**Section 5**

|  |  |  |
| --- | --- | --- |
| **Expected and actual resistances and voltages** | Expected | Actual |
| First Battery = V1 | 1.5 V | 1.110 ± 0.001 V |
| Second Battery = V2 | 1.5 V | 1.547 ± 0.001 V |
| 100 Ω Resistor = R1 | 100 Ω | 100.2 ± 0.1 Ω |
| 10 Ω Resistor = R2 | 10 Ω | 10.2 ± 0.1 Ω |
| 330 Ω Resistor = R3 | 330 Ω | 326.5 ± 0.1 Ω |

I1 = I2 + I3

0 = -I+ I2 + I3

0 = V1 - R1 I1 - R2 I2

0 = V1 - R1 I1 - R3I3 - V2

0 = -I1 + I2 + I3

V1 = R1 I1 + R2 I2

V1 - V2 = R1 I1 + R3I3

0 = -I1 + I2 + I3

1.110 V = (100.2 Ω) I1 + (10.2 Ω) I2

1.110 V – 1.547 V = -0.437 V = (100.2 Ω) I1 + (326.5 Ω) I3

Numbers for I1, I2, and I3 in the calculation and the measurements were the same

Calculated Currents

I1 = 0.010 A

I2 = 0.014 A

I3 = -0.004 A

Table of Measured Voltages and Currents

|  |  |  |  |
| --- | --- | --- | --- |
| Measured Current (A) | | Measured Voltages(V) | |
| I1 | 0.010 ± 0.001 | VR,1 | 0.965 ± 0.001 |
| VR,2 | 0.140 ±0.001 |
| VR,3 | -1.411 ± 0.001 |
| I2 | 0.014 ± 0.001 | VR,1 | 0.947 ±0.001 |
| VR,2 | 0.139 ±0.001 |
| VR,3 | -1.143 ± 0.001 |
| I3 | 0.004 ± 0.001 | VR,1 | 0.966 ± 0.001 |
| VR,2 | 0.140 ± 0.001 |
| VR,3 | -1.143 ± 0.001 |

Comparison of Measured Currents and expected currents using a T score

For I1: For I2:

For I3:

Average for VR,1: 0.959 V =

Average for VR,2: 0.140 V =

Average for VR,3: -1.232 V =

Standard Deviation for VR,1: 0.009 V =

Standard Deviation for VR,2: 0.0005 V =

Standard Deviation for VR,3: 0.1 V =

Ohm’s Law = V = IR 🡪

I1 = (0.959 V)/(100.2 Ω) = 0.010 A

δ I1 =

δ I1 = = 0.0001 A

I2 = (0.140 V)/(10.2 Ω) = 0.014 A

δ I2 =

δ I2 = = 0.0001 A

I1 = (-1.232 V)/(326.5 Ω) = -0.004 A

δ I1 =

δ I1 = = 0.0003 A

For I1: For I2:

For I3:

**Section 7**

Resistance of RC = 985 ± 1 Ω

Resistance of RD = 99.8 ± 0.1 Ω

Expected RA = 147.8 ± 0.1 Ω

RB, upper = 19.9 ± 0.1 Ω (upper + lower)/2 = 17.0 ± 0.1 Ω = calculated RB

RB, lower = 14.0 ± 0.1 Ω

Calculation of RA

RARD = RBRC

RA (99.8 Ω) = (17.0 Ω)(985 Ω)

RA = = 167.2 Ω

δRA = = 1 Ω

= 19.11 = not acceptable

Discussion

When the batteries are connected in parallel, if the batteries do not have the same voltage, the loop that has the batteries would not have a zero voltage differential over the loop, breaking Kirchhoff’s laws. This is neglected because every battery has internal resistances that would basically cancel out the voltage differences. In many circuit diagrams, the differences in voltages are ignored because the diagrams feature “ideal batteries” that have no internal resistance and have a set ideal voltage.