Instrumentation Design 1

Lab 1: Introduction to DC circuits. Series circuits.

Lab report for Matt Rixman

2. Resistor Color Code and Measurement of Resistance

1-2: populate table 2.3

	1	2	3	4	5	6	7	8	9	10
First color band	brown	brown	red	blue	red	grey	brown	yellow	brown	orange
Second color band	black	black	red	gray	brown	red	black	brown	black	orange
Third color band	yellow	green	orange	red	orange	red	gold	orange	yellow	yellow
Fourth color band	gold	gold	gold	gold	gold	gold	gold	gold	gold	gold
Coded value (Ω)	100k	1M	22k	6.8k	21k	8.2k	1.0	41k	100k	330k
Tolerance (%)	5	5	5	5	5	5	5	5	5	5
Measured value (Ω)	98.0k	984k	21.7k	6.80k	26.3k	8.0k	1.2	46.0k	97.7k	322k

3-5: populate table 2.4

Setting of Potentionmeter Control	R_{AB} (Ω)	R_{AC} (Ω)	R_{BC} (Ω)	$R_{AC} + R_{BC}$ Calculated Value
Completely CCW	9.39k	8.69k	0.58k	9.97k
Completely CW	0.49k	8.69k	9.17k	9.66k

6: Shorting terminals A and C has no effect on the resistance between B & C, it remains at 490Ω

7: Shorting terminals B and C has no effect on the resistance between A & C, it remains at 9.20kΩ

8: There is no 8

9:

- (a) 0.27Ω, 1/2W, 5% : red violet silver gold
- (b) 2.2Ω, 1/4W, 10% : red red gold silver
- (c) 39Ω, 1/8W, 10% : orange white black silver
- (d) 33kΩ, 1W, 20% : orange orange orange none

3. Measurement of Direct Current

1 & 2: 1kΩ resistor measured 0.99kΩ

3 - 5: at 6V, the circut in figure 3.2 drew 6.05 mA

6: Removing the resistor dropped the current draw to 0 mA

7: Two 1kΩ resistors in series measured 1.97kΩ

8: At 6V, the current through them measured 2.90 mA

9: At 6V, 3x 1kΩ resistors in series measured 1.96 mA

> More resistance => less current

10:

> A series circuit's current is the same regardless of where it is measured

11-18: For the circuit in figure 3.2

Voltage	Resistance (Ω)	Current (A)
8	1k	8.024m
6	1k	6.50m
4	1k	3.64m
2	1k	1.85m
0	1k	0.20µ

1. > Less voltage => less current

4. Ohm's Law

Despite an initial calibration of 1kΩ, we mishandled our potentiometer--so its resistance was at 0.86Ω for the following measurements.

In [4]:

```
# code block, these values used to render the table below

k = 10**3
m = 10**-3
R = 0.86 * k
I_2 = 2.15 * m
I_4 = 4.25 * m
I_6 = 7.22 * m
I_8 = 10.28 * m

from si_prefix import si_format as f
```

1-6. This table shows how the current in the circut in figure 4.1 varies as the voltage is changed, given a fixed resistance

V	R (Ω)	I (A)	V/I
2	860	2.15 m	930
4	860	4.25 m	941
6	860	7.22 m	831
8	860	10.28 m	778

1. > V = IR, I = V/R

8.

- At 5.5 volts, calculated current: 6.4 mA

- At 9 volts, calculated current: 10.5 mA

9.

- At 5.5 volts, current was measured to be 6.19mA
- At 9 volts, current was measured to be 12.2ma

5. Series Circuits

In [5]:

```
# chosen resistors:
R = { 1 : 100,
      2 : 1 * k,
      3 : 10 * k,
      4 : 100 * k,
      5 : 2.2 * k,
      6 : 1.6 * k }

def resistance(resistors):
    return sum([R[r] for r in resistors])

def current(resistors, voltage):
    return voltage / resistance(resistors)
```

At 10 volts...

Figure	Contains Resistors	Measured R (Ω)	Calculated R (Ω)	Measured I (A)	Calculated I (A)
5.3a	1, 3	9.94k	10.1 k	1m	990.1 µ
5.3b	3, 4	108.4k	110.0 k	92.4m	90.9 µ
5.3c	5, 6	7.7k	3.8 k	1.29m	2.6 m
5.3d	1, 2, 3	10.9k	11.1 k	0.91m	900.9 µ
5.3e	3, 4, 5	110.3k	112.2 k	90.7µ	89.1 µ
5.3f	1, 2, 3, 4	109.3k	111.1 k	91.5µ	90.0 µ
5.3g	1, 2, 3, 4, 5	111.7k	113.3 k	89.8µ	88.3 µ

> The resistance of a series circuit is the sum of the resiststances of the resistors in that circuit.

6. Designing Series Circuits

Problem 2: Given two resistors at 820Ω and 680Ω and a 15V power supply we calculate a current of 10mA. Setting up this circuit showed 9.98mA through the ammeter.

7. Voltage Divider Circuits

We were unable to find the correct resistors to implement the circuit in Figure 7.1, so we made the following substitutions:

Name	Called For	Used
R1	7.5kΩ	8.2kΩ
R2	2.5kΩ	2.2kΩ

Targeting 10.4kΩ total reistance with a 12V potential...

In [6]:

```
R_1 = 8.2 * k
R_2 = 2.2 * k
R_total = R_1 + R_2

V_total = 12
V_1 = (R_1 / R_total) * V_total
V_2 = (R_2 / R_total) * V_total
```

In the circuit shown by Figure 7.1 (given the substitutions) we calculate:

$V_1 = 9.46$

$V_2 = 2.54$

Experimentally we find:

$V_1 = 9.51$

$V_2 = 2.55$