Experiment Name: To determine the RC time constant in an RC circuit

Theory: Charging a capacitor

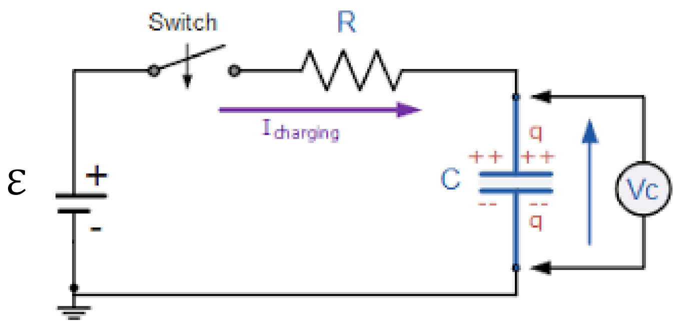


Fig 1 : Charging a capacitor

Kirchhoff's loop theorem:

$\mathcal{E}$ – iR - $\frac{q}{C}$ = 0

$\mathcal{E}$ = iR + $\frac{q}{C}$ [i & q = two variables, i = $\frac{dq}{dt}$]

$\mathcal{E} = R\frac{dq}{dt} + \frac{q}{C}$

q = C$\mathcal{E}$(1 – $e^{\frac{-t}{RC}}$)

CV_c = C$\mathcal{E}$(1 - $e^{\frac{-t}{RC}}$) [q = CV_c]

V_c = $\mathcal{E}$(1 – $e^{\frac{-t}{RC}}$)

$\frac{V_c}{\mathcal{E}} = 1 - e^{\frac{-t}{RC}}$

$e^{\frac{-t}{RC}}$ = 1 - $\frac{V_c}{\mathcal{E}}$

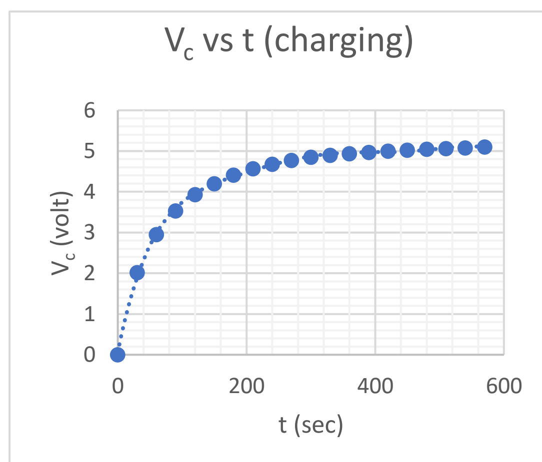
$\ln(1 - \frac{V_c}{\mathcal{E}}) = \ln(e^{\frac{-t}{RC}})$

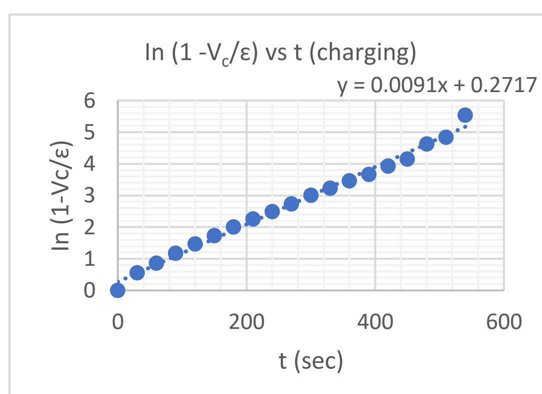
$\ln(1 - \frac{V_c}{\mathcal{E}})$ = - $\frac{t}{RC}$

$\ln(1 - \frac{V_C}{\mathcal{E}})$ = (- $\frac{1}{RC}$)t

From the graph, y = mx + b

Slope, m = (- $\frac{1}{RC}$)





Discharging a capacitor:

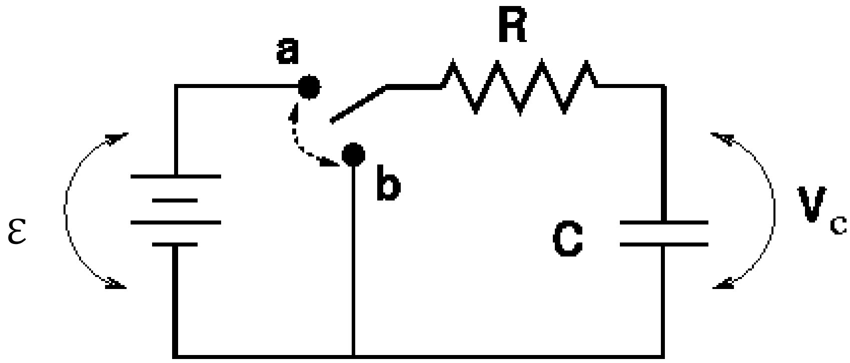
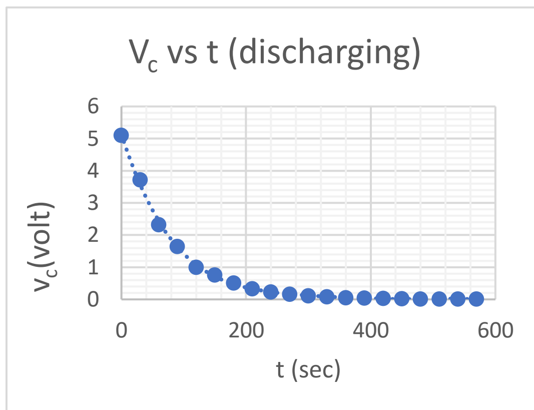


Fig 2: Discharging a capacitor

Kirchhoff's loop theorem:



$$-iR - \frac{q}{c} = 0$$

$$-(iR + \frac{q}{c}) = 0$$

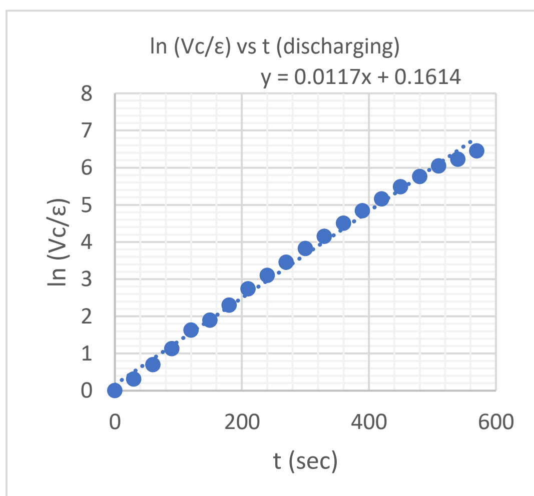
$$R\frac{dq}{dt} + \frac{q}{c} = 0 \qquad [\ i = \frac{dq}{dt}\ ]$$

$$q = C\mathcal{E}e^{\frac{-t}{RC}}$$

$$CV_c = C\mathcal{E}e^{\frac{-t}{Rc}} \qquad [q = CV_c]$$

$$V_c = \mathcal{E}e^{\frac{-t}{RC}}$$

$$\frac{V_c}{\mathcal{E}} = e^{\frac{-t}{RC}}$$



$$\ln(\frac{V_c}{\mathcal{E}}) = \ln(e^{\frac{-t}{RC}})$$

$$\ln(\frac{V_c}{\mathcal{E}}) = -\frac{t}{RC}$$

$$\ln(\frac{V_c}{\mathcal{E}}) = \left(-\frac{1}{RC}\right)t$$

From the graph, y = mx + b

Slope, m = $(-\frac{1}{RC})$

Apparatus: Resistor, capacitor, power supply, voltmeter and stop watch

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Data Table: Charging & Discharging of an RC circuit

Maximum potential difference (Ɛ) =

Time (s)	**Charging capacitor**		**Discharging capacitor**	
	V_c(volt)	In (1 - $\frac{V_c}{\varepsilon}$)	V_c (volt)	In ($\frac{V_c}{\varepsilon}$)
0				
30				
60				
90				
120				
150				
180				
210				
240				
270				
300				
330				
360				
390				
420				
450				
480				
510				
540				
570				
600				
630				
660				
690				

Calculation: Charging a capacitor

Theoretically:

Time constant, $\tau = RC =$

Experimentally:

From the graph: Slope, m = $-\frac{1}{\tau}$

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

Error of $\tau = \frac{\tau_{th} - \tau_{ex}}{\tau_{th}} \times 100\%$

Calculation: Discharging a capacitor

Theoretically:

Time constant, $\tau = RC =$

Experimentally:

From the graph: Slope, m = $-\frac{1}{\tau}$

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

Error of $\tau = \frac{\tau_{th} - \tau_{ex}}{\tau_{th}} \times 100\%$