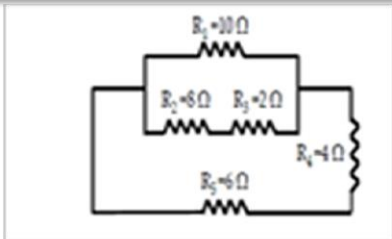
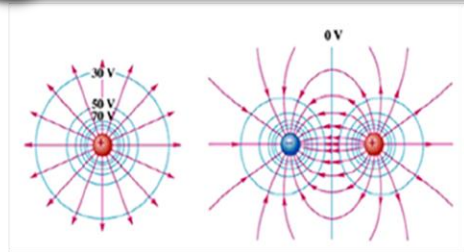
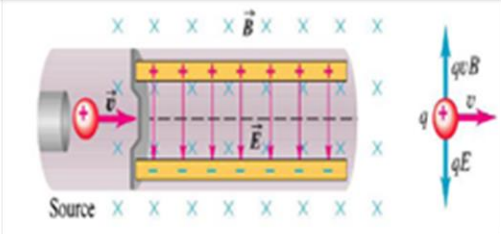
Physics-2







Ch-7

Resistors Connection

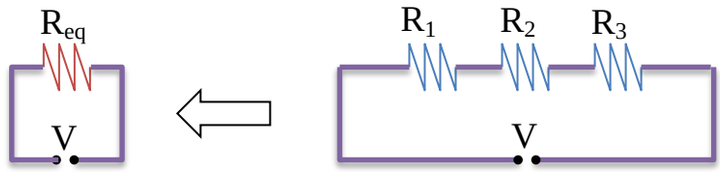
یوسف زویل

Best wishes and good Luck

00966502047005

Resistors Connection
توصيل المقاومـــات

Series Connection التوصيل على التوالي



$R_{eq} = R_1 + R_2 + R_3$

$I_1 = I_2 = I_3 = \frac{V}{R_{eq}}$ التيار ثابت على التوالي

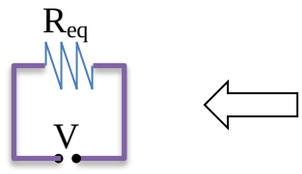
$V_1 = I_1R_1 \quad V_2 = I_2R_2 \quad V_3 = I_3R_3 \ , \ V = V_1 + V_2 + V_3$

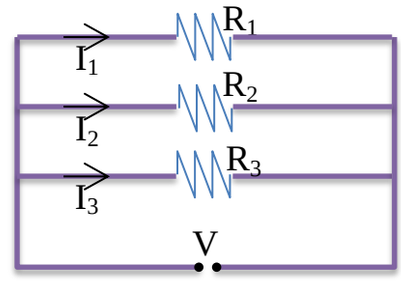
ملاحظة: في حالة توصيل عدد n من المقاومات المتساوية كل منها R على التوالي $R_{eq} = nR$

****

Parallel Connection التوصيل على التوازي

$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$





$R_{eq} = \frac{R_1 R_2}{R_1 + R_2}$ في حالة مقاومتي R_1 , R_2

$V_1 = V_2 = V_3 = V$ الجهد ثابت على التوازي

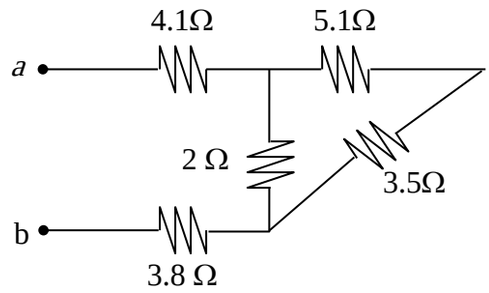
$I_1 = \frac{V_1}{R_1}$ $I_2 = \frac{V_2}{R_2}$ $I_3 = \frac{V_3}{R_3}$

ملاحظة: في حالة توصيل عدد n من المقاومات المتساوية كل منها R على التوازي فإن: $R_{eq} = \frac{R}{n}$

Ex1: The equivalent resistance between the point a and b in the figure is:

(a) 19.04 Ω (b) 9.52 Ω

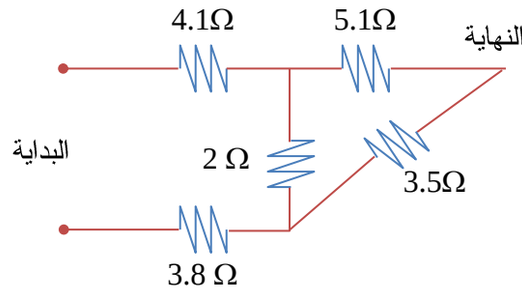
(c) 9.76 Ω (d) 1.12 Ω



Solution

نبدأ دائماً من نهاية الدائرة

$5.1\ \Omega, 3.5\ \Omega \xrightarrow{\text{series}} 8.6\ \Omega$

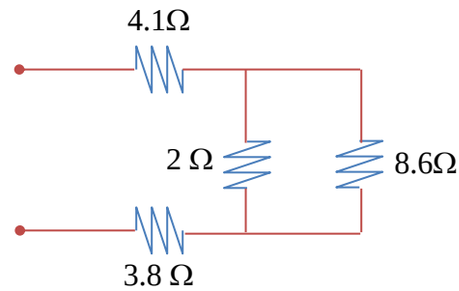


$8.6\ \Omega\ //\ 2\ \Omega \Rightarrow$

$$\frac{1}{8.6} + \frac{1}{2} = 0.616$$

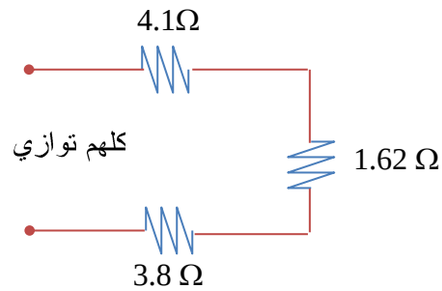
نقلب

$1.62\ \Omega$



$R_{eq} = 4.1 + 1.62 + 3.8$

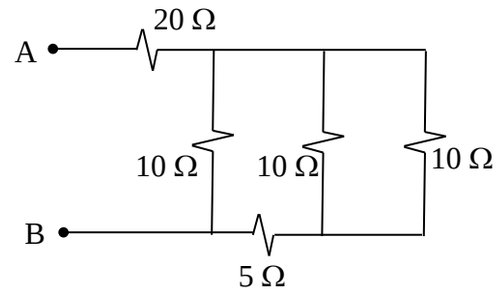
$= 9.52\ \Omega$



Ex2: Find the equivalent resistance between points A and B

(a) 55 Ω (b) 15 Ω

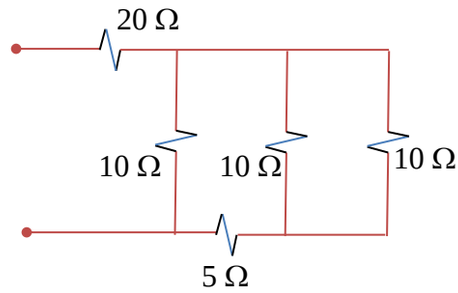
(c) 25 Ω (d) 10 Ω



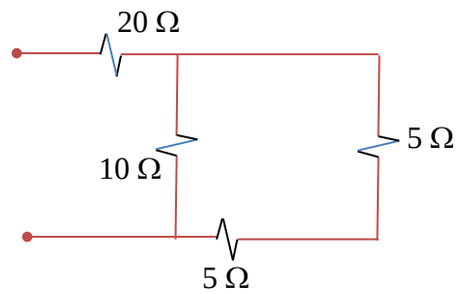
Solution

$10\ \Omega\ //\ 10\ \Omega \Rightarrow$

$= \frac{1}{10} + \frac{1}{10} = \frac{1}{5} \Rightarrow 5\ \Omega$

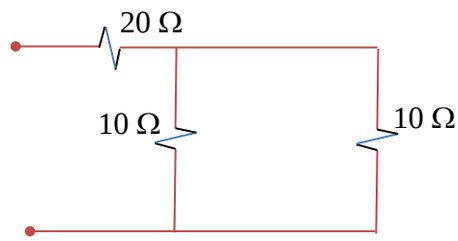


$5\ \Omega\ ,\ 5\ \Omega \xrightarrow{\text{series}} 10\ \Omega$

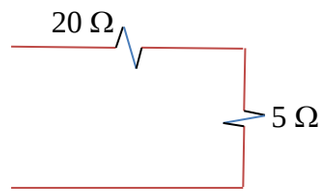


$10\ \Omega\ //\ 10\ \Omega \Rightarrow$

$= \frac{1}{10} + \frac{1}{10} = \frac{1}{5} \Rightarrow 5\ \Omega$



$R_{eq} = 20 + 5 = 25\ \Omega$



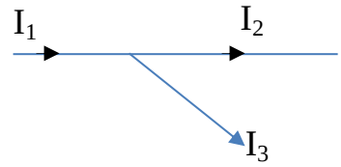
Kirchhoff's lows

(1) Kirchhoff Current Low (KCL)

عند أي عقدة (node) يكون:

مجموع التيارات الداخلة = مجموع التيارات الخارجة

العقدة تلاقي 3 أفرع على الأقل

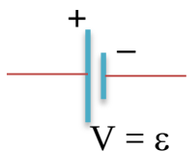


$$I_1 = I_2 + I_3$$

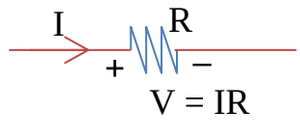
(2) Kirchhoff Voltage Low (KVL)

في أي مسار مغلق يكون

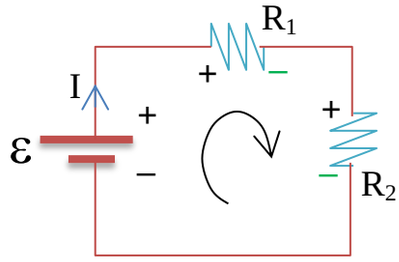
$$\Sigma V = 0$$



نضع الإشارة التي يخرج منها التيار

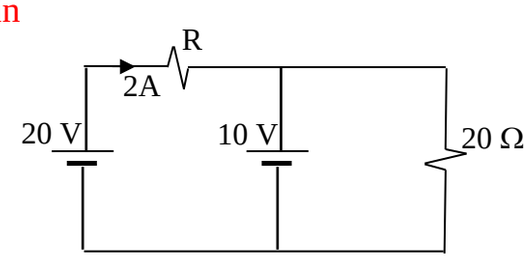


التيار يدخل من (+) ويخرج من (-)



$$\varepsilon - I R_1 - I R_2 = 0$$

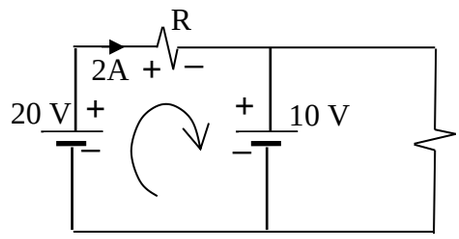
Ex3: Find the value of R in the circuit shown in the figure:



(a) 1 Ω (b) 5 Ω

(c) 2 Ω (d) 7 Ω

Solution



R = ??

Apply KVL

$20 - 2R - 10 = 0$

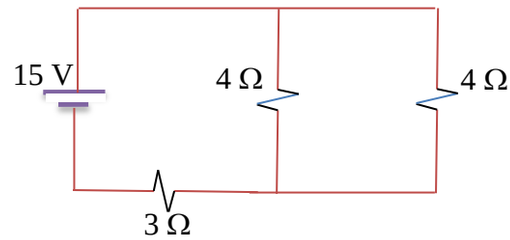
$10 = 2R$

$\therefore \quad R = 5\ \Omega$

Ex4: What is the power dissipated المستهلكة in the 3 Ω resistor shown in the figure:

(a) 72 W (b) 27 W

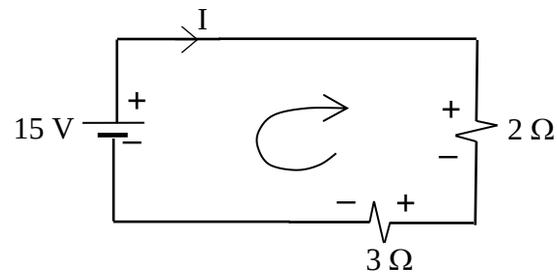
(c) 22 W (d) 36 W



Solution

$4\,\Omega \;//\; 4\,\Omega \Rightarrow$

$\frac{1}{R} = \frac{1}{4} + \frac{1}{4} = \frac{1}{2} \Rightarrow$ نقلب $R = 2\,\Omega$



نفرض التيار يخرج من القطب الموجب

Apply KVL

$15 - 2I - 3I = 0$

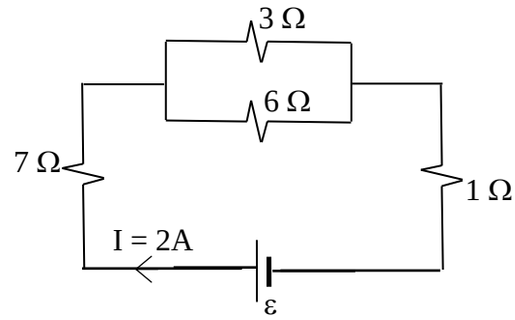
$15 = 5I \qquad I = 3\,A$

$P_{3\,\Omega} = I^2 R = (3)^2\,(3) = 27\ W$

Ex5: Calculate the voltage ε of the battery shown in the figure:

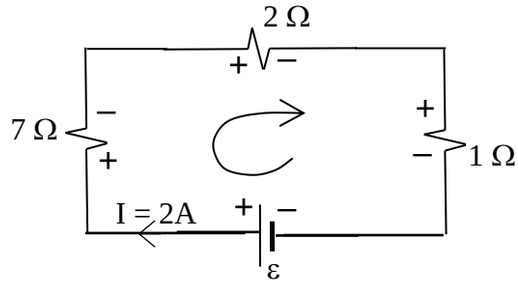
(a) 30 V (b) 40 V

(c) 10 V (d) 20 V



Solution

$3\,\Omega \;//\; 6\,\Omega \Rightarrow \frac{1}{3} + \frac{1}{6} = \frac{1}{2}$ نقلب $\Rightarrow 2\,\Omega$



Apply KVL

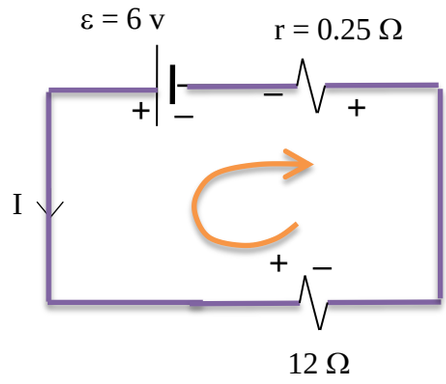
$$\varepsilon - 7\,(2) - 2\,(2) - 1\,(2) = 0$$

$$\varepsilon = 20\ \text{V}$$

Ex6: A 12 Ω resistance is connected across a battery of emf 6 V and internal resistance 0.25 Ω. What potential difference will be measured across the 12 Ω resistor?

(a) 5.88 V (b) 6 V (c) 1.8 V (d) 1 V

Solution



Apply KVL

$$-6 + 0.25\,I + 12\,I = 0$$

$$12.25\,I = 6$$

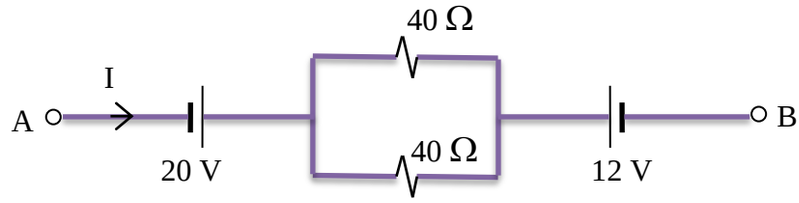
$$I = \frac{6}{12.25} = 0.49\ A$$

$$V = I\,R = 0.49 \times 12 = 5.88\ V$$

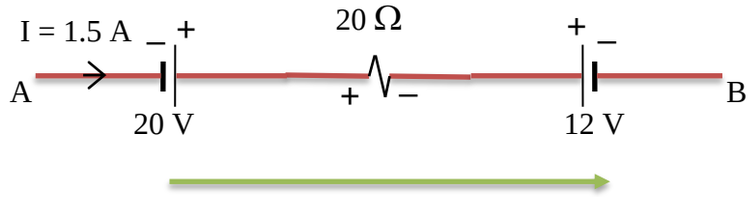
Ex7: If I = 1.5 in the circuit shown. Find the potential difference VB – VA

(a) -34 V (b) -40 V

(c) -10 V (d) -18 V



Solution



$$40\ \Omega\ //\ 40\ \Omega$$

$$\Rightarrow \frac{1}{40} + \frac{1}{40} = \frac{1}{20}$$

$$R_{eq} \Rightarrow\ 20\ \Omega$$

$V_B - V_A$

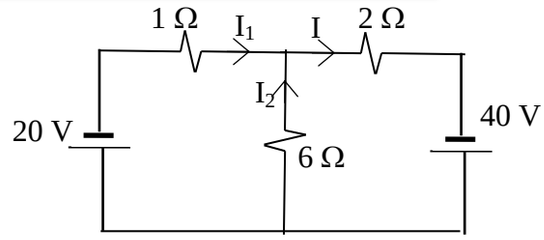
النهاية البداية

$$V_B - V_A = 20 - 20\,I - 12$$

$$= 20 - 20\,(1.5) - 12$$

$$= -22\ V$$

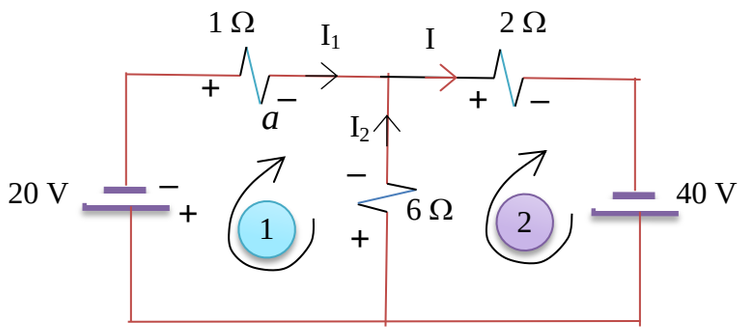
Ex8: Find the current I



(a) 8 A (b) 5 A

(c) 2 A (d) 3 A

Solution



Apply KCL at node *a*

$I_1 + I_2 = I$

$I_1 + I_2 - I = 0$ (1)

Apply KVL for loop (1)

$-20 - (1) I_1 + 6 I_2 = 0$

$-I_1 + 6 I_2 + 0 = 20$ (2)

Apply KVL for loop (2)

$-6 I_2 - 2 I + 40 = 0$

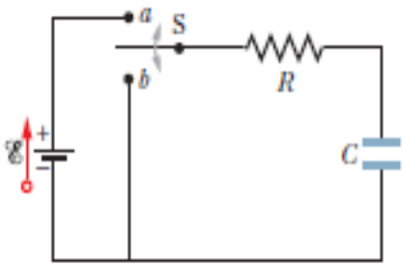
$0 - 6 I_2 - 2 I = -40$ (3)

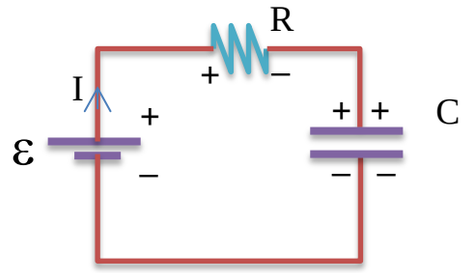
Solve (1) , (2) and (3)

$I_1 = 4$ A $I_2 = 4$ A $I = 8$ A

RC-Circuits

(1) Charging الشحن



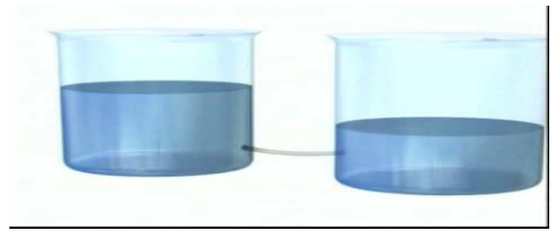


من كيرشوف الثاني يكون $\varepsilon - IR - \frac{q}{c} = 0$

$q = q_0 (1 - e^{-t/\tau})$, $V_c = \varepsilon (1 - e^{-t/\tau})$, $i = i_0 (e^{-t/\tau})$

$q_0 = C\,\varepsilon$ $\tau = CR$ $i_0 = \frac{\varepsilon}{R}$

q_0	maximum charge , final charge , equilibrium charge
i_0	Maximum current
τ	time constant
q	Charge on Capacitor after t second
V_c	potential difference on Capacitor after t second
i	current in Circuits after t second



Ex10: Capacitor in an RC circuits is charged to 49% of its maximum value in 10 sec. Find the capacitance C of the circuit if R = 5 MΩ

(a) 5 μF (b) 9 μF (c) 3 μF (d) 7 μF

Solution

$q = 0.49\, q_0$ $t = 10$ S

$0.49q_0 = q_0 (1 - e^{-t/\tau})$ $\div q_0$

$1 - e^{-t/\tau} = 0.49$

$1 - 0.49 = e^{-t/\tau}$

$0.51 = e^{-t/\tau}$

للطرفين ln

$\ln 0.51 = \ln e^{-t/\tau}$

$-0.673 = -\frac{t}{\tau}$

$\tau = \frac{-10}{-0.673} = 14.85$ S

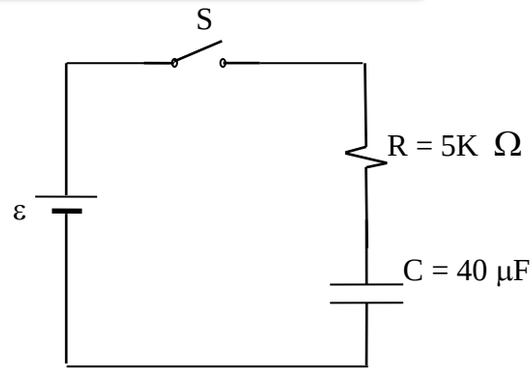
$\tau = R\,C$

$C = \frac{\tau}{R} = \frac{14.85}{5 \times 10^6}$

$= 2.97 \times 10^{-6}$

$C \cong 3\ \mu F$

Ex11: The capacitor is uncharged before the switch S is closed. the emf of the battery (ε) if the charge on the capacitor becomes 20 μC, after 80 μs of the switch is closed.



(a) *1250 V* (b) *1250 V* (c) *1250 V* (d) *1250 V*

Solution

$R = 5 \times 10^{3}\ \Omega, t = 80\ \mu s, C = 40 \times 10^{-6}\ F, q = 20 \times 10^{-6}\ C$

$\tau = R C$

$= 5\times10^{3} \times 40\times10^{-6}$

$= 0.2\ S$

$q = q_0 (1 - e^{-t/\tau})$

$20\times10^{-6} = q_0 \left(1 - e^{-\frac{80\times10^{-6}}{0.2}}\right)$

$20 \times 10^{-6} = 3.999\times10^{-4}\ q_0$

$q_0 = \frac{20 \times 10^{-6}}{3.999\times10^{-4}} = 0.05\ C$

$\varepsilon = \frac{q_0}{C}$

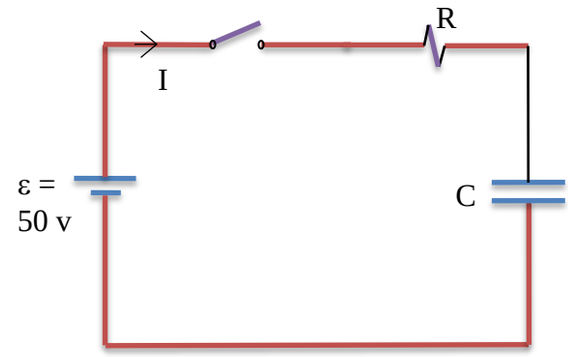
$= \frac{0.05}{40 \times 10^{-6}}$

$= 1250\ V$

Ex12: At t = 0, the switch S is closed with the capacitor uncharged. If C = 40 μF and R = 5 KΩ. How much energy is stored by the capacitor when I = 2 mA?

(a) 2.8×10-2 J (b) 3.6×10-2 J

(c) 3.2×10-2 J (d) 4×10-2 J



Solution

$C = 40 \times 10^{-6}$ F, $\varepsilon = 50$ v, $R = 5 \times 10^{3}$ Ω, $I = 2$ m A

$\tau = R\,C$

$= 5\times10^{3}\times40\times10^{-6}$

$= 0.2$ S

$I_0 = \frac{\varepsilon}{R} = \frac{50}{5\times10^{3}}$

$= 0.01$ A

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

$2 \times 10^{3} = 0.01\ e^{-t/0.2}$

$e^{-t/0.2} = 0.2$

$\ln e^{-t/0.2} = \ln 0.2$

$-\frac{t}{0.2} = -1.61$

$t = 0.322$ S

$V_C = \varepsilon\,(1 - e^{-t/\tau})$

$= 50\,(1 - e^{-\frac{0.322}{0.2}})$

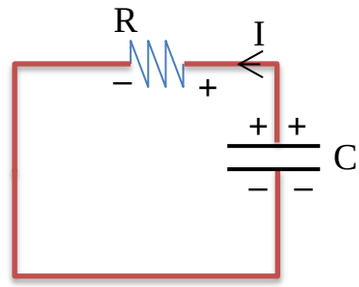
$= 40$ V

$U = \frac{1}{2} C V_c^2$

$= \frac{1}{2}\,(40 \times 10^{-6})\,(40)^2$

$= 0.032$ J $= 3.2 \times 10^{-2}$ J

(2) Discharging التفريغ



$\tau = RC$, $q = q_0\, e^{-t/\tau}$, $q_0 = C\,\varepsilon$, $V_c = \varepsilon\, e^{-t/\tau}$, $I_0 = \frac{\varepsilon}{R}$, $I = -I_0\, e^{-t/\tau}$

q_0 = initial charge q = final charge	ε = فرق الجهد بين لوحي المكثف في بداية التفريغ

Ex13: A Capacitor of capacitance 1.8 μF is discharging through a resistance R = 1.4×106 Ω. The time at which its charge would become one-half of its initial value is

(a) 0.3 s (b) 0.6 s (c) 0.8 s (d) 1.7 s

Solution

$C = 1.8 \times 10^{-6}$ F , $R = 1.4 \times 10^{6}$ Ω , $q = 0.5\, q_0$, t = ??

$\tau = R\,C$

$= 1.4\times10^{6}\times1.8\times10^{-6}$

$= 2.52$ S

$q_0\, e^{-t/\tau} = 0.5\, q_0$

ln

$\ln e^{-t/2.52} = \ln 0.5$

$\frac{-t}{2.52} = -0.693 \Rightarrow$

$t = 1.75$ S

Ex14: A 4 μF Capacitor is charged to 24 V. Find the charge on the capacitor 4 ms after it is connected across a 200 Ω resistor:

(a) 15.5 μC (b) 2.45 μC (c) 1 μC (d) 0.324 μC (e) 0.647 μC

Solution

$V_0 = \varepsilon = 24\ V\ ,\ t = 4 \times 10^{-3}\ S\ ,\ R = 200\ \Omega\ ,\ C = 4 \times 10^{-6}\ F$

$\tau = R\ C$

$= 200 \times 4 \times 10^{-6}$

$= 8 \times 10^{-4}\ S$

$q_0 = C\ \varepsilon$

$= 4 \times 10^{-6} \times 24$

$= 96 \times 10^{-6}\ C$

$q = q_0\ e^{-t/e}$

$= 96 \times 10^{-6} \times e^{-\frac{4 \times 10^{-3}}{8 \times 10^{-4}}}$

$q = 0.647 \times 10^{-6}\ C$

$= 0.647\ \mu C$