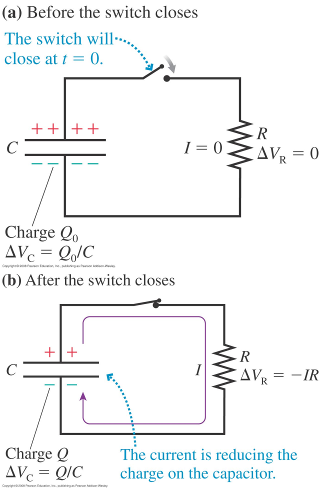
RC Circuits (32.9)



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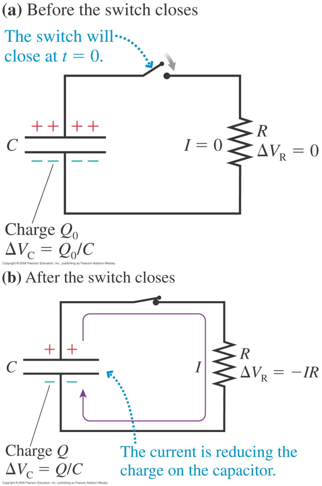

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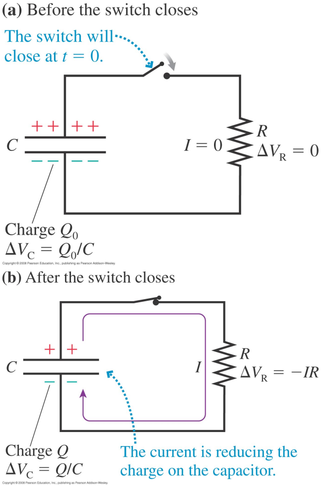

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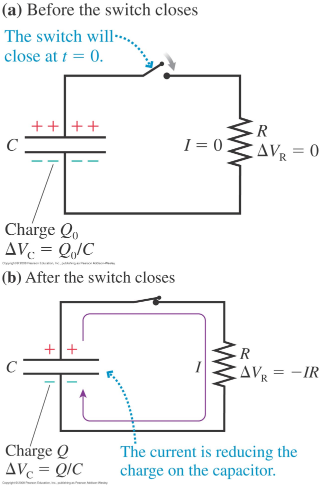

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- The voltage around the loop is

$$\Delta V_C + \Delta V_R = \frac{Q}{C} - IR = 0$$

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- The rate of charge leaving the capacitor is equal to the rate of charge passing through the circuit (the current)

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

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- We can solve this by integrating it.

RC Circuits

- The integral is

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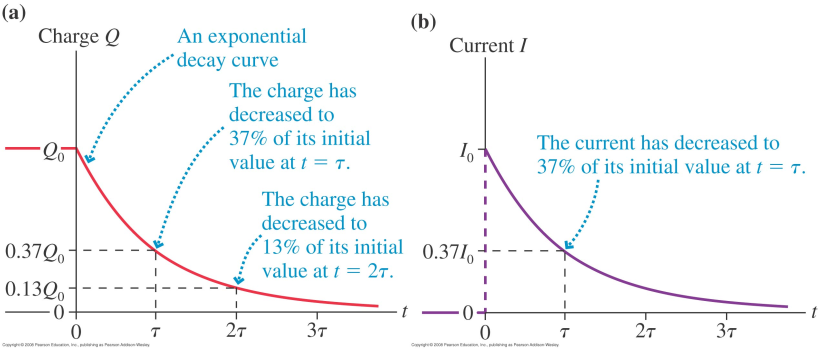
- The resistor current is then

$$I = -\frac{dQ}{dt} = \frac{Q_0}{\tau}e^{-t/\tau} = \frac{Q_0}{RC}e^{-t/\tau} = \frac{\Delta V_C}{R}e^{-t/\tau} = I_0 e^{-t/\tau}$$


(a)
Charge Q
An exponential decay curve
The charge has decreased to 37% of its initial value at $t = \tau$.
The charge has decreased to 13% of its initial value at $t = 2\tau$.
Q_0
$0.37Q_0$
$0.13Q_0$
0
t
0
τ
2τ
3τ
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(b)
Current I
I_0
The current has decreased to 37% of its initial value at $t = \tau$.
$0.37I_0$
0
t
0
τ
2τ
3τ
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Charging a Capacitor