LAB REPORT FOR EXPERIMENT 7

Date: ----------

Name:----

Partner's Name:----------

Registration No:-2'

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Physics Section:-

Instructor's Name:---

PHYSICS LAB EXPERIMENT 7 : THE RC TIME CONSTANT

1. PURPOSE

To determine the time constant for an RC-circuit by measuring the charging current

IV. DATA AND DATA ANALYSIS:

1- *Enter your data of the* **charging current** , the corresponding **time** and the *measured voltage source* V_0 *in* Table 7.1 below:

Table 7.1

Case 1 (190 mF, 61.6 KW)				Case 2 (435, 61.6 K)			
C_1 = ~~200~~ μF , R = ~~60KΩ~~				C_2 = ~~500~~ μF , R = ~~60KΩ~~			
V_o = 6V Volts, I_o = (μA)				V_o = 6V Volts, I_o = (μA)			
Current (μA)	Time (s)	I/I_o	$Ln(I/I_o)$	Current (μA)	Time (s)	I/I_o	$Ln(I/I_o)$
90	0	1	0	90	0	1	0
63	5	0.7	-0.35	71	5	0.78	-0.24
43	10	0.47	-0.73	60	10	0.66	-0.41
32	15	0.35	-1.04	50	15	0.55	-0.59
22	20	0.24	-1.4	44	20	0.48	-0.73
Slope = -0.066, τ_1 =				Slope = -0.04 , τ_2=			

2- Plot the **charging current** as dependent variable versus **time** as independent variable **for case 1**. Is the plot linear? What can you say about the shape of your graph?

Not Linear (decreasing)

3- From the data of charging current versus time, determine the value of the initial charging current I_0 . This is the value of the current at t = 0. Record the value in table 7.1 .

case 1 → $I_0 = 90\ mA$
case 2 → $I_0 = -90\ mA$

4- Plot Ln (I / I_0) as the dependent variable versus time. Here, *I* is the charging current and I_0, the initial current determined in step (3) above. Is the plot linear?

Yes, Linear

5- Draw the straight line that best fits the data and determine the slope of the line. Record the value of the slope in table 7.1 .

6- *Repeat steps 3,4 and 5 above for the second case.*

7- Determine the time constant for each case from the equation:

$$\tau = \frac{-1}{\text{slope}}$$

and record it in table 7.1.

τ_1 (experimentally) = + 15 Ω.F

τ_2 (experimentally) = + 25 Ω.F

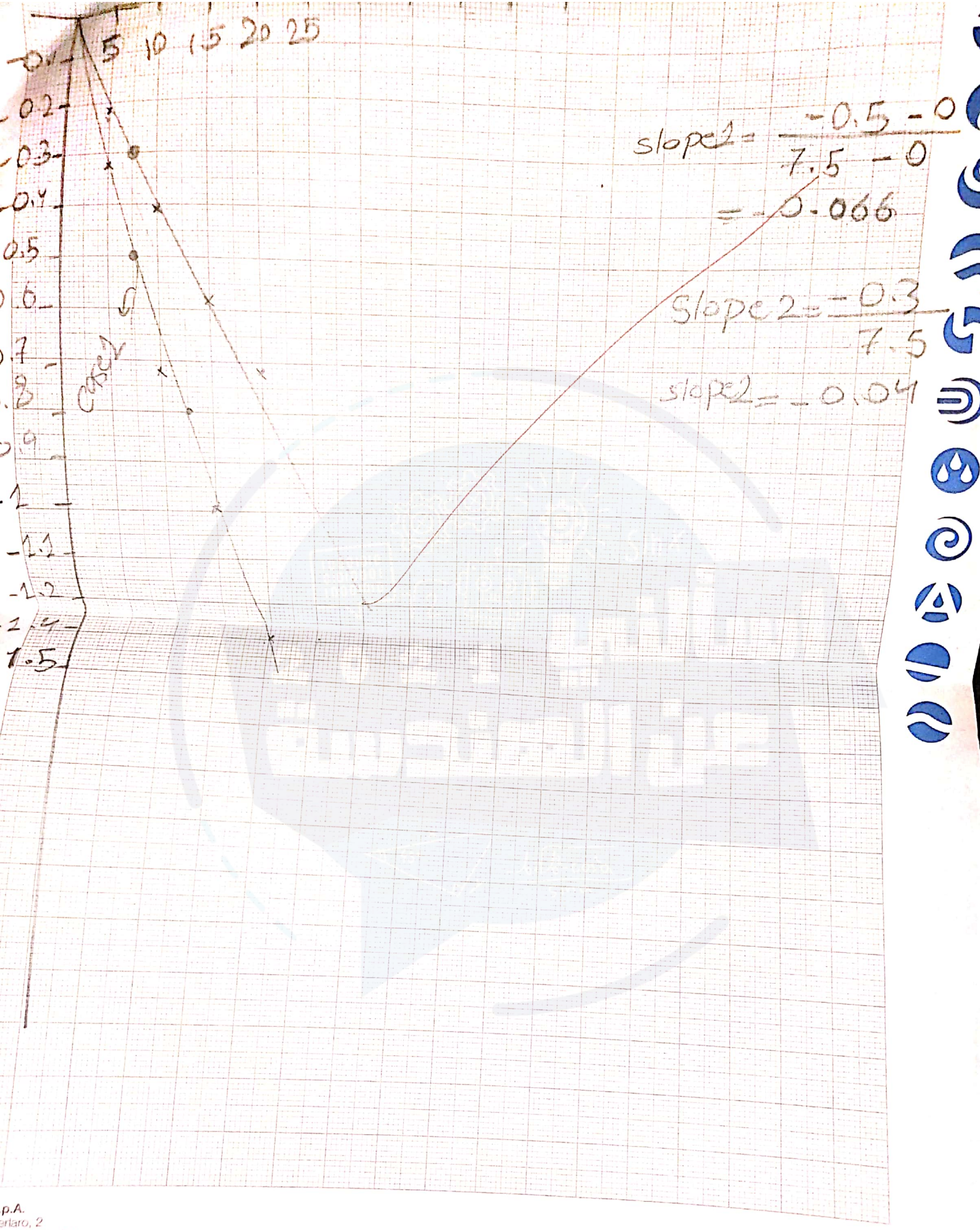
8- From the known values of C and R for each case, calculate $\tau_1 = RC_1$ and $\tau_2 = RC_2$ and compare these values with those obtained in step (6).

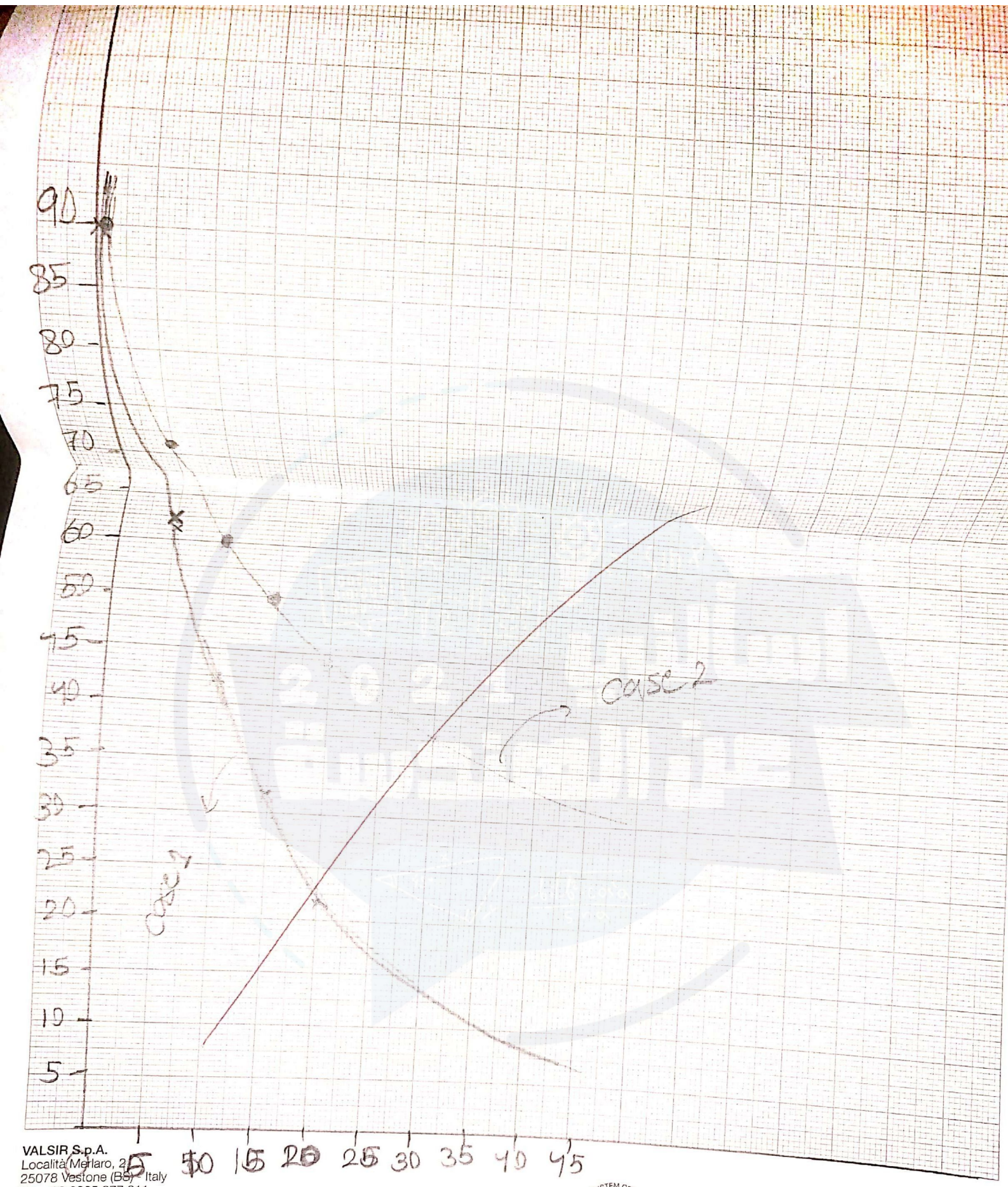
τ_1 (Calculated) = 11.704 -2.F

τ_2 (Calculated) = 26.796 -2.F

9- From the known values of V_o and R, , calculate $I_o = \frac{V_o}{R}$ which is the same for both cases. Compare this value with the one obtained in step (3) above.

I_o(calculated) = $\frac{V_o = 6V}{R \quad (61.6)K\Omega} = 0.097mA$





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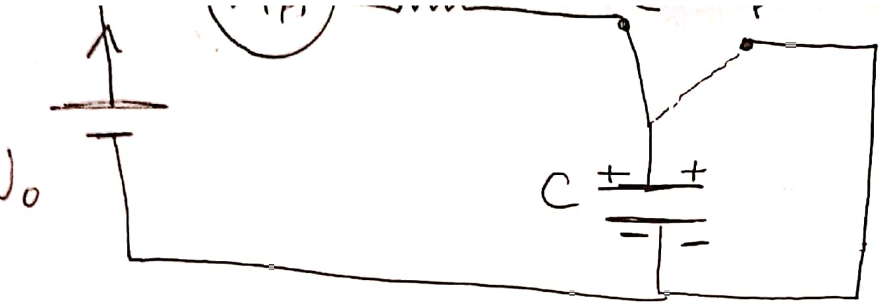


$$C = \frac{Q}{V_c}$$ شحنة / فرق الجهد

farad

- لبداية التجربة مافيهم أي شحنة
مقدار الشحنة الـ + = مقدار الشحنة السالبة
ما بيمشي بين الصفيحتين لأنو داخله مادة عازلة #
وهادي العملية اسمها

* charging capacitor → الـ switch بيكون مغلق

$RC \equiv \tau$ → تاو

$V_0 - IR - V_C = 0$

$V_0 - IR - \frac{Q}{C} = 0$

هون لما مشينا بالمواسعة حطينا سالب لأنو حنلاقي بيصير انخفاض في الجهد إذا مشينا مع المجال

ثابت $V_0 - R\frac{dQ}{dt} - \frac{Q}{C} = 0$ (ثابت)

$$\frac{dQ}{dt} = \frac{V_0 - Q/C}{R}$$

* seperation variables *

$$\frac{dQ}{V_0 - \frac{Q}{C}} = \frac{dt}{R}$$

$u = V_0 - \frac{Q}{C} \rightarrow du = \frac{-1}{C} dQ$

$$-C\frac{du}{u} = \frac{dt}{R} \rightarrow -C\int_{u_1}^{u_2} \frac{du}{u} = \int_{t_1}^{t_2} \frac{dt}{R}$$

$$\ln u \Big|_{u_1}^{u_2} = \frac{-1}{RC} t \Big|_{t_1}^{t_2}$$

$$\ln u_2 - \ln u_1 = \frac{-t}{RC}$$

$$\ln \frac{u_2}{u_1} = \frac{-t}{RC}$$

$u_2 = u_1 e^{-t/RC}$

$V_0 - \frac{Q}{C} = V_0 e^{-t/\tau}$

$RC \equiv \tau$
time constant of the RC circuit

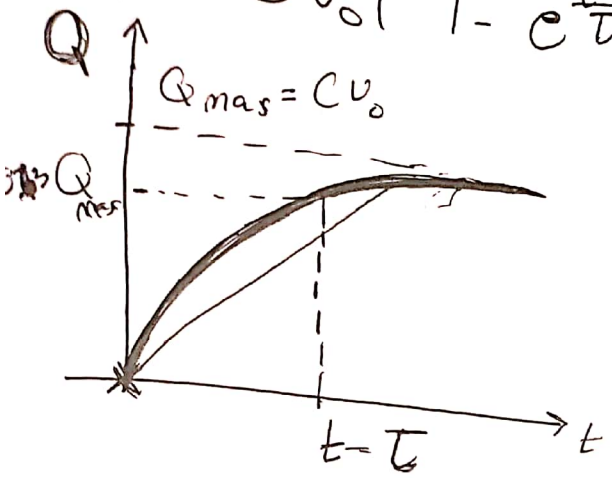
$Q = CV_0(1 - e^{-t/\tau})$
معادلة الشحنة تتغير بالمواسعة مع الزمن

// S is closed (at instant closing S at time t)

$V_c + V_R = 0$

$\Sigma \Delta V = 0$ → متغير $\frac{q}{C} + iR$ متغير

$Q = CV_0(1 - e^{\frac{t}{\tau}})$



* بعد زمن طويل من اغلاق السويتش

When $t \gg \tau$

$Q = \varepsilon(1 - e^{-t/\tau})$ ← بسيط

$\therefore Q = CV_0$

* نصل لـ Q_{max} التي بتتجمع في الصفيحة بعد فترة طويلة

at $t = \tau$

$Q|_{t=\tau} = Q_{max}(1 - e^{-1})$

$Q|_{t=\tau} = 0.63\, Q_{max}$

بعد زمن τ الـ capacitor جمّع Q_{max} من 0.63

at $t = 2\tau$

$Q|_{t=2\tau} = Q_{max}(1 - e^{-2})$

$Q|_{t=2\tau} = 0.84\, Q_{max}$

* مقدار الـ τ يحدّد سرعة شحن الـ capacitor

* كلما زادت τ بزيد الوقت اللازم لشحن الـ capacitor

* "الشحن أبطأ"

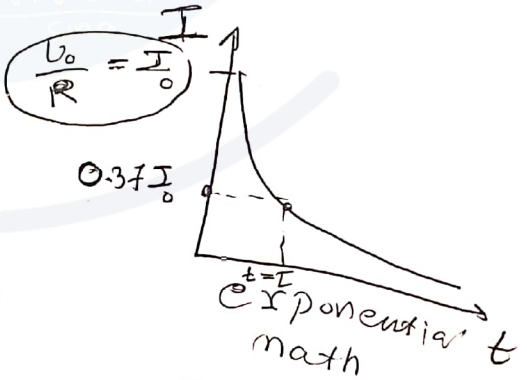
$I = \frac{dQ}{dt}$

$I = \frac{CV_0}{\tau} e^{\frac{t}{\tau}}$

$= \frac{qV_0}{RC} e^{\frac{t}{\tau}}$

$\boxed{I = \frac{V_0}{R} e^{-\frac{t}{\tau}}}$

I ← t عكسي مع زيادة بتناقص



$I|_{t=\tau} = \frac{V_0}{R} \cdot e^{-1} = 0.37\, I_0$

0 current بعد زمن طويل

R ↗ بزيد ← τ بزيد

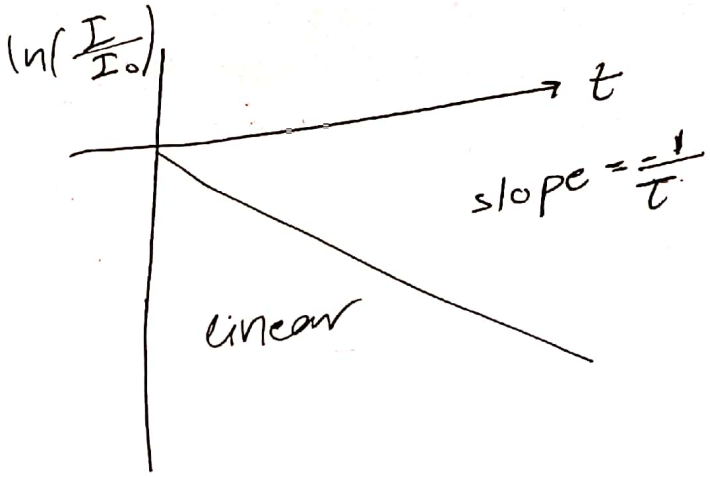
$V_C + V_R = 0$ ، $\Delta V = 0$ time ↑ متغير

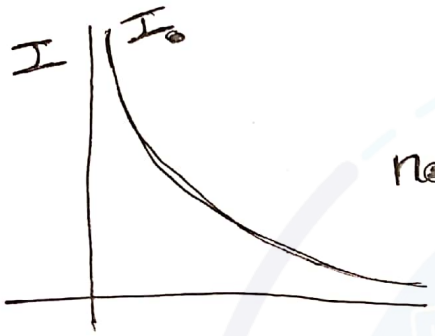
$$Q = CV_0\left(1 - e^{-\frac{t}{\tau}}\right)$$

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

$$\ln\left(\frac{I}{I_0}\right) = \boxed{\frac{1}{\tau}}\, t$$

↳ slope





not linear

* لما يقول $t=0$ أو , initial current , I_0 , I_{max} =

① $\boxed{i_0 = \frac{\varepsilon}{R}}$ ← $\boxed{q = 0}$

② for time t ↘

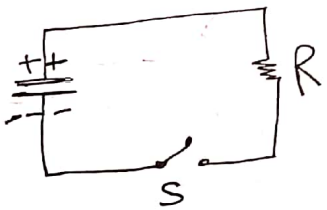
$q(t) = \varepsilon C\left(1 - e^{-\frac{t}{RC}}\right)$ ⟶ بجد مورزمه

$i(t) = \frac{\varepsilon}{R} e^{-\frac{t}{RC}}$ ⟶ بجد مورزمه

③ for long time t >>

$q_{max} = q_{final} = \varepsilon C \Rightarrow CV_0$

عملية (A) الشحن



① S is open

$q_0 = \varepsilon C = CV_0$

$i_0 = \frac{\varepsilon}{R} = \frac{V_0}{R}$

عملية (B) التفريغ

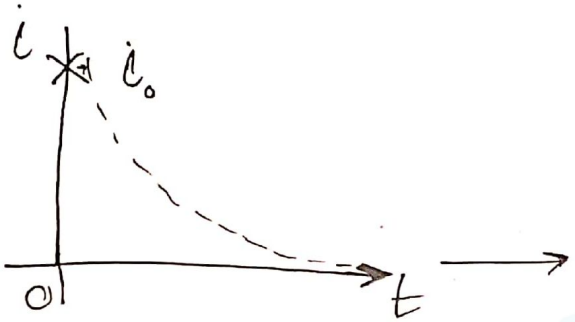
② S is closed (at instant closing S at time +) ، $V_C + V_R = 0$ ، $\Sigma \Delta V = 0$ ⟶ $\frac{q}{C} + iR = 0$ متغير متغير

$\frac{\Delta x}{\Delta t}$

$$i(t) = \left(\frac{\varepsilon}{R}\right) e^{-\frac{t}{\tau}} \quad \text{——— (1)}$$

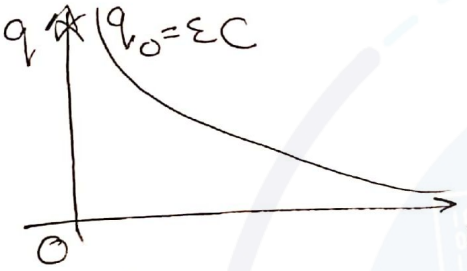
$$q(t) = (q_0)\, e^{-\frac{t}{\tau}} \quad \text{——— (2)}$$

$\hookrightarrow \varepsilon C = C V_0$

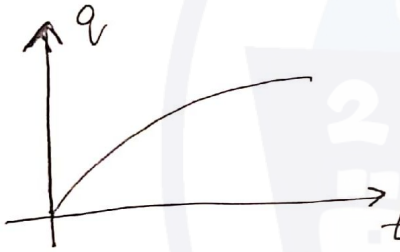


i_0 when $\boxed{t=0}$ مباشرة بشروع نقطة تقاطع مع y

شحن وتفريغ نفس الرسمة



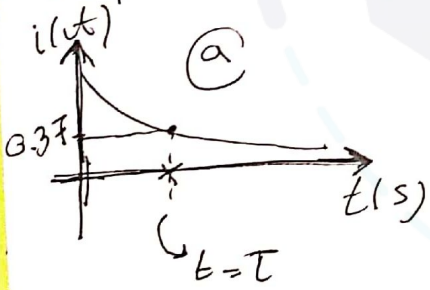
* التفريغ



* شحن

experimentally to calculate τ

$t = \tau$



ⓐ

$$i = i_0 e^{-\frac{t}{\tau}}$$

$$i = i_0 e^{-1}$$

$$i = 0.37\, i_0$$

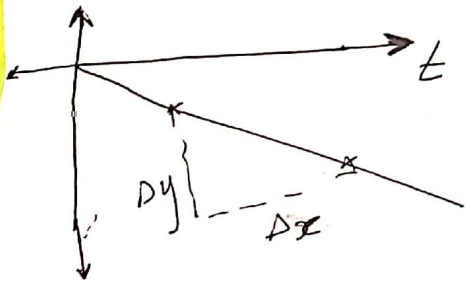
① منحنى يؤخذ τ

ⓑ $\tau = RC$ ← يؤخذ من الجدول

② by slope ← نأخذ ln لطرفين

$$\left(\frac{i}{i_0}\right) = e^{-\frac{t}{\tau}}$$

$$\ln\left(\frac{i}{i_0}\right) = \frac{-t}{\tau}$$



$$\text{slope} = \frac{\Delta \ln\left(\frac{i}{i_0}\right)}{\Delta t}$$

ⓒ $\tau = \frac{1}{|\text{slope}|}$

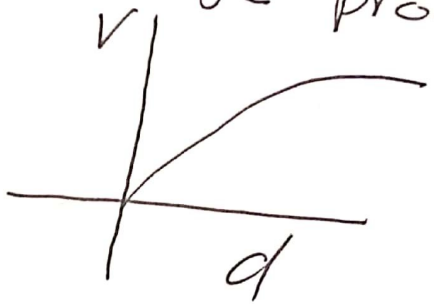
multiameter & read deflection = i

Which of the following represent discharge process.

a ✓

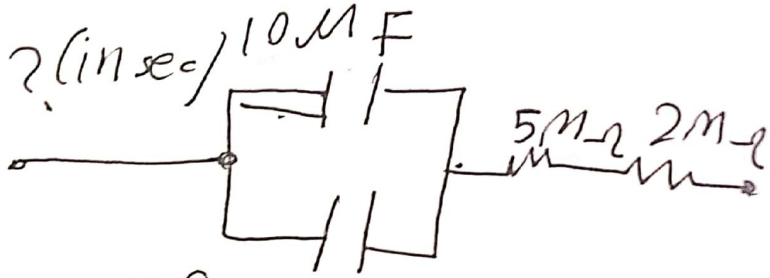
b

c



d

R_2 in circuit shown time constant ?(in sec)



$= RC$

$= 20 * 10^{-6} * 7 * 10^{6}$

$\tau = 140\,sec$

توقع ال C هو مجموع طبيعي