Mar 2

Office hours cut short this week: Wed from 10:00-10:30. If you need to see me, we can set up an appointment for another time.

Get Clickers

QUIZ

5. (20 pts) A hydrogen chloride (HCl) molecule consists of a positive ion with charge $+e$ and a negative ion with charge -e, separated by a distance of 2×10^{-11} m, as shown in the diagram. Locations 1, 2, 3, and 4 are shown in the diagram. **Note that the diagram is not to scale.**

   (a) (12 pts) Location 1 is 2×10^{-8} m from the center of the molecule, and location 2 is 3×10^{-8} m from the center of the molecule. Calculate the potential difference $V_2 - V_1$, both magnitude and sign. *Show all steps in your work.*

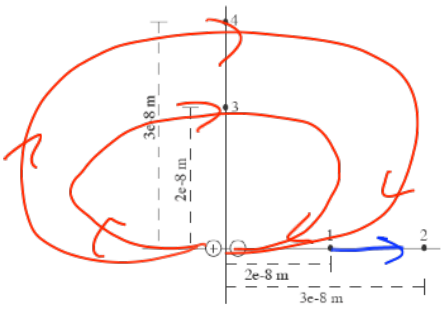
$$V_2 - V_1 = -\int_1^2 \vec{E} \cdot d\vec{l}$$

$$= -\int_1^2 (-E_x)\, dx$$

$$= \frac{1}{4\pi\epsilon_0} 2qs \int_1^2 \frac{dx}{x^3}$$

$$= \frac{1}{4\pi\epsilon_0} 2qs \left(\frac{-1}{2x^2}\right)_1^2$$

$$= 9\times10^9 \times 1.6\times10^{-19} \times 2\times10^{-11} \left[-\frac{1}{(3\times10^{-8})^2} + \frac{1}{(2\times10^{-8})^2} \right] = 4.0\times10^{-1}\ \text{V}$$

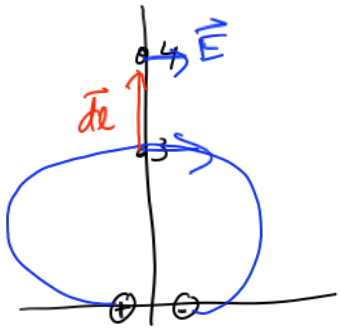


(b) (8 pts) Location 3 is 2×10^{-8} m from the center of the molecule, and location 4 is 3×10^{-8} m from the center of the molecule. Calculate the potential difference $V_4 - V_3$, both magnitude and sign. *Show all steps in your work.*

$\vec{E} \cdot d\vec{l} = 0$

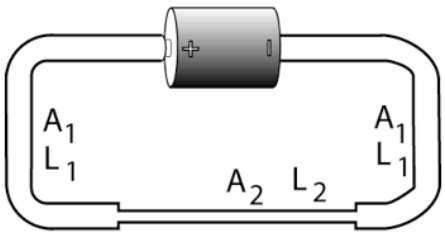
$\int \vec{E} \cdot d\vec{l} = 0$

$V_4 - V_3 = 0$



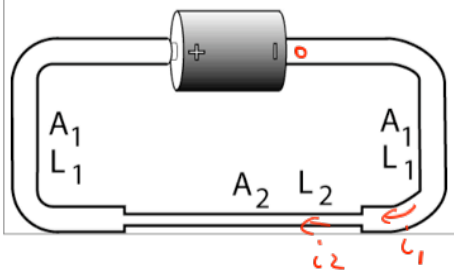
Q18.10b Battery emf = 1.5 V

$n = 9e28$ electrons/m^3	$u = 7e\text{-}5$ (m/s)/(V/m)	What must we do to find the current?
$L_1 = 0.2$ m	$L_2 = 0.05$ m	
$A_1 = 9e\text{-}8$ m^2	$A_2 = 1.5e\text{-}8$ m^2	A) Solve for E_1 B) Solve for E_2 C) Solve for E_1 and E_2 D) Not enough information



Q18.10b Battery emf = 1.5 V

$n = 9e28$ electrons/m^3	$u = 7e\text{-}5$ (m/s)/(V/m)	What is E_2? A) 50.4 V/m B) 12.9 V/m C) 3.15 V/m D) 0.788 V/m E) Not enough information
$L_1 = 0.2$ m	$L_2 = 0.05$ m	
$A_1 = 9e\text{-}8$ m^2	$A_2 = 1.5e\text{-}8$ m^2	



$i_1 = i_2$

$n A_1 u E_1 = n A_2 u E_2$

$E_1 = \frac{A_2}{A_1} E_2$

$\Delta V = 0 = +\mathcal{E}mf - E_1 L_1 - E_2 L_2 - E_1 L_1 = +\mathcal{E}mf - 2E_1 L_1 - E_2 L_2 = 0$

$\left(2\frac{A_2}{A_1} E_2 L_1 + E_2 L_2\right) = \mathcal{E}mf$

$E_2 = \frac{\mathcal{E}mf}{2\frac{A_2}{A_1} L_1 + L_2} = 12.9\ V/m$

Discussion: Summary

for steady state

$\vec{E}$ is parallel to wire

$\vec{E}$ is constant along wire (for same geometry & material)

$\vec{E}$ is const across wire's diameter

Tangible: Do charges from the battery drive *i*?

Charges on surface of wire + battery

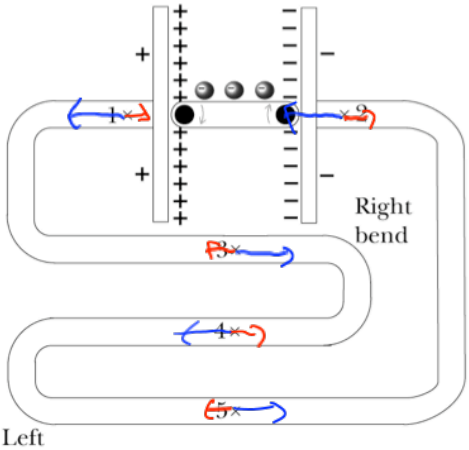
Q2: What makes current flow in a circuit?

A) Electrons push each other through the wire

B) Since there is no friction, no force is needed to keep electrons moving

C) A nonzero electric field inside the wire keeps the electrons moving

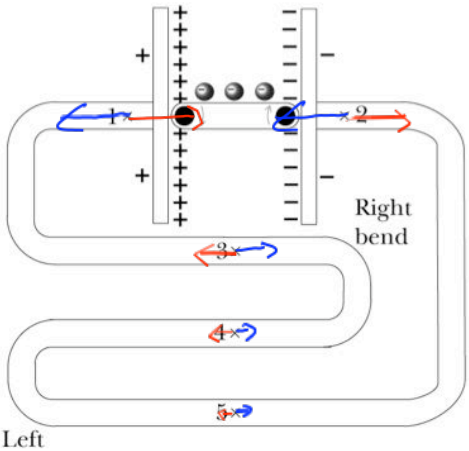
Ponderable: Squiggly Circuit



$\vec{V}$ = drift velocity

$\vec{E}$

Ponderable: Squiggly Circuit



$\vec{E}$

$\vec{V} = uE$

Wiggly