Physics 102

Lab 10: R-C Circuits

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Purpose

The purpose of this tenth lab is to obtain practical skills in verifying the time constant of an RC circuit.

Members

This lab group consisted of four members.

1. Myat Thit Ko Ko (author)
2. Cristina Zoldi
3. Jorge Ramirez
4. Sergio Cano

Procedure

The lab consists of the following steps and procedures.

Case I

- Measuring voltage from DC battery, resistance, and capacitance
- The switch breaks the circuit and time is read as voltage decreases gradually.
- Graphing voltage against time to obtain its slope

Case II

- Measuring voltage from DC battery, resistance, and capacitance
- The switch breaks the circuit and time is read as voltage decreases gradually.
- Graphing voltage against time to obtain its slope

All calculated values in this lab are rounded to 3 significant figures when necessary.

Deriving Formula

$$C = \frac{Q}{V}$$

Thus,

$$V = \frac{Q}{C}$$

Also,

$$V = IR$$

and

$$I = \frac{Q}{t} = \frac{dQ}{dt}$$

Hence,

$$V = \frac{Q}{C} - \left(\frac{dQ}{dt}\right)R = 0$$

$$\frac{dQ}{dt} = \frac{Q}{RC}$$

$$\int_{-Q}^{Q} \frac{dQ}{Q} = \int_{0}^{t} \frac{dt}{RC}$$

$$-\ln\left(\frac{Q}{Q_0}\right) = \frac{t}{RC}$$

$$\frac{Q}{Q_0} = e^{-\frac{t}{RC}}$$

$$Q = Q_0 e^{-\frac{t}{RC}}$$

$$Q = Q_0 e^{-\frac{t}{RC}}$$

$$\frac{Q}{t} = \frac{Q_0}{t} e^{-\frac{t}{RC}}$$

Recall that $I = \frac{Q}{t}$

$$I = I_0 e^{-\frac{t}{RC}}$$

Since $V = IR$

$$\frac{V}{R} = \frac{V_0}{R} e^{-\frac{t}{RC}}$$

$$V = V_0 e^{-\frac{t}{RC}}$$

$$\ln V = \ln V_0 - \left(\frac{1}{RC}\right) t$$

$$\ln V = \left(-\frac{1}{RC}\right) t + \ln V_0$$

Compare with y = mx + c

$$m = -\frac{1}{RC}$$

$$RC = -\frac{1}{m} = \tau$$

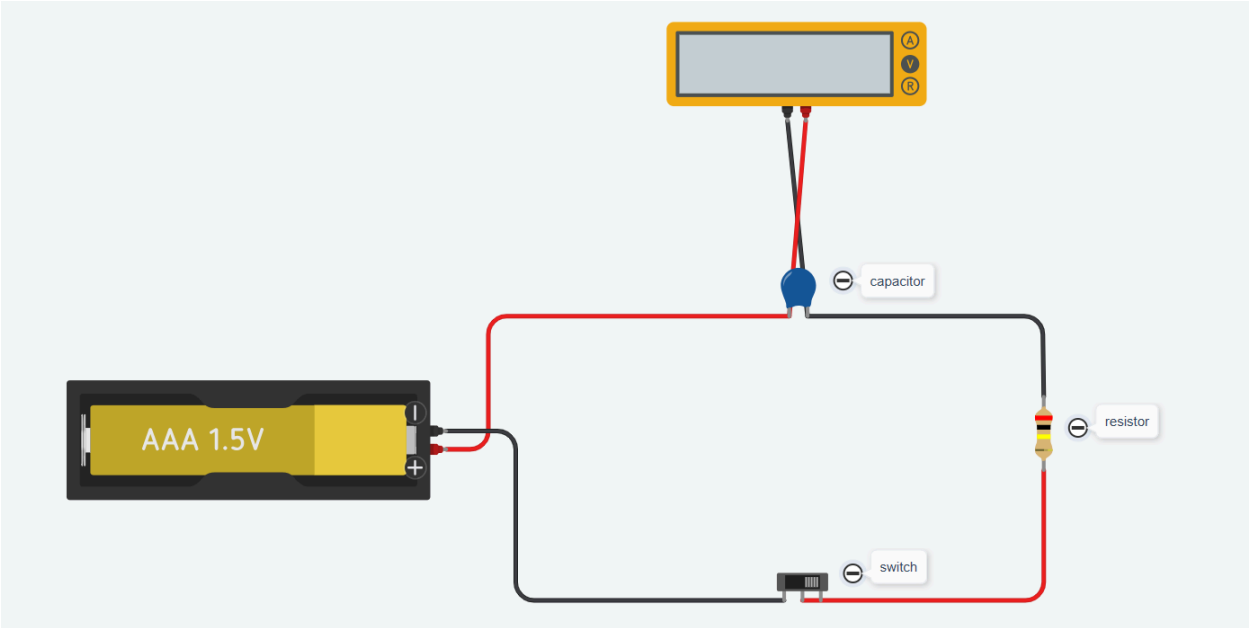
Therefore,

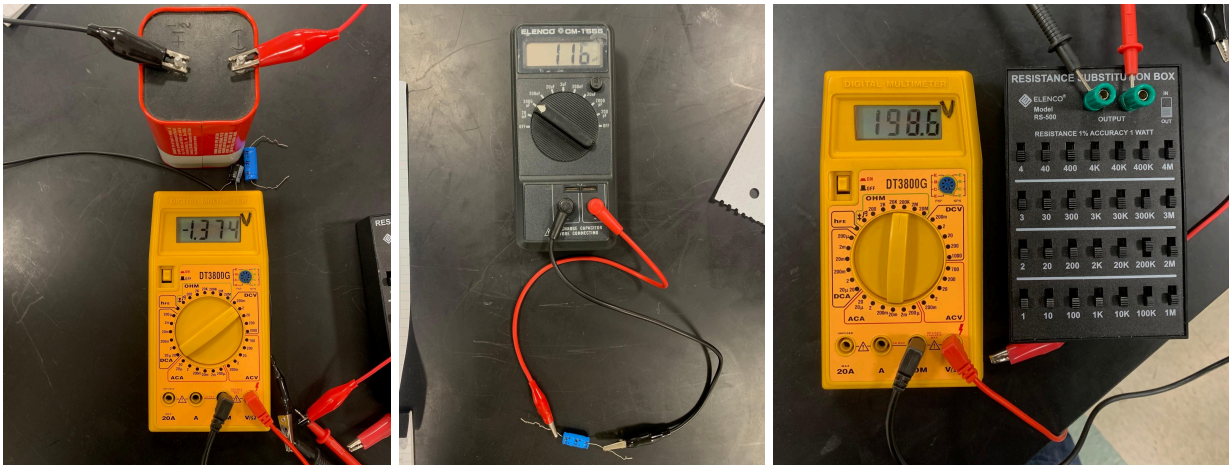
$$\tau_{theo} = RC$$

$$\tau_{exp} = -\frac{1}{m}$$

Data & Analysis

Case I





V0 = 1.374 V

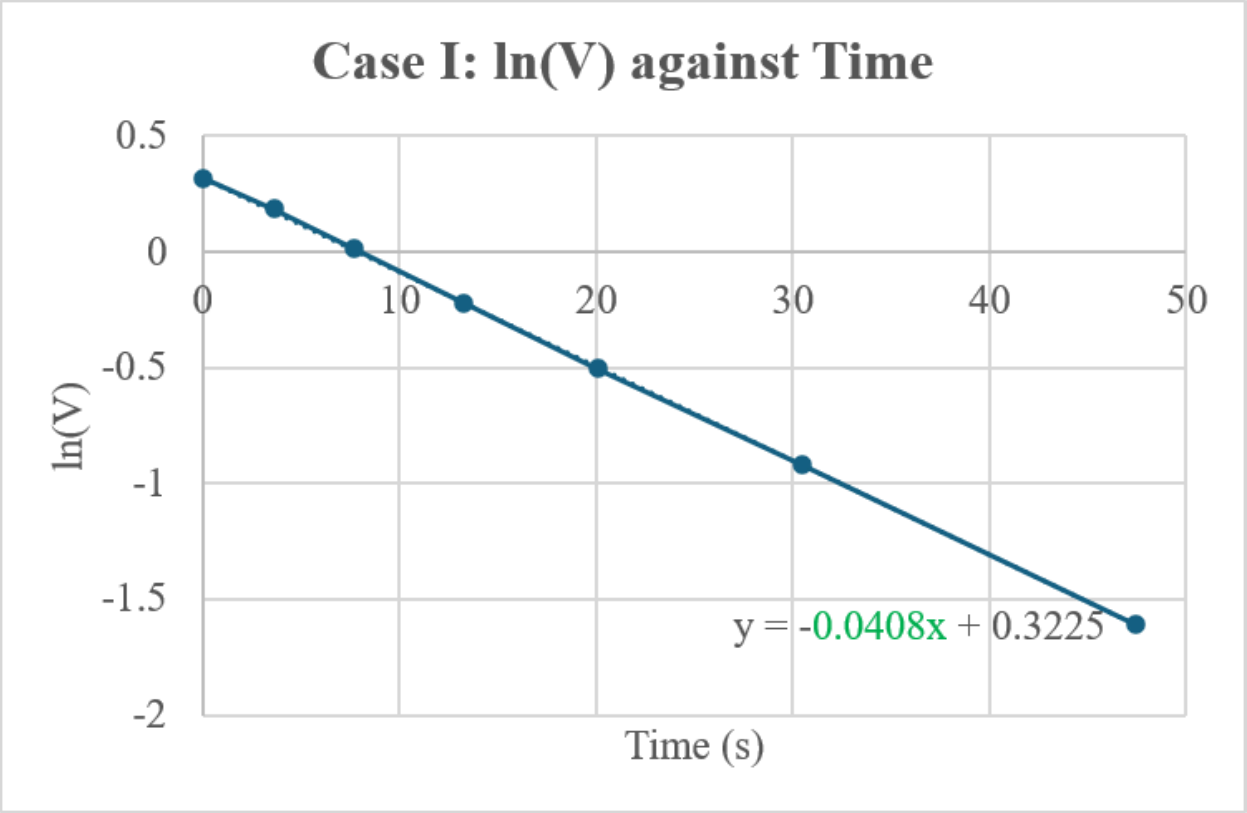
R =198.6 kΩ

C = 116μF

$$\tau_{theo} = RC = (198.6 \times 10^{3}\Omega)(116 \times 10^{-6}F) = 23.0\ s$$

Case I (cont.)

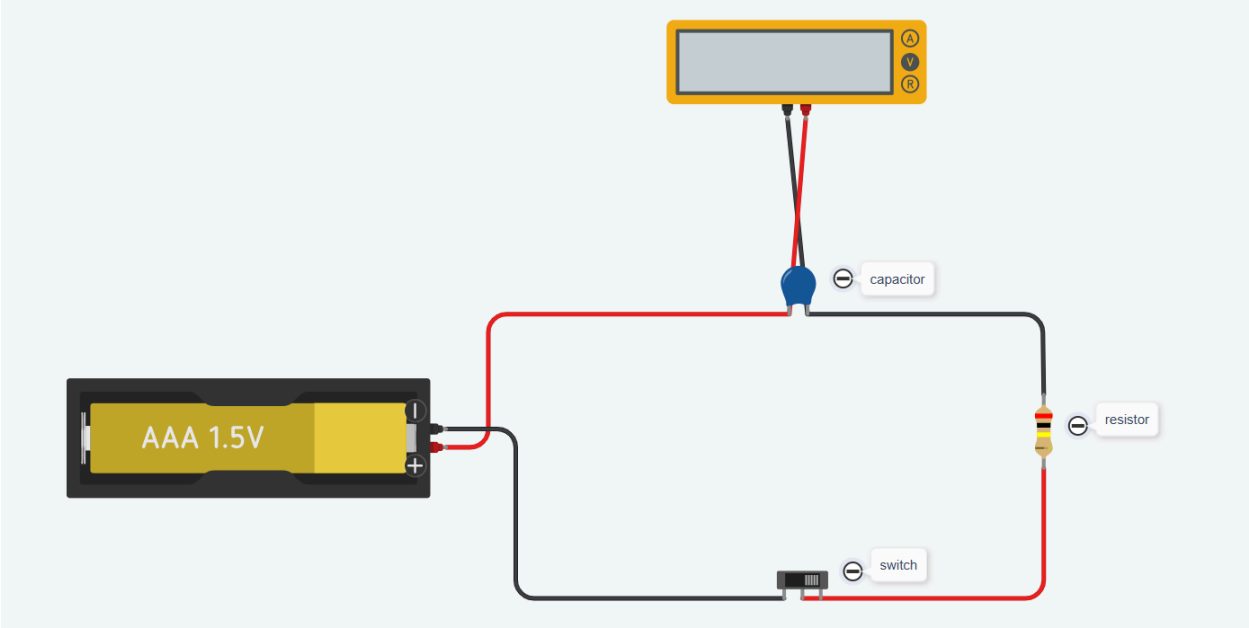
Time (s)	V (V)	lnV
0	1.374	0.31773
3.62	1.203	0.18482
7.72	1.012	0.01193
13.23	0.801	-0.2219
20.07	0.605	-0.5025
30.52	0.398	-0.9213
47.47	0.2	-1.6094

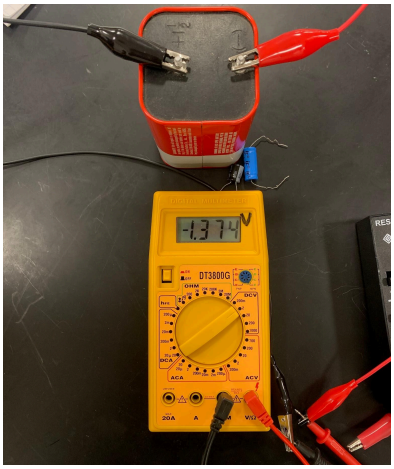


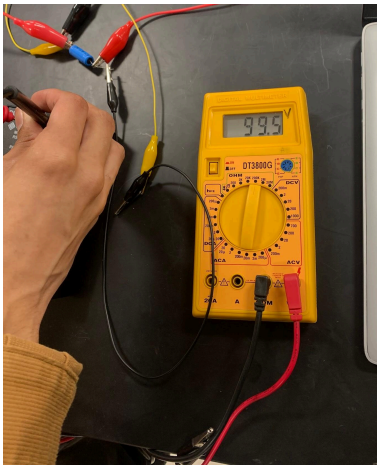
$$\tau_{exp} = -\frac{1}{m} = -\frac{1}{(-0.0408)} = 24.5\ s$$

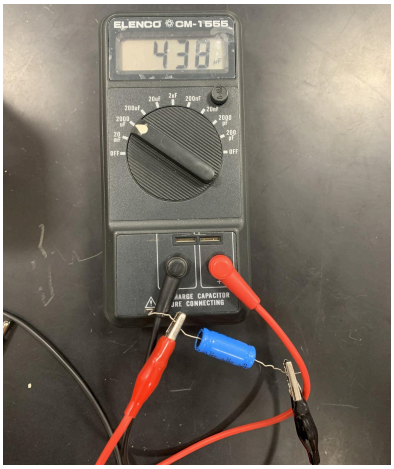
$$\%error = \frac{|\tau_{theo} - \tau_{exp}|}{\tau_{theo}} \times 100\% = \frac{|23\ s - 24.5\ s|}{23\ s} \times 100\% = 6.52\%$$

Case II









V0 = 1.374 V

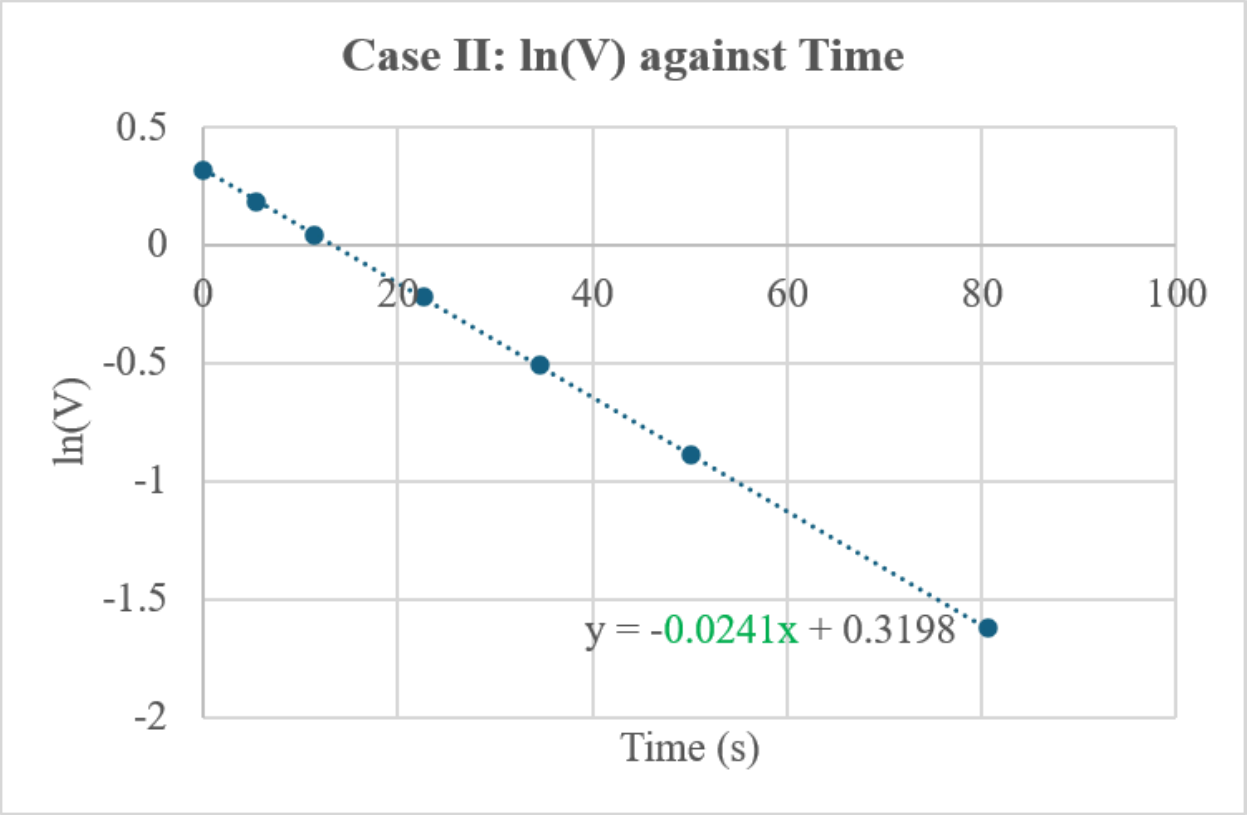
R =99.5 kΩ

C = 438μF

$$\tau_{theo} = RC = (99.5 \times 10^{3}\Omega)(438 \times 10^{-6}F) = 43.6\ s$$

Case II (cont.)

Time (s)	V (V)	lnV
0	1.374	0.31773
5.46	1.202	0.18399
11.5	1.04	0.03922
22.7	0.804	-0.2182
34.63	0.601	-0.5092
50.06	0.41	-0.8916
80.61	0.197	-1.6246



$$\tau_{exp} = -\frac{1}{m} = -\frac{1}{(-0.0241)} = 41.5\ s$$

$$\%error = \frac{|\tau_{theo} - \tau_{exp}|}{\tau_{theo}} \times 100\% = \frac{|43.6\ s - 41.5\ s|}{43.6\ s} \times 100\% = 4.82\%$$

Analysis

Error percentages were found to be around 5%. Several factors such as component tolerances, measurement equipment, and circuit connections may have contributed to the differences between the theoretical and experimental results.

Conclusion

Since all error percentages were found to be less than 10%, this lab is deemed satisfactory.

Summary

Experiment Title: R-C Circuits

Student's name: Myat Thit Ko Ko

Date: 11/05/2026

Purpose: To verify the time constant of an RC circuit.

Procedure: Measuring units. Keeping time as voltage decreases. Graphing for the gradient.

Analysis: Error percentages were 6.52%, and 4.82% respectively.

Conclusion: Satisfactory