Statement of Objectives:

1) To study charging and discharging process through capacitors.

2) To determine the time constant T of an RC-Circuit.

Background and Summary:

a) Brief Description of Theory:

* charging a capacitor;
The electrical charge Q of the capacitor at avg given time t is equal to: $Q = C\mathcal{E}(1 - e^{-\frac{t}{RC}})$
* the voltage across the capacitor Vc: $V_c = \mathcal{E}(1 - e^{-\frac{t}{RC}})$
* At aspecific value of time $t = T = RC$: $V_c = \mathcal{E}(1 - e^{-1})$
or $V_c = 0.63\,\mathcal{E}$
* The current: in the circuit at a given time t is given as
$$i = \frac{\mathcal{E}}{R} e^{-\frac{t}{RC}}$$

* power relation :-
instantanuous rate at which the battery delivers energy to the circuit: $P_{\mathcal{E}} = i\mathcal{E}$.

* Discharging a capacitor :-
* The electricical Q of a discharging capacitor at any given time, $Q = C\mathcal{E}\ e^{-\frac{t}{RC}}$
* the Valtage across the Capacitor Vc: $V_c = \mathcal{E} e^{-\frac{t}{RC}}$
* At time $t = T = RC$
$$V_c = \mathcal{E}\ e^{-1}$$
$$V_c = 0.37\ \mathcal{E}$$
the current i in the circuit
$$i = \frac{\mathcal{E}}{R}\ e^{-\frac{t}{RC}}$$

②

b) Brief Description of Experiment and Procedure:

we are going to measure the (t) For different value oF (v) in both process charge.

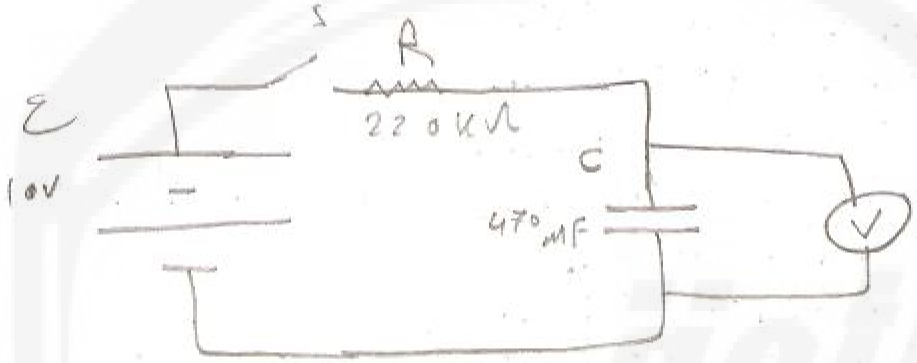
in the other side of the experiment we are going to connect and turn the power supply to record the time the repeat the steps to calculate the bav, Finally plot the graph. vc. vs. tavg. and calculate τ and c

Methodology:

a) List of Equipment:

- Electronic design experimentor.
- 220 kΩ resistor.
- 470 μF capacitor.
- Multimeter.
- Stop watch.
- Connection wires.

b) Diagrams of the Experimental Setup:



→ Figure (1)

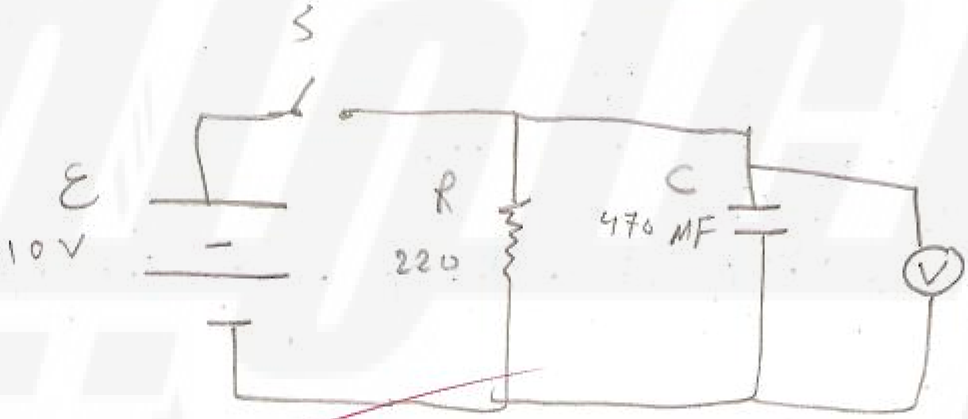


Figure (2)

c) Detailed Description of the Experimental Procedures:

* part 1: Charging a capacitor (Voltage Vs time):

1) Connect the circuit.
2) Turn on the power supply.
3) short out the capacitor
4) Close the switch S, and reset the stop watch.
5) record the time t_1
6) reset the stop watch.
7) repeat steps above for time corresponding
8) Calculate the average time t_{avg}.
9) plot a graph Vs Vs t_{avg}.

* part 3: Discharging a capacitor (voltage Vs time)

1) Connect the circuit.
2) Turn on the power supply.
3) close the switch.
4) Start the stopwatch and open the switch S.
5) Corresponding to integer values of Vc according to table 3.
6) reset the stopwatch.
7) Repeat steps above for time
8) Calculate the average time t_{avg}.
9) Plot a graph for Vc vs t_{avg}.

d) Statement of Error Sources:

1) Wrong in Reading numbers.

2) wrong in connections.

3) The stop watch may giving a wrong number.

4) The capacitor could not has charge before starting changing process.

Data and Analysis of Results

a) Data tables, Sample calculations, and Error Analysis:

table (2)
capacitor voltage versus time of charging capacitor

Data table

V_c (V)	t_1 (s)	t_2 (s)	$t_{av} = \frac{t_1+t_2}{2}$ (s)
0	0	0	0
1	11.97	12.19	12.08
2	24.75	24.82	24.785
3	39.5	39.63	39.56
4	56.66	56.75	56.70
5	1.17.26	1.17.28	77.265
6	1.43.07	1.42.78	102.925
7	2.18.07	2.16.78	137.74
8	3.10.97	3.07.97	199.47

← table (2) ←

capacitor voltage versus time of discharging capacitor

Data table

V_C (v)	t_1 (s)	t_2 (s)	t_{av} (s)
10	0	0	0
9	11.11	11.69	11.4
8	23.58	23.97	23.77
7	38.14	37.94	38.04
6	54.49	54.31	54.4
5	1.14.05	1.14.13	74.09
4	1.39.05	1.37.95	97.95
3	2.09.33	2.08.72	124.625
2	2.54.05	2.53.57	173.81

* Time constant (T) from the graph

$T = RC$, $T = 115$

$R = 220 \times 10^{3}\ \Omega$

$C = \frac{T}{R} = \frac{115}{220 \times 10^{3}}$

$= 5.2 \times 10^{-4}\ F$

* capacitance C (from the graph)

Data table

Discussion and Conclusions:

a) Statement of Results and Comparison with Accepted Values:

- from first graph

$I = Rc$ when $R = 220\times10^{3}$

$$c_1 = \frac{5.1\times10^{-4}}{220\times10^{3}} = 2.3\times10^{-9}$$

$$error = \frac{470\times10^{-6} - 2.3\times10^{-9}}{470\times10^{-4}} \times 100$$

$$= 0.999\ \%$$

from the second graph

$I = Rc$ when $R = 220\times10^{3}$

$$c = \frac{5.2\times10^{-4}}{220\times10^{3}} = 2.3\times10^{-9}$$

$$error = \frac{470\times10^{-6} - 2.3\times10^{-9}}{470\times10^{-4}} \times 100$$

$$= 0.999\ \%$$

b) Discussion of Possible Methods to Reduce Uncertainties:

1) writing the right number

2) making the right connection

3) The stopwatch giving the Readings

c) Statement of General Conclusion:

* In charging a capacitor a resistor is usually connected in series.

* In discharging a capacitor a resistor is usually connected in parallel

* The power conservation

$$P_E = P_R + P_C$$

* Refrance *

Laboratory Manual

General physics Lab II

Phys. 107 & 127

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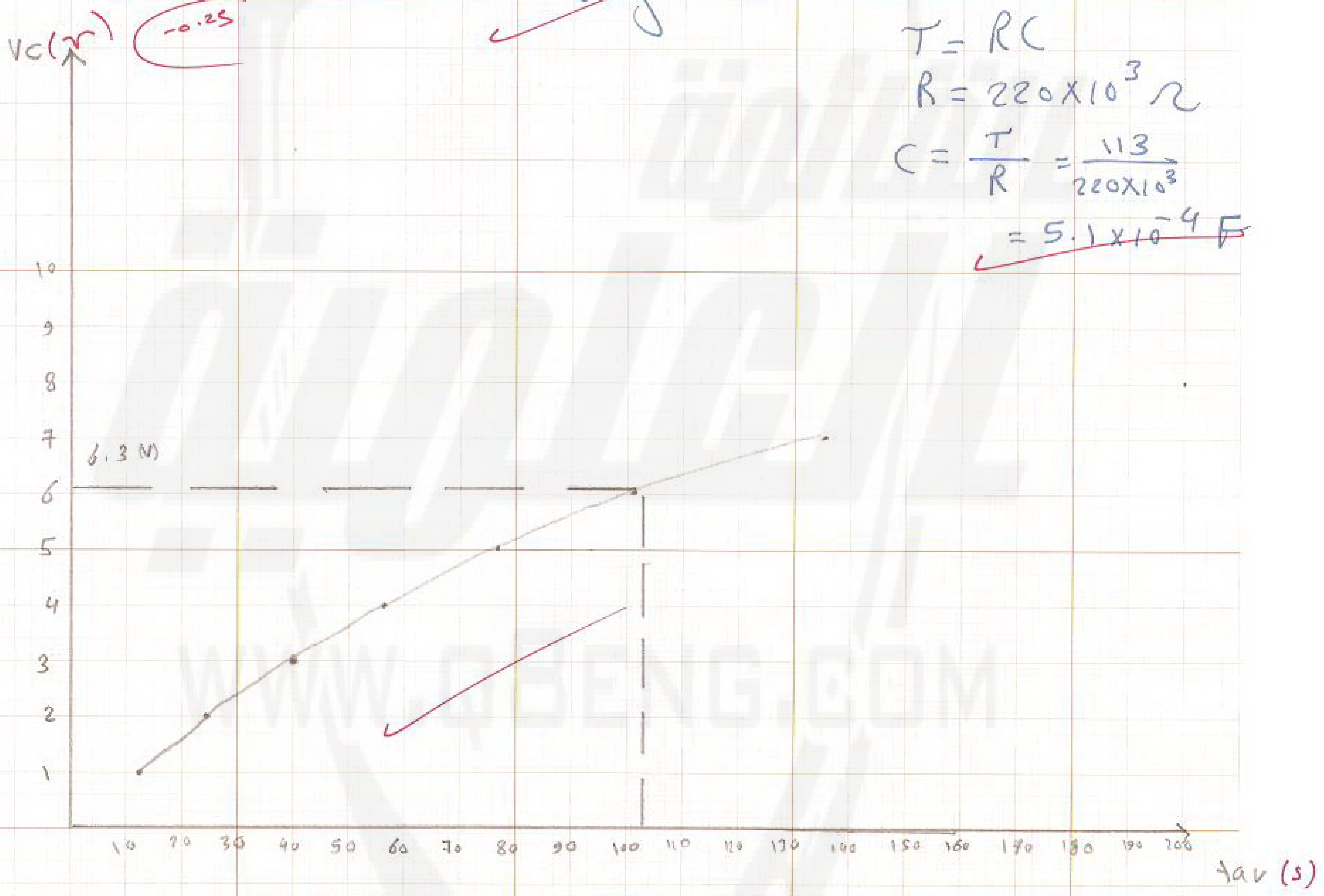
Graph (1)

Charging Table (1)



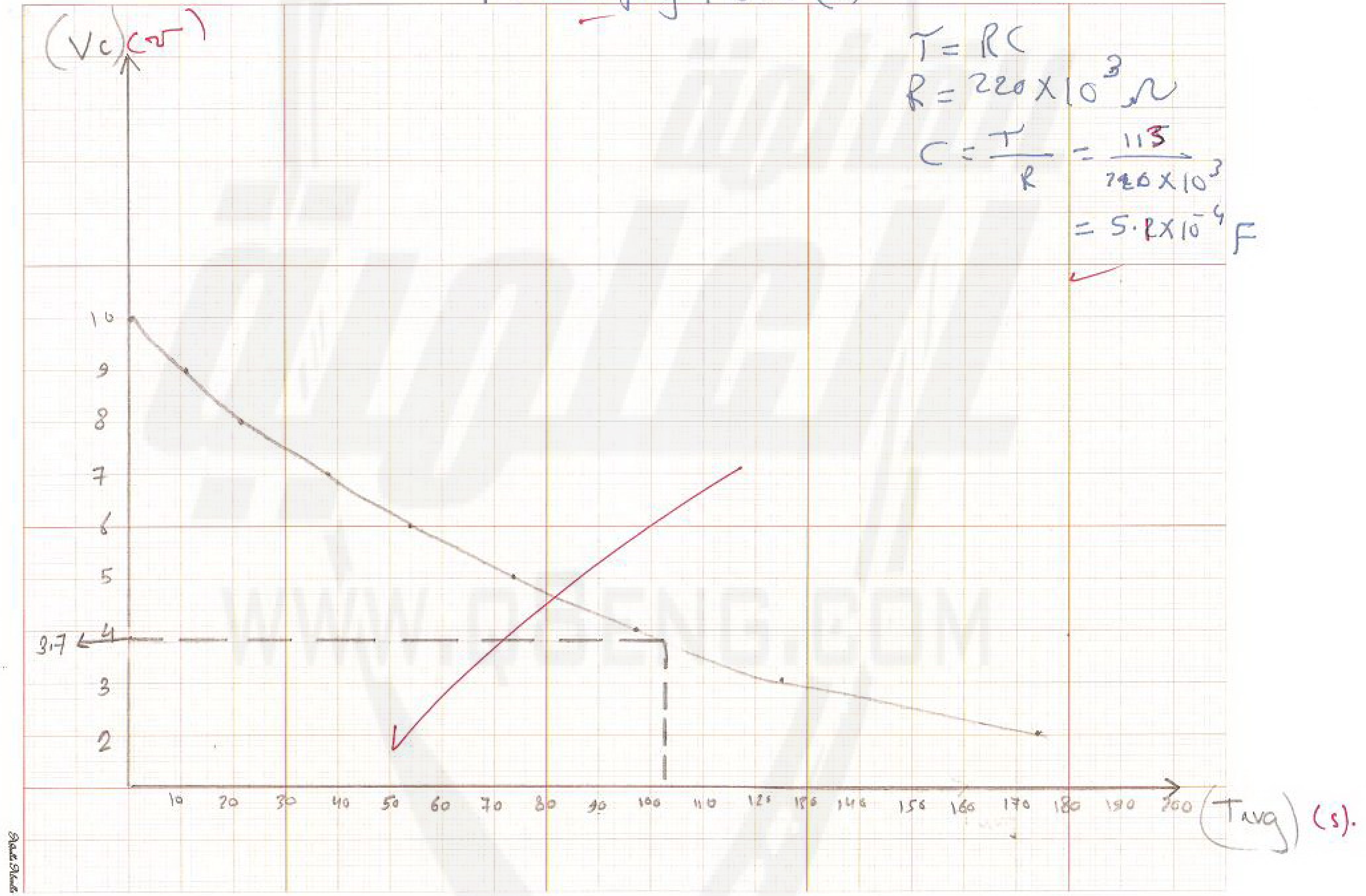
$T = RC$

$R = 220 \times 10^3 \, \Omega$

$C = \frac{T}{R} = \frac{113}{220 \times 10^3}$

$= 5.1 \times 10^{-4} F$

Graph (2)
Discharging Table (3)



$T = RC$

$R = 220 \times 10^{3}\ \Omega$

$C = \frac{T}{R} = \frac{113}{220 \times 10^{3}}$

$= 5.2 \times 10^{-4}\ F$