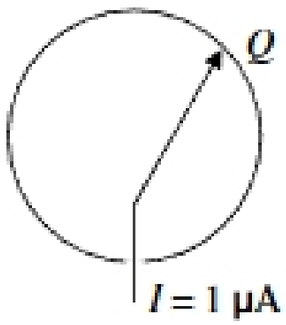
4. A high voltage generator is made of a metal sphere with a radius of 6 cm sits on an insulating post. A wire connects to the sphere's inner surface through a small hole. The wire carriers a current of 1 μ A and flows into the sphere when the switch is closed. One (1) minute after the switch is closed, what is the electric potential at the surface of the surface assuming potential far away from the sphere is zero.



$$Q = I \cdot t = 1\mu\text{A} \cdot 60\text{sec} = 60\mu\text{C}$$

$$U = k\frac{Q}{r} = 8.99\times10^{9} \cdot \frac{60\times10^{-6}}{6\times10^{-2}}(\text{V}) = 8.99\times10^{6}(\text{V})$$

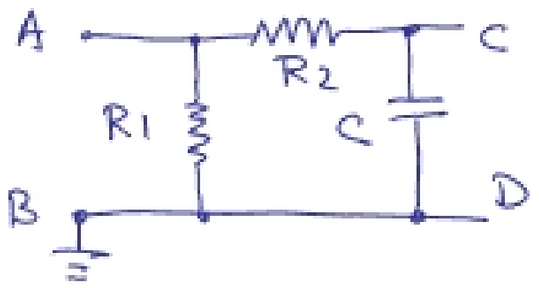
7. Twisted wire pairs are used to reduce interference generated from signal transmission. In each twisted wire pair, the current is the same in magnitude but flows the opposite direction. Use Ampere's Law to prove that the magnetic field generated by this twisted wire pair is zero.

   Constructed an arbitrary Ampere loop around the twisted wire pair.

   From Ampere's Law $\oint \vec{B} \cdot d\vec{l} = \mu_0 I = 0$ because the current sum from the two wires $I = 0$.

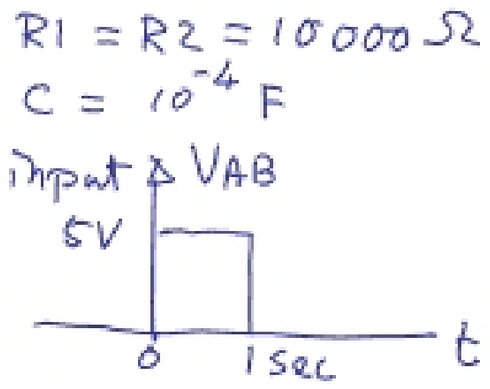
   Because the Ampere loop is arbitrary, only $\vec{B} = 0$ satisfies the condition that $\oint \vec{B} \cdot d\vec{l} = 0$

11. An electric pulse of 5V with duration of 1 second is applied at point A and B. calculate the potential difference of C and D (VCD) as a function of time.



$R1 = R2 = 10000\ \Omega$

$C = 10^{-4}\ F$



$t: 0 \to 1$ Sec. $\quad I(t) = \frac{V_{AB}}{R_2} e^{-\frac{t}{R_2 C}}$

$R_2 C = 10000 \cdot 10^{-4}\ Sec = 1\ Sec$

$= \frac{V_{AB}}{R_2} e^{-t}$

at $t = 1$ Sec, $\quad V_{CD} = V_{AB} - I(t=1) \cdot R_2$

$= 5V - 5V \cdot e^{-1}$

$= 3.16\ V$

$t: 1\ Sec \to \infty$

$$I(t) = \frac{V_{CD}}{R_1 + R_2} e^{-\frac{t-1}{(R_1+R_2)C}}$$

$V_{CD}(t) = I(t) \cdot (R_1 + R_2)$

$= V_{CD} e^{-\frac{t-1}{2}} \quad = 3.16V\, e^{-\frac{t-1}{2}}$

$(R_1 + R_2) C = 2 R_2 C = 2\ Sec$