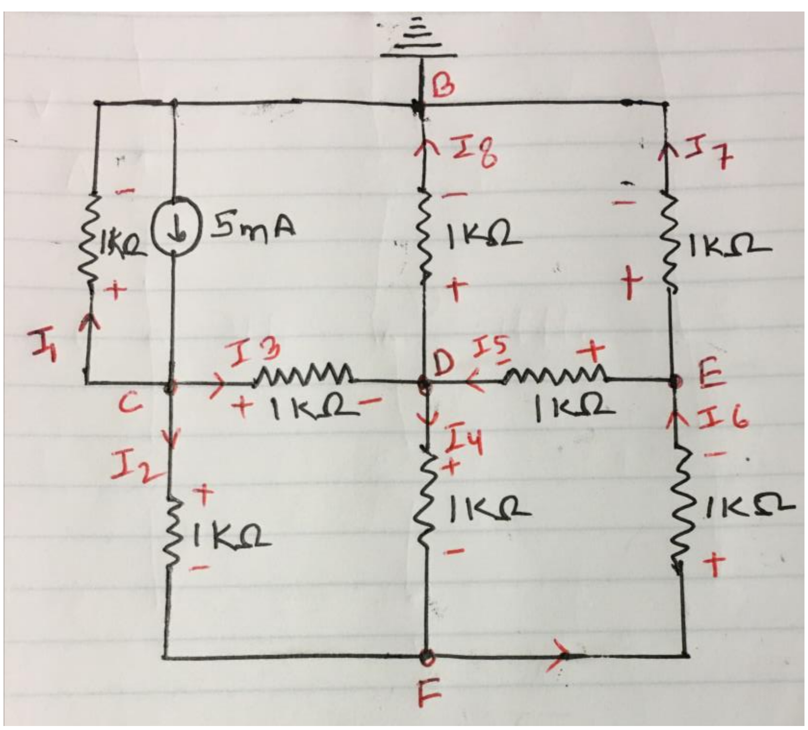


The circuit diagram above constructed in the lab

Calculation of Voltages using Nodal analysis:

We calculate the values of voltages at different points using nodal analysis. In nodal analysis we will apply the kirchhoff's current law to determine the potential difference (voltage) at any point with respect to some arbitrary reference point in a network.

Below is the circuit diagram showing the nodal analysis:



Step 1: Arbitrarily assign a reference node within the circuit and indicate this node as ground. We assigned the arbitrary point at B in the circuit and indicated this node as ground.

Step 2: Convert each voltage source in the network to its equivalent current source. The 5V voltage source is converted to 5 mA current source in the above figure.

Step 3: Arbitrarily assign voltages (V1, V2, . . . , Vn) to the remaining nodes in the circuit. We assigned Voltages V_C, V_D, V_E and V_F at nodes C, D, E and F. Voltage at point B is $V_B = 0$ as it is the reference node and connected to the ground.

Step 4: Arbitrarily assign the current direction to each branch in which there is no current source. We assign the currents I_1 to I_8 as shown in the above figure.

Step 5: With the exception of the reference node (ground), apply Kirchhoff's current law at each of the nodes. Following are the equations of the current at every node.

Node Vc : I1 + I 2 + I 3 = 5mA

Node V_D : I5 + I3 = I4 + I8

Node V_E : I6 = I5 + I7

Node V_F : I2 + I4 = I6

Step 6: Rewrite each of the arbitrarily assigned currents in terms of the potential difference across a known resistance. Representing Current at different nodes in terms of voltage and resistance:

$I_1 = \frac{Vc}{1000\ \Omega}$ amp = V_C mA

$I_2 = \frac{Vc-Vf}{1000\ \Omega}$ amp = V_C - V_F mA

$I_3 = \frac{Vc-Vd}{1000\ \Omega}$ amp = V_C - V_D mA

$I_4 = \frac{Vd-Vf}{1000\ \Omega}$ amp = V_D - V_F mA

$I_5 = \frac{Ve-Vd}{1000\ \Omega}$ amp = V_E - V_D mA

$I_6 = \frac{Vf-Ve}{1000\ \Omega}$ amp = V_F – V_E mA

$I_7 = \frac{Ve}{1000\ \Omega}$ amp = V_E mA

$I_8 = \frac{Vd}{1000\ \Omega}$ amp = V_D mA

Substituting the above current equations in Step 5, now we have below 4 equations

Node Vc:

$$V_C + (V_C - V_F) + (V_C - V_D) = 5mA$$

$$3\,V_C - V_D + 0\,V_E - V_F = 5 \;\ldots\ldots\ldots\ldots\ldots\ldots\ldots\;(i)$$

Node V_D:

$$V_E - V_D + V_C - V_D = V_D - V_F + V_D$$

$$-\,V_C + 4\,V_D - V_E - V_F = 0 \;\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\;(ii)$$

Node V_E:

$$V_F - V_E = V_E - V_D + V_E$$

$$0\,V_C - V_D + 3\,V_E - V_F = 0 \;\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\;(iii)$$

Node V_F:

$$V_C - V_F + V_D - V_F = V_F - V_E$$

$$V_C - V_D - V_E + 3\,V_F = 0 \;\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\;(iv)$$

Step 7: Solving the linear equations (i), (ii) , (iii) , (iv)

From the above linear equations we can form the matrix of the determinants and solve the equations. I have used the wolframalpha to solve the equations. The link of the website which I have used:

https://www.wolframalpha.com/input/?i=3a-b%2B0c-d%3D5,+-a%2B4b-c-d%3D0,+0a-b%2B3c-d%3D0,+-a-b-c%2B3d%3D0

Hence, the value of the voltages at points C, D, E and F are:

V_C = 2.667V

V_D = 1.33V

V_E = 1.00V

V_F = 1.667V

Voltages at point B and A are

V_B = 0 V

V_A = 5 V

Comparing the above calculated values of the voltage at different points with the values we measured in the lab, I can conclude that the calculated and measured values are approximately equal.

Circuit points	Measured Voltage (V)	Calculated Voltage (V)
A	4.99 V	5 V
B	0.001 V	0 V
C	2.687 V	2.667 V
D	1.333 V	1.33 V
E	1.002 V	1 V
F	1.675 V	1.667 V