PHYSICS PRACTICAL SHEETS

Date: 15 Aug 2023
Class: CE 1/2
Roll No.: 25
Shift: Afternoon

KU CAMPUS

Experiment No. 5
Group: T
Subject: PHYS102
Set:

2023/8/11

Object of the Experiment (Block Letter)

DETERMINATION OF CAPACITANCE OF GIVEN CAPACITOR BY CHARGING AND DISCHARGING OF CAPACITOR

Apparatus Required:

i) Capacitor
ii) Resistor
iii) Ammeter
iv) Battery (DC source).

Theory:

If the key is closed in the circuit of fig. 1, the dc emf source will charge the capacitor through the resistance. Then charge in capacitor at any instance is given by

$$Q = Q_0 (1 - e^{-t/RC}) \quad \text{— (i)}$$

where, Q_0 = maximum charge stored in capacitor
R = resistance C = capacitance

Then, differentiating (1), charging current is obtained as,

$$I = I_0 e^{-t/RC} \quad \text{— (ii)}$$

Now, if source is disconnected and points A and B are connected, the capacitor ~~will~~ will discharge through the resistor. Then charge in the capacitor at any instance during discharge is given as,

$$Q = Q_0 e^{-t/RC} \quad \text{— (iii)}$$

and discharging current is given by

$$I = I_0 e^{-t/RC} \quad \text{— (iv)}$$

Note: Discharging current is in opposite direction than charging current.

Here, if a graph is drawn betn 'I' versus 't' for (ii) & (iv), exponentially decaying curves obtained. Then taking logarithm of eqn (ii) and (iv)

$$\ln I = \ln I_0 - \frac{t}{RC} \quad \text{— (v)}$$

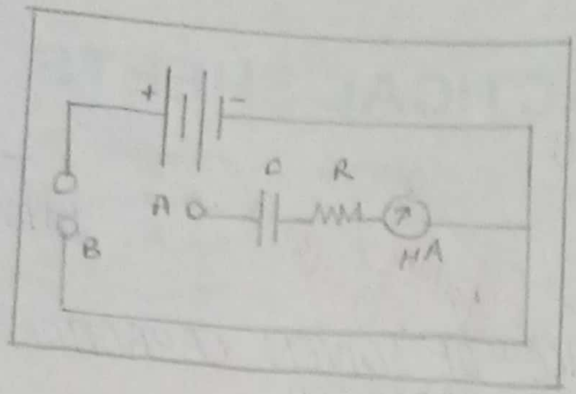
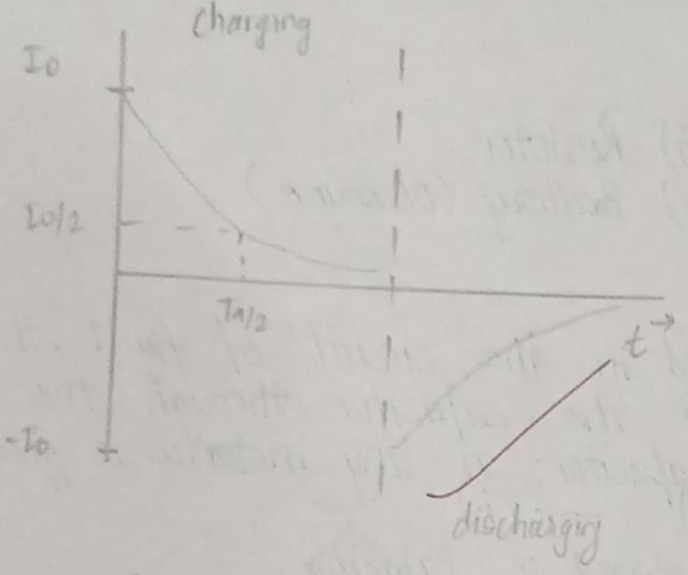
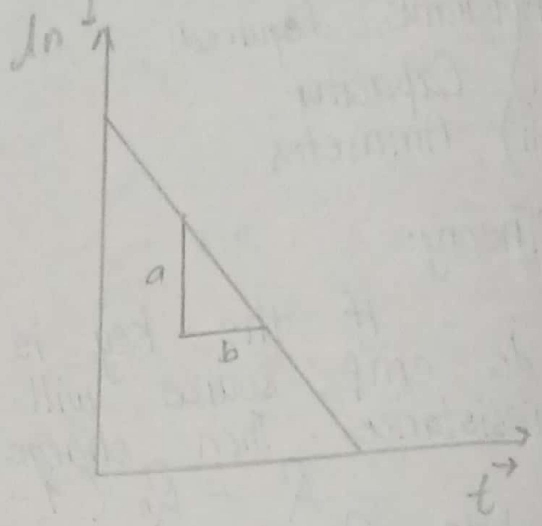


Fig. 1



Graph 1



Graph 2

If a graph is plotted between '$\ln I$' and 't', a straight line with slope $-1/RC$ is obtained.
If a point where $I = I_0/2$ is considered, eq^n(5) becomes

$$\ln \frac{I}{2} = \frac{T_{1/2}}{RC} \qquad \text{or,} \quad C = \frac{T_{1/2}}{R \cdot \ln 2} \qquad \text{— (6)}$$

Similarly, if slope of the straight line in graph 2,

$$m = \frac{a}{b} = \frac{1}{RC}.$$

$$\text{or,} \quad C = \frac{1}{R \cdot m} \qquad \text{— (7).}$$

Observations:

10 division of microammeter = 0.5 mA
1 division of microammeter = 0.05 mA = 50 μA

⇒ for $R = 10\ k\Omega = 10000\ \Omega$

Charging ~~Discharging~~

No. of obs	Time (s)	Current (μA)	ln I	No. of obs	Time (s)	Current (μA)	ln I
1	0	800	6.68	14	50.74	100	4.60
2	3.41	700	6.65	15	68.40	50	3.91
3	5.55	650	6.47	16	124.77	0	
4	6.09	600	6.39				
5	8.46	550	6.30				
6	11.24	500	6.21				
7	13.35	450	6.10				
8	15.75	400	5.99				
9	18.96	350	5.86				
10	23.59	300	5.70				
11	27.97	250	5.52				
12	32.90	200	5.29				
13	40.16	150	5.01				

Discharging:

No. of obs	Time (s)	Current (μA)	ln I	No. of obs	Time (s)	Current (μA)	ln I
1	0	800	6.68	9	20.27	350	5.86
2	4.09	700	6.55	10	23.86	300	5.70
3	6.12	650	6.47	11	27.49	250	5.52
4	8.31	600	6.39	12	33.52	200	5.29
5	10.52	550	6.30	13	40.96	150	5.01
6	12.24	500	6.21	14	48.87	100	4.60
7	14.62	450	6.10	15	68.59	50	3.91
8	16.06	400	5.99	16	146.58	0	

For $R = 15\,k\Omega = 15000\,\Omega$

Charging

No. of obs	Time (s)	Current (μA)	ln I
1	0	525	6.26
2	7.15	450	6.10
3	11.27	400	5.99
4	14.49	350	5.86
5	20.43	300	5.70
6	26.98	250	5.52
7	32.65	200	5.29
8	42.96	150	5.01
9	57.98	100	4.60
10	82.64	50	3.91
11	143.71	0	

Discharging

No. of obs	Time (s)	Current (μA)	ln I
1	0	525	6.26
2	7.62	450	6.10
3	11.59	400	5.99
4	15.74	350	5.86
5	20.75	300	5.70
6	26.34	250	5.52
7	34.32	200	5.29
8	45.55	150	5.01
9	59.87	100	4.60
10	67.28	50	3.91
11	193.27	0	

Calculations:

For $10\,k\Omega$,

For $10\,k\Omega$, the value of capacitance from

Eq^n (7) is

$$C = \frac{1}{Rm} = \frac{1}{10\times10^3\times1.8/40}$$

$$= 2220\,\mu F$$

Eq^n (6) is.

$$C = \frac{T_{1/2}}{R\cdot\ln2} = \frac{15}{10\times10^3\times\ln2}$$

$$= 2170\,\mu F$$

For $15\,k\Omega$, the value of capacitance from.

Eq^n(7) is

$$C = \frac{1}{Rm} = \frac{1}{15\times10^3\times1.6/56}$$

$$= 2330\,\mu F$$

Eq^n(6) is

$$C = \frac{T_{1/2}}{R\cdot\ln2} = \frac{24}{15\times10^3\times\ln2}$$

$$= 2320\,\mu F$$

Result:

The value of mean capacitance is found to be 2260 μF.

% Error

Standard value of capacitance = 2220 μF
Obtained value of capacitance = 2260 μF

$$\therefore \%\ \text{Error} = \left|\frac{2260-2220}{2220}\right| \times 100\%$$

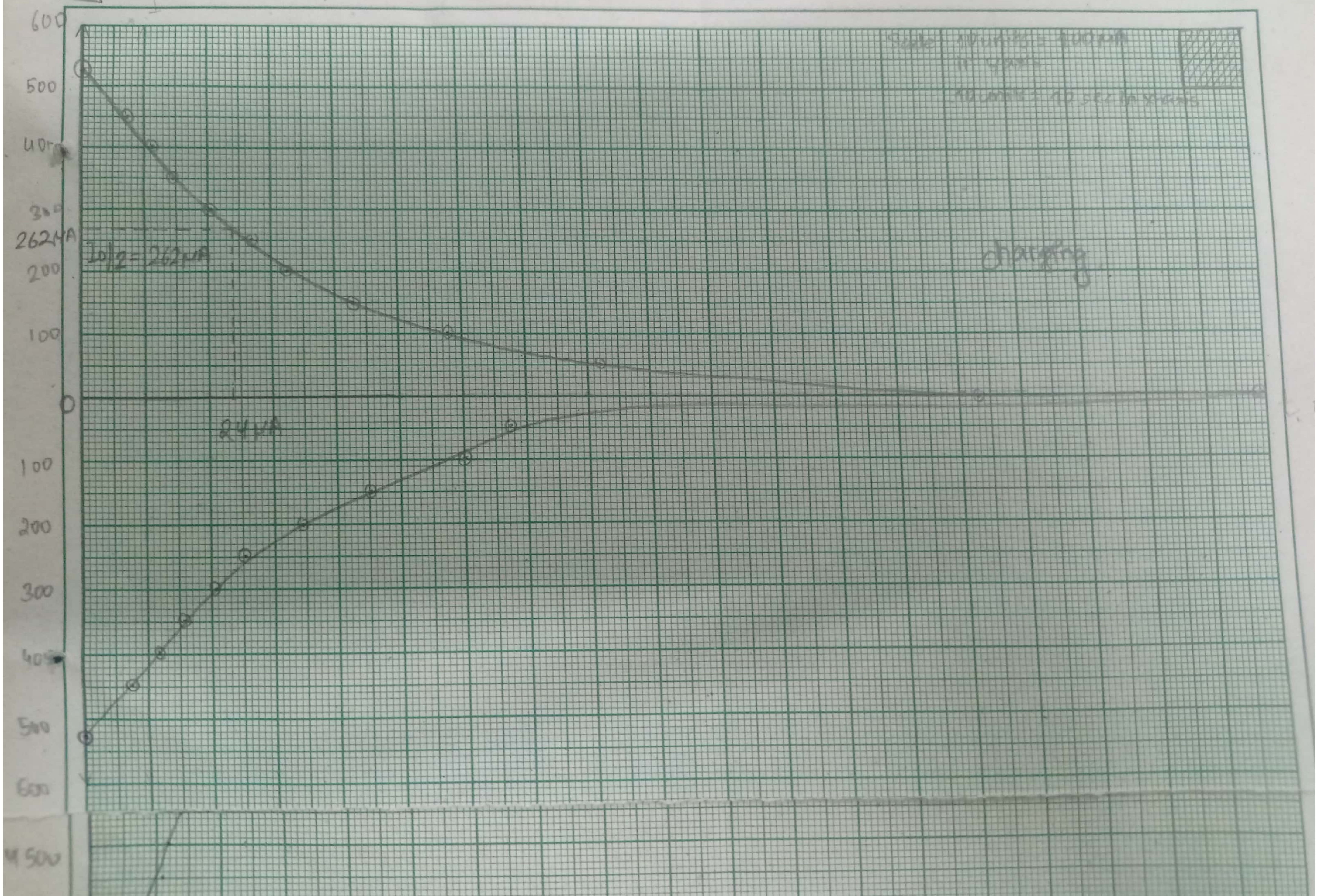
$$= 1.8\%$$

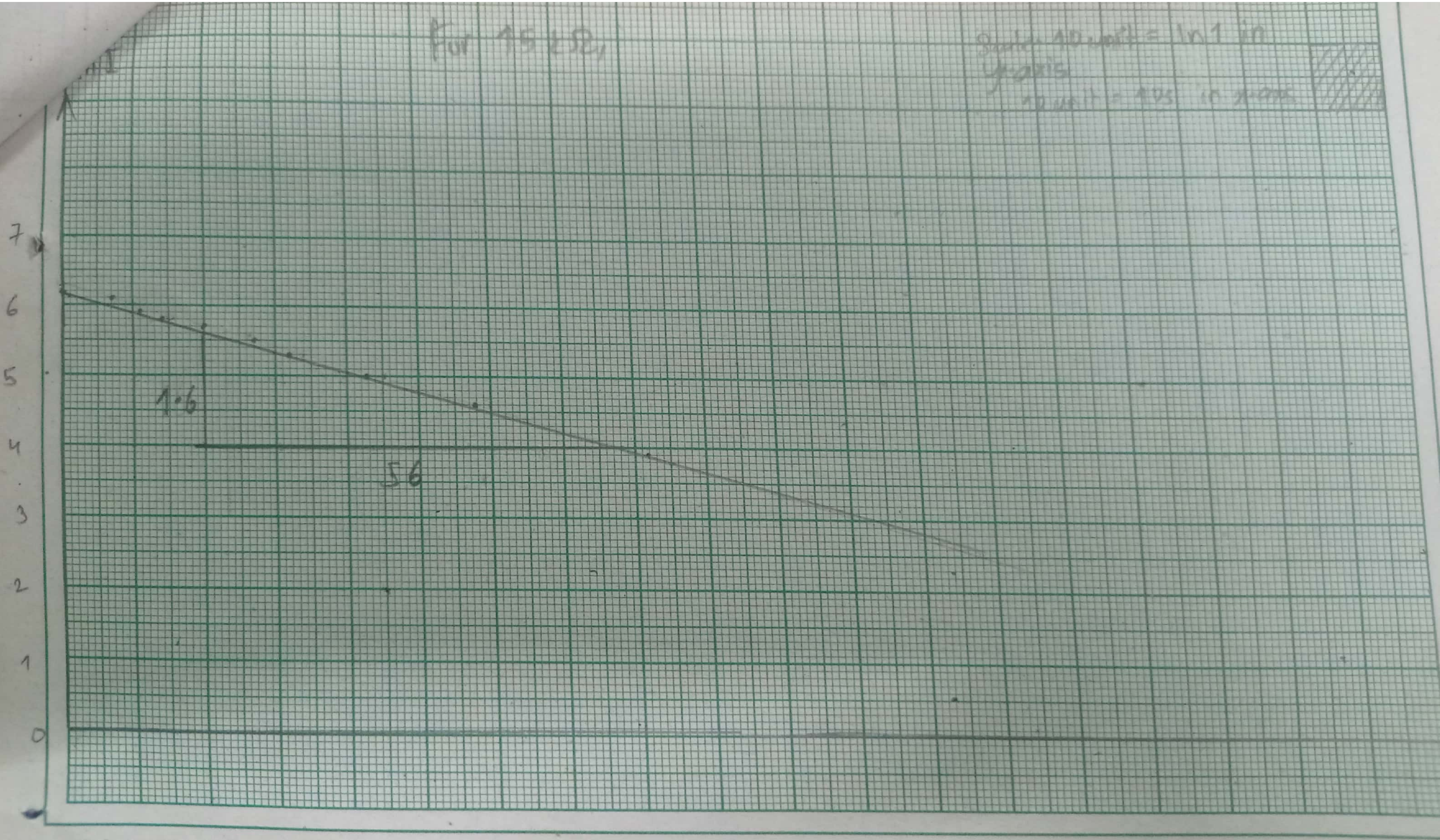
Conclusion:

The capacitance of capacitor was obtained with an error of 1.8%.

Ashraya ~~Shraddha~~ Kadel Rollno: 25 Exp: 5

I For 15 kΩ

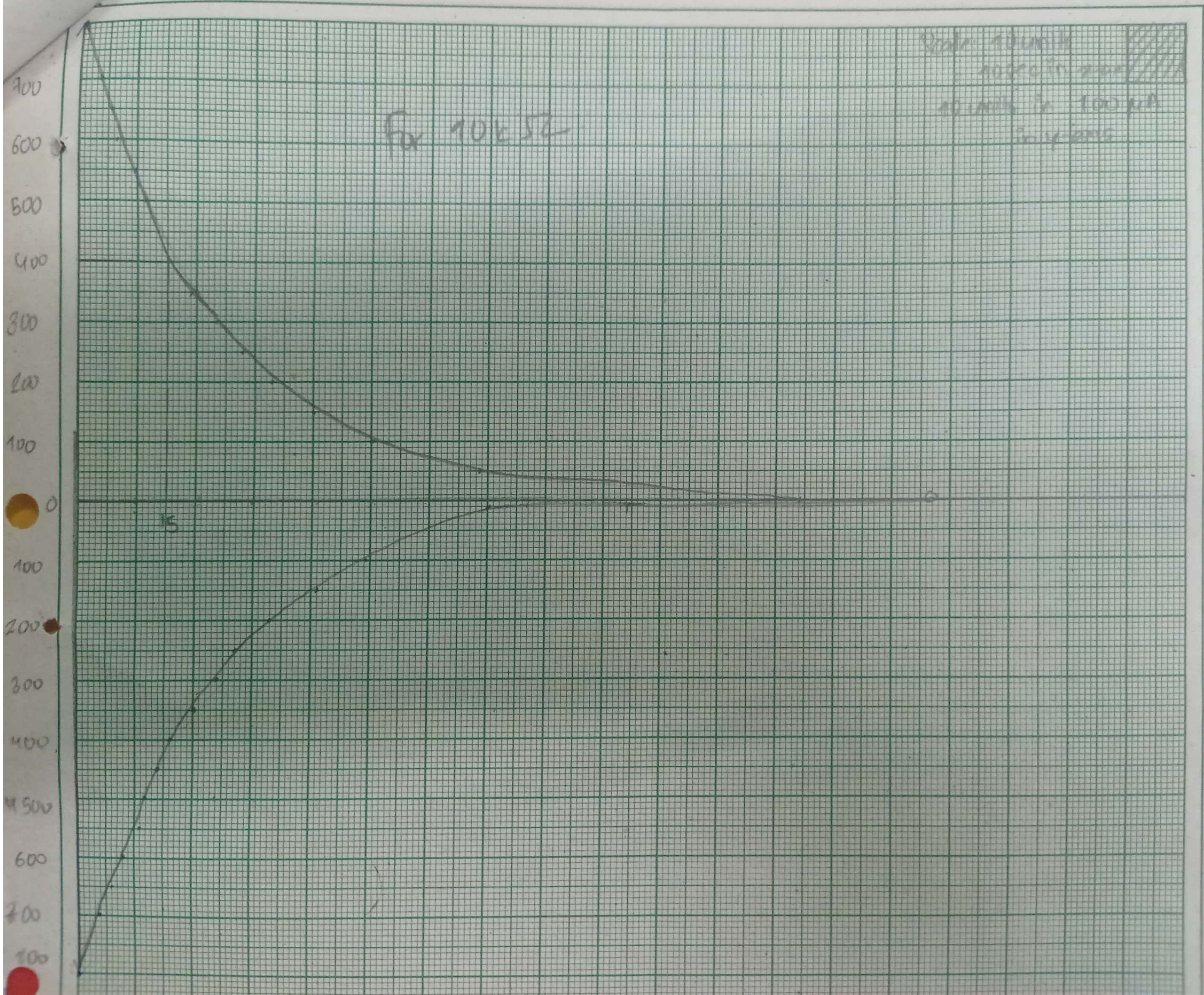


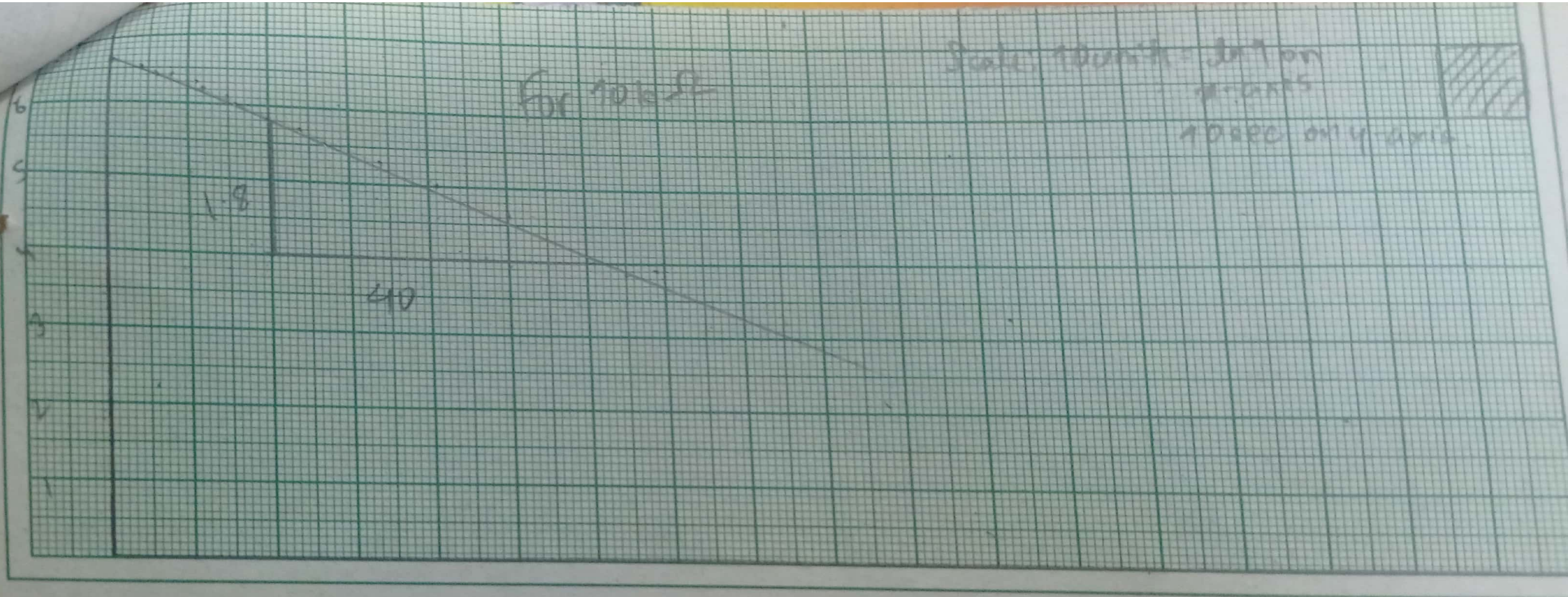


For 15 kΩ,
Scale: 10 unit = ln 1 in
y-axis
10 unit = 10s in x-axis
ln I
7
6
5
4
3
2
1
0
1·6
56

Appo

Ashraya ~~Shraddha~~ Kadel Exp no: ~~02~~ 05
Roll no: 25





For 10kΩ
6
5
4
3
2
1
1.8
40