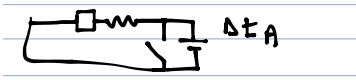
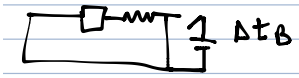
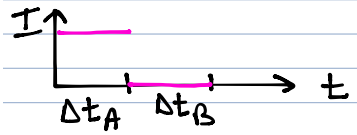
ch10 s9.html RC circuit intro

option c

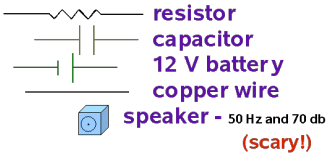




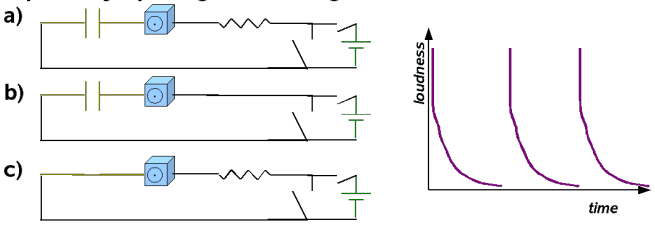


It's 4:00 pm on October 31, and you just realized that it was your job to contribute the scary sound for this year's haunted house.

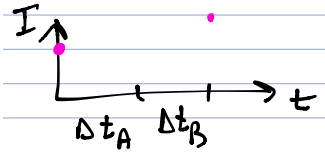
Supplies at hand:



For optimal scariness, you should modulate the sound by repeatedly opening and closing:

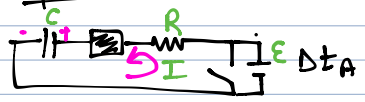


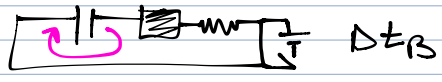
option b

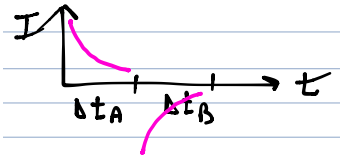


no resistance → C can charge and discharge immediately

option a







In Δt_A, charge builds up on capacitor ($I \neq 0$)

$V_c(t) = q(t)/C$ until at some much later time t_f

$V_c(t_f) \approx \frac{Q_f}{C}$ ($I = 0$)

"loop it": $\sum \Delta V = 0 = \mathcal{E} - i(t)R - \frac{q(t)}{C}$

using $i(t) = \frac{dq(t)}{dt}$: $\mathcal{E} - \frac{dq(t)}{dt}R - \frac{q(t)}{C} = 0$

$\rightarrow$ $q(t) = C\mathcal{E}(1 - e^{-t/RC})$ charging capacitor in RC circuit

does it work? $q(0) = C\mathcal{E}(1-1) = 0$ ✓

$q(t_f \rightarrow \infty) = C\mathcal{E}(1-0) = C\mathcal{E}$ ✓

what is current? $i(t) = \frac{dq}{dt} = C\mathcal{E}\left(0 + \frac{1}{RC}e^{-t/RC}\right)$

does this work? $i(0) = \frac{\mathcal{E}}{R} e^{-0} = \frac{\mathcal{E}}{R} = I_0$ ✓

$i(t_f \to \infty) = \frac{\mathcal{E}}{R} e^{-\infty} = 0$ ✓

During Δt_B

"loop it": $-iR - \frac{q}{C} = 0 \Rightarrow i(t) = -\frac{q(t)}{RC} \quad \Rightarrow \frac{dq}{dt} = -\frac{q}{RC} \Rightarrow$

$$\int_Q^q \frac{dq'}{q'} = \int_0^t -\frac{dt'}{RC} \Rightarrow \ln\frac{q}{Q} = \frac{-t}{RC} \Rightarrow q = Q e^{-t/RC}$$

$\Rightarrow i = dq/dt = -\frac{Q}{RC} e^{-t/RC}$

ch 10 s4.html C

ch 10 s6.html B

ch 10 s7.html C

Example

a)

loop it $\mathcal{E} - I_1 R_1 + \mathcal{E}_2 - I_2 R_2 = 0$

$I_1 = I_2 \Rightarrow I_1 = \frac{\mathcal{E}_1 + \mathcal{E}_2}{R_1 + R_2} = 0.229\ A$

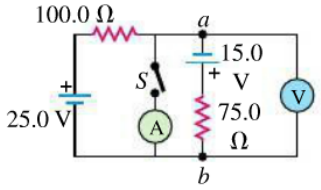
if $V_b = 0$, $V_a = 25V - 0.229A(100\Omega)$

$= 2.15V$

a is higher

26.33 • In the circuit shown in Fig. E26.33 all meters are idealized and the batteries have no appreciable internal resistance. (a) Find the reading of the voltmeter with the switch S open. Which point is at a higher potential: a or b? (b) With S closed, find the reading of the voltmeter and the ammeter. Which way (up or down) does the current flow through the switch?

Figure E26.33



b) two mini-loops

i) $\mathcal{E}_1 - I_1 R_1 = 0 \longrightarrow I_1 = \mathcal{E}_1/R_1 = 0.25\ A$

ii) $\mathcal{E}_2 - I_2 R_2 = 0 \longrightarrow I_2 = \mathcal{E}_2/R_2 = 0.20\ A$

$I_{\text{thru ammeter}} = I_2 - I_1 = 0.20 - 0.25\ A = -0.05\ A$ (flowing downward)