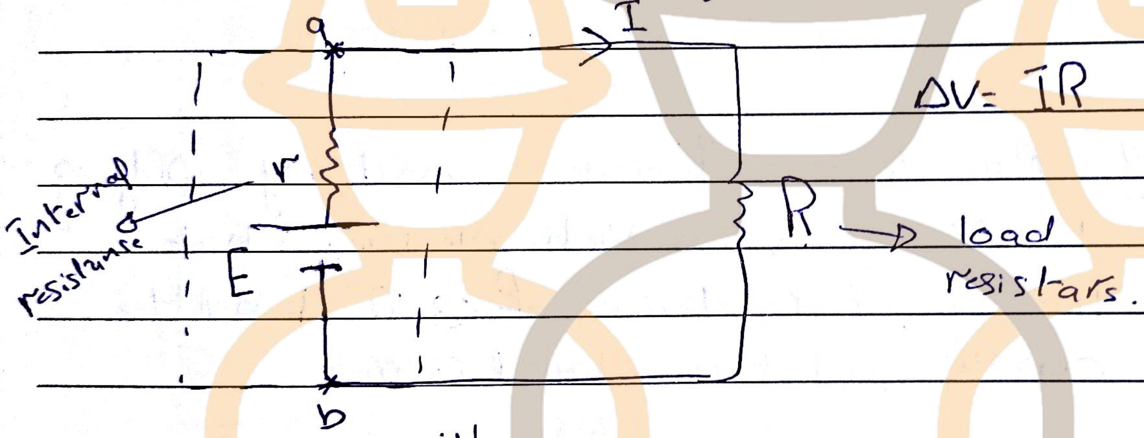
CH28 Direct current circuits (dc) تيار ثابت مقداراً واتجاهاً

I = constant

Battery is called Electromotive force ~~Emf~~ القوة الدافعة أو فرق جهد البطارية
Emf

E the maximum potential a battery can provide
(open circuit voltage)



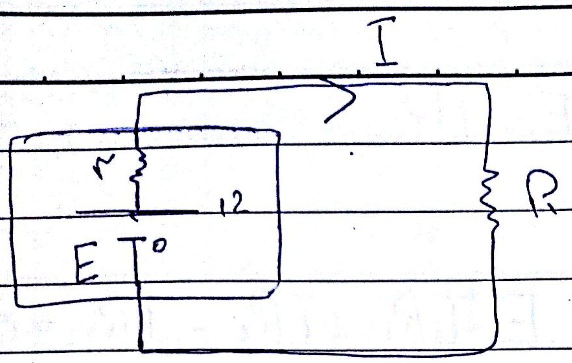
الأطراف
ΔV_{ab} = terminals voltage فرق الجهد حول أطراف البطارية

$\Delta V = E - Ir$

$\boxed{\text{Ex 28.1}}$ A battery with $E = 12V$ and internal resistance $r = 0.05\ \Omega$ is connected to $R = 3\ \Omega$. Find the current and the terminal voltage of the battery.

Subject Date No.

I



$E = IR + Ir$

$I = \dfrac{E}{r+R} = \dfrac{12}{3+0.05} = 3.93\,A$

$\Delta V = E - Ir = IR = 11.8$

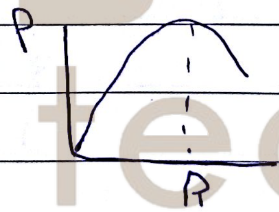
Ex 28.2 At what load resistance the delivered Power is maximum

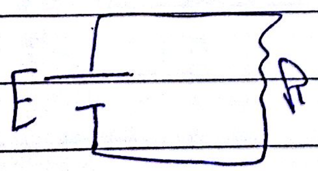
$P = I^2 R$

كل قيم عظمى
عن طريق الاشتقاق

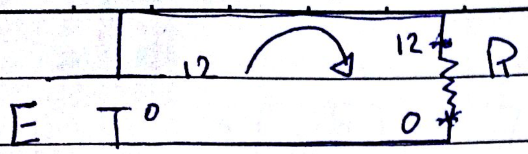
$I = \dfrac{E}{r+R} \Rightarrow P = \dfrac{E^2 R}{(r+R)^2}$

$\dfrac{dP_R}{dR} = 0$ $\boxed{r = R}$

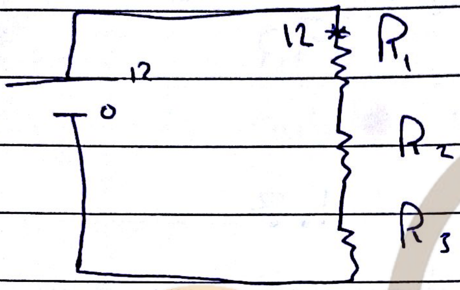




$P = \dfrac{E^2}{R}$



$E = IR$



$E - IR_1 - IR_2 - IR_3 = 0$

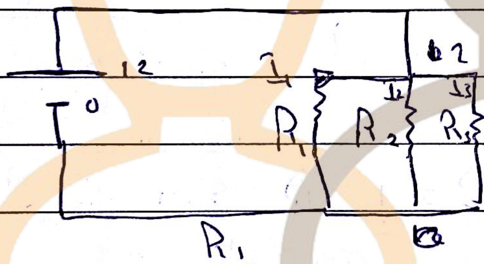
نرجع لنفس النقطة

$E = I(R_1 + R_2 + R_3)$

$E = I R_{eq}$

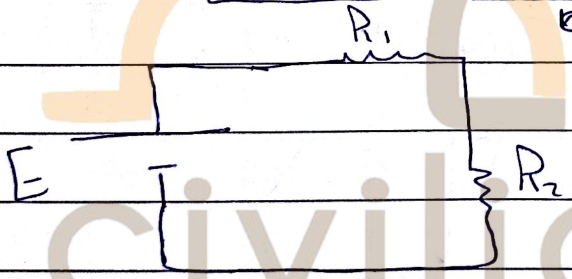
resistors connected is series (sam I)

$R = R_1 + R_2 + R_3 + \dots$

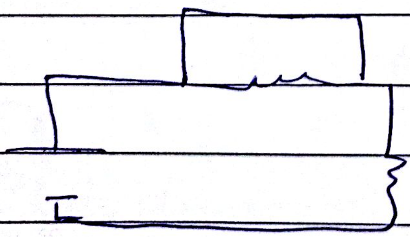


$E = \Delta V_1 = \Delta V_2 = \Delta V_3$

$I = I_1 + I_2 + I_3$



$I = \frac{E}{R_1 + R_2}$



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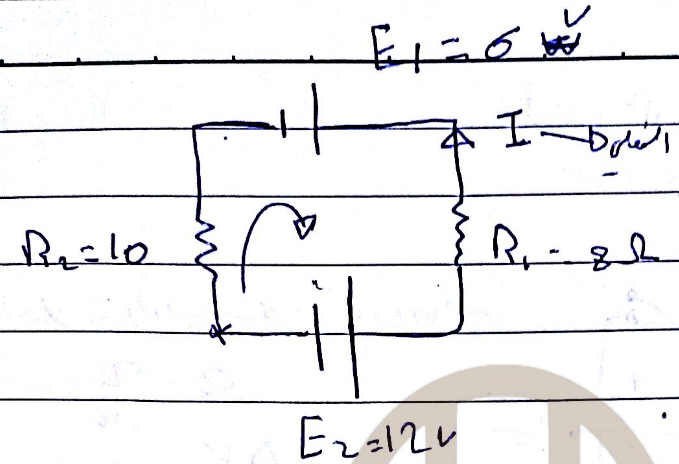
Ex



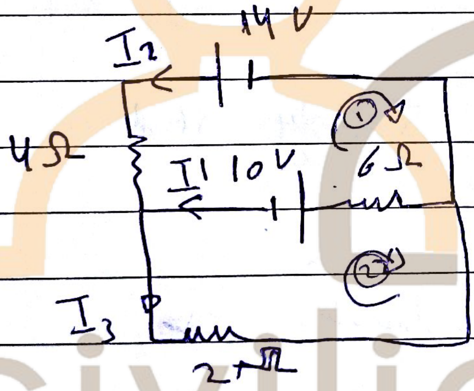
$$-IR_2 + E_1 - IR_1 - E_2 = 0$$

$$\frac{E_1 - E_2}{R_1 - R_2} = I$$

$$\frac{6 - 12}{18} = \frac{-6}{18} = \frac{-1}{3}$$

السالب يعني عكس
الي فرضناه

بالامتحان اي شي سالب نعكس اتجاهه فقط



$$\boxed{I_3 = I_1 + I_2}$$

$$-6I_1 - 10 + 4I_2 - 14 = 0$$

$$\boxed{2I_2 - 3I_1 = 12}$$

$$2I_3 + 10 + 6I_1 = 0$$

$$\boxed{I_3 + 3I_1 = -5}$$

$$\boxed{\begin{aligned} I_1 &= -2A \\ I_2 &= +3A \\ I_3 &= 1A \end{aligned}}$$

اذا طلع معنا التيار سالب ما بنعكسه الا
لبعد ما أوجد باقي التيارات.

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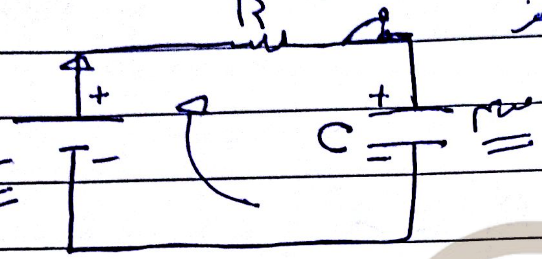
28.4 RC - circuits

charging capacitor



لحظة اغلاق الدارة شحنة C تساوي صفر

$$C = \frac{q}{\Delta V}$$

$$\Delta V = \frac{q}{C}$$

شرح الكيرشوف على الحلقة (مشتقة من قانون العام للدوائر)

$$E - RI - \frac{q}{C} = 0 \rightarrow$$ رجعت لنفس النقطة

at $t = 0$

$$\boxed{I_1 = \frac{E}{R}}$$

After long time $t \rightarrow \infty$ steady state

$I_f = 0$

$$E = \frac{q_f}{C} \qquad \boxed{q_f = EC}$$ فقط في هذه الدارة

$$\rightarrow E - \frac{dq}{dt}R - \frac{q}{C} = 0$$

$$\frac{dq}{dt} = \frac{E - \frac{q}{C}}{R} \Rightarrow \frac{dq}{dt} = \frac{E}{R} - \frac{q}{RC}$$

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$$\frac{dq}{dt} = \frac{Ec-q}{RC}$$

$$\int_0^q \frac{-dq}{Ec-q} = \int_0^t \frac{-dt}{RC}$$

$$\frac{\cancel{\ln|q|}}{\cancel{Ec}} = \frac{-t}{RC}\Big|_0^t$$

$$\ln|Ec-q|\Big|_0^q = \frac{-t}{RC}\Big|_0^t$$

$$\ln|Ec-q| - \ln Ec$$

$$\ln\frac{Ec-q}{Ec} = \frac{-t}{RC}$$

$$\frac{Ec\,q}{Ec} = e^{-t/RC}$$

$$Ec - q = Ec\,e^{-t/RC}$$

$$q(t) = Ec\left(1 - e^{-t/RC}\right)$$

$$q(t) = q_f\left(1 - e^{-t/RC}\right)$$

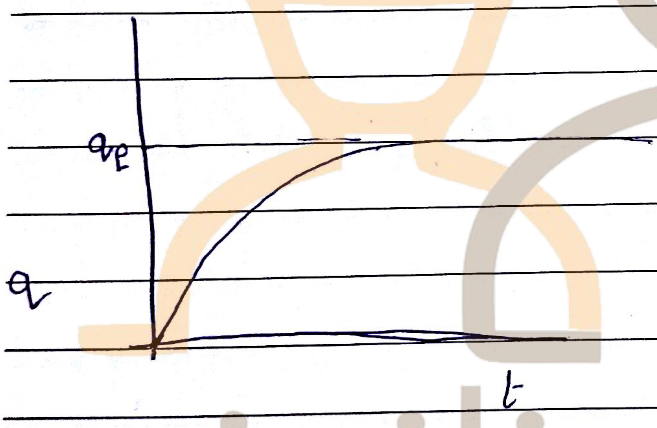
$$I(t) = \frac{q_f}{RC} e^{-t/RC} = I_i e^{-t/RC}$$

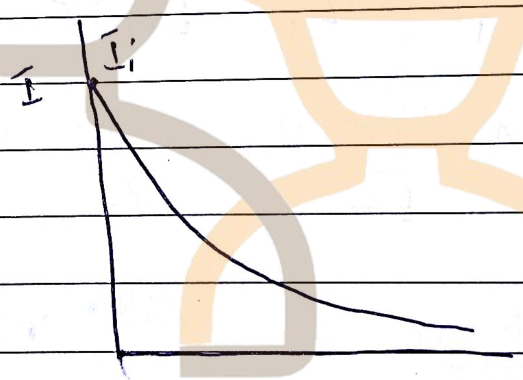
$$I(t) = I_i e^{-t/RC}$$

* $q(t) = q_f (1 - e^{-t/RC})$

$$I(t) = \frac{E}{R} e^{-t/RC}$$

$$q_f = EC$$





$\tau = RC$ time constant

find I after one time constant

$$I = I_i e^{-t/\tau}$$

$$I(t = \tau) = I_i e$$

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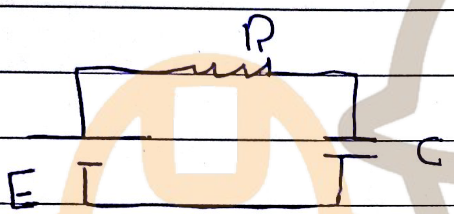
$I_i e^{-1} = \cancel{0.8}\ 0.368\ I_i$

$\tau = RC$
$= \Omega F = S$

* Energy supplied by the battery $q_f E$

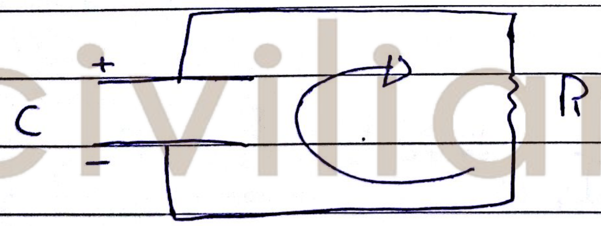


$U_c = \frac{1}{2} q_f E$

$\Delta U = q \Delta V$
$= q_f E \rightarrow$ اللي اعطتنا ياه البطارية والباقي في المقاومة

$U_R = \frac{1}{2} q_f E$

* discharging تفريغ



at $t = 0$
q_i , $\Delta V = \frac{q_i}{C} \rightarrow$ فرق الجهد حول المواسع

$\sum \Delta V = 0$

$+\frac{q}{C} - |I|R = 0$

N O T E B O O K

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

$$I = -\frac{dq}{dt}$$ لإن الشحنات تتناقص

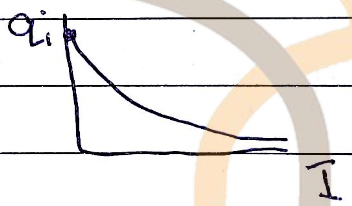
دائماً سالبة

$$\frac{q}{c} + \frac{dq}{dt} R = 0$$

$$\frac{dq}{dt} R = -\frac{q}{c}$$

$$\int_{q_i}^{q} \frac{dq}{q} = \int_{0}^{t} \frac{-1}{RC} \Rightarrow \ln \frac{q}{q_i} = -\frac{t}{RC}$$

$$q = q_i e^{-t/RC}$$



$$I = -\frac{dq}{dt}$$

من مشتقة ال q اللي فوق

$$I = \frac{q_i}{RC} e^{-t/RC} = I_i e^{-t/RC}$$

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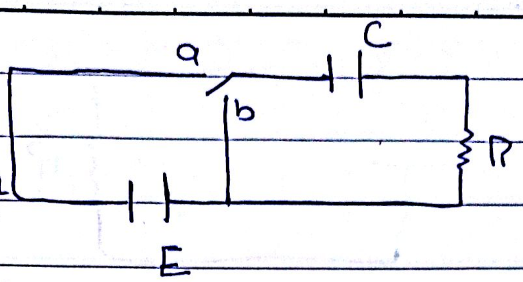
Ex 28.9



عند a شحن
عند b تفريغ

$E = 12V$ $R = 8\times10^{5}\,\Omega$

$C = 5\mu F$

uncharged capacitor, if the switch is thrown to position (a. find,

1. time constant
2. maximum charge
3. " current
4. $I(t)$
5. $q(t)$

Sol

1. $\tau = RC = 4\ s$
2. $q_f = CE = 60\ \mu C$
3. $I_i = \dfrac{E}{R} = 15\ \mu A$
4. $I = I_i e^{-t/RC} = 15\ mA\ e^{-t/4}$
5. $q(t) = q_f\left(1-e^{-t/RC}\right) = 6\ \mu C\left(1-e^{-t/4}\right).$

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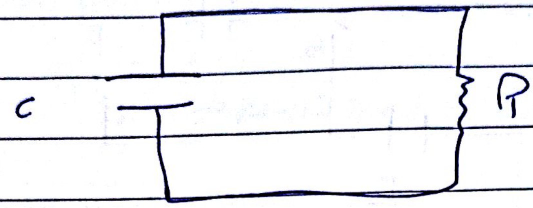
28.10

مهم



After How many time constant is the charge on the capacitor 1/4 of its initial value

$$q = q_i e^{-t/\tau}$$

$$q = \frac{1}{4} q_i$$

$$\frac{1}{4} \cancel{q_i} = \cancel{q_i} e^{-t/\tau}$$

$$-\ln 4 = \frac{-t}{\tau}$$

$$t = (\ln 4)\, \tau$$

$$t = 1.39\, \tau$$

مسألة أخرى

After How τ is the stored energy is 1/4 of ~~the~~ its initial value

$$q = q_i e^{-t/\tau}$$

$$U = \frac{q^2}{2C}$$

$$U = \frac{q_i^2 e^{-2t/\tau}}{2C}$$

at $t = 0$

$$q = q_i$$

$$U_i = \frac{q_i^2}{2C}$$

$$U = \frac{1}{4} U_i$$

$$\frac{1}{4} \cancel{U_i} = \cancel{U_i} e^{-2t/\tau}$$

$$-\ln 4 = \frac{-2t}{\tau}$$

$$t = \frac{\ln 4}{2} \tau$$

$$t = 0.69\, \tau$$

NOTEBOOK

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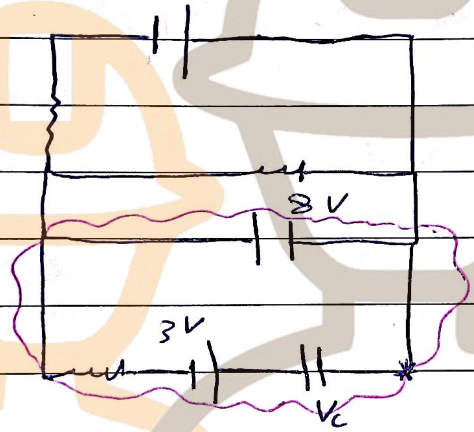
$\boxed{28.11}$ 5 MF capacitor is charged with 800 v potential then is discharged through aresistor How much energy is delivered to the resistor

$U_C = U_R = \frac{1}{2} C \Delta V^2$

$= 1.6 J$

Ex

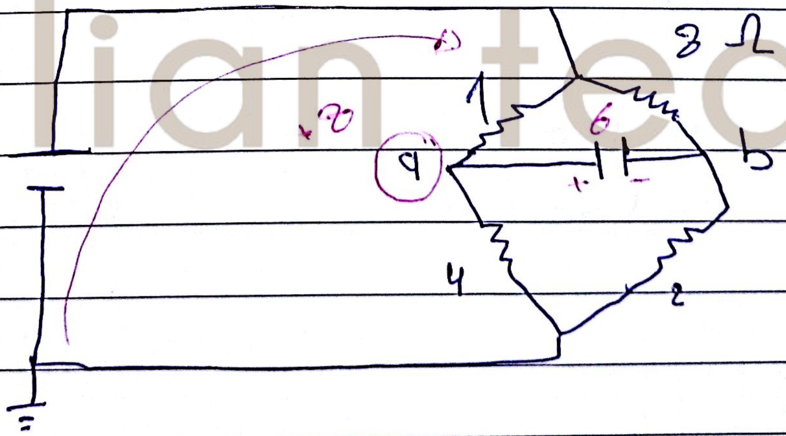


After long time (steady state) find ΔV_c

$V_c - 3 - 8 = 0$

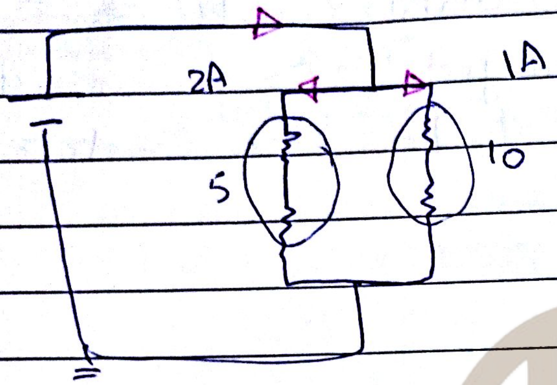
$V_c = 11$

P.37

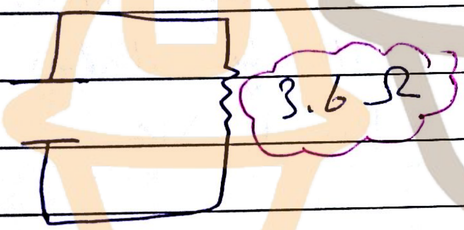


After long time V_c

After long time



اذا شلنا البطارية (remove the battery).



المقاومة الكلية

$I < 5\ mA$

$I > 10\ mA$

$I \sim 100\ mA$

$I \sim 1A$

R_{skin} 100kΩ

$R_{wet} \sim 1000\ \Omega$