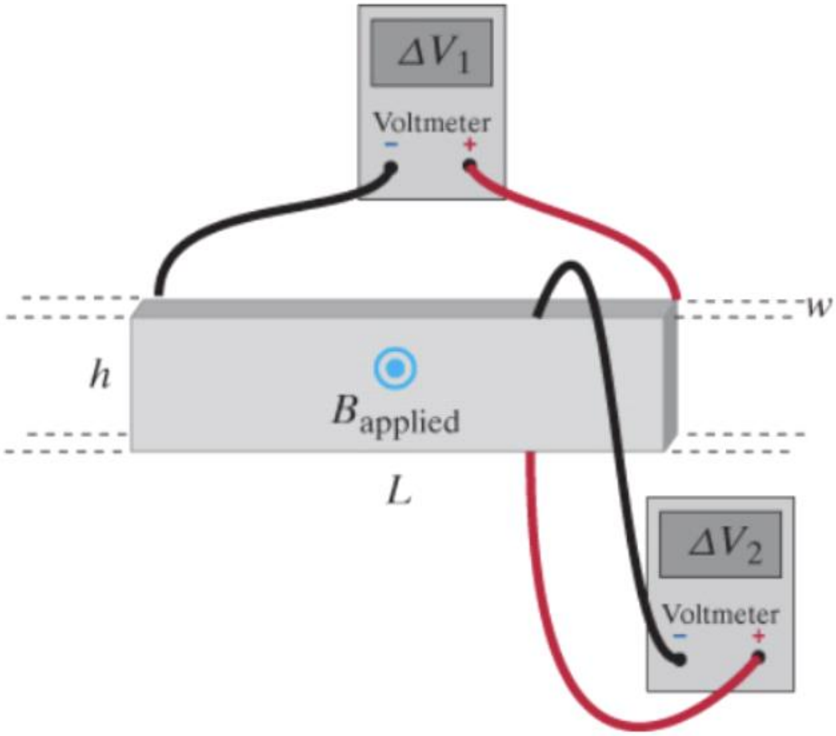
Class Prep Week 2

Monday, January 22, 2024   11:20 PM

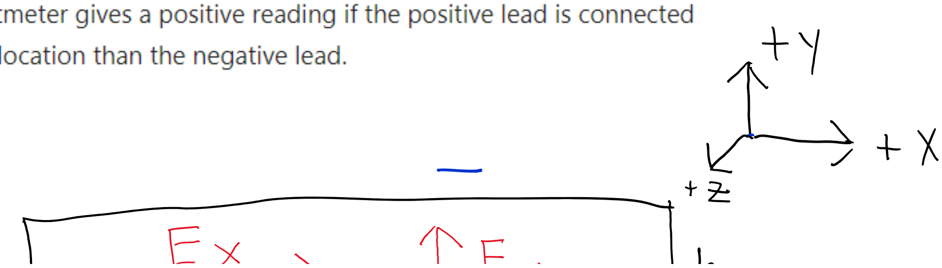


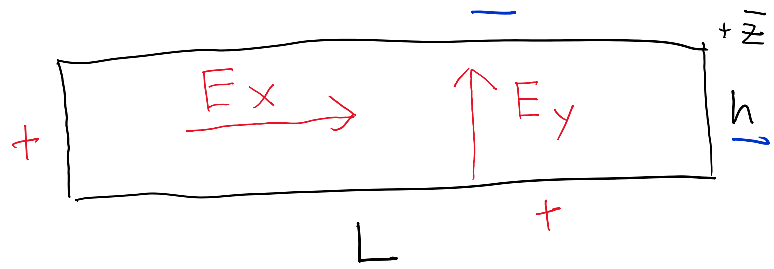
An experiment was carried out to determine the electrical properties of a new conducting material. A bar was made out of the material, L= 18 cm long with a rectangular cross section h= 5 cm high and w= 0.8 cm deep. The bar was part of a circuit and carried a steady current (the diagram shows only part of the circuit). A uniform magnetic field of 1.8 tesla was applied perpendicular to the bar, coming out of the page (using some coils that are not shown). Two voltmeters were connected along and across the bar as shown. The reading on Voltmeter 1 is $\Delta V1 = -0.45$ volt. The reading on Voltmeter 2 is $\Delta V2 = +0.00028$ volt. The connections across the bar for Voltmeter 2 were carefully placed directly across from each other to eliminate false readings corresponding to the much larger voltage along the bar. There is only one kind of mobile charge in this material.

Part 1

What is the sign of the mobile charges, and which way do they move?

Remember that a voltmeter gives a positive reading if the positive lead is connected to a higher potential location than the negative lead.

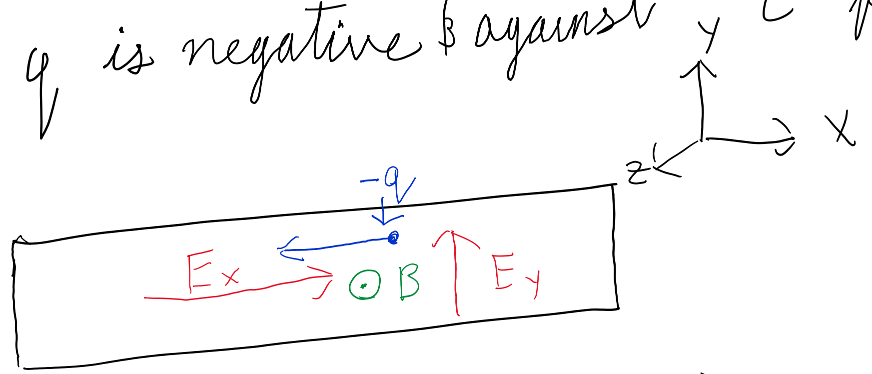




Voltage is positive if voltmeter's positive lead is connected to a higher potential.

A positive voltage goes with the E-field and a negative voltage goes with the E-field.

If q is negative & against E-field



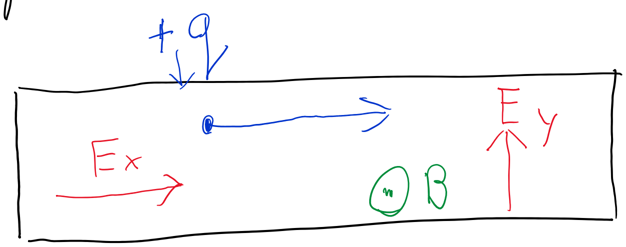
$$\vec{F}_B = -q\vec{v}\times\vec{B} = q(\vec{B}\times\vec{v})$$

$$q(B\hat{k}\times -v\hat{\imath}) = -F_B\hat{\jmath} = -qBv\hat{\jmath}$$

charge would be

A negative charge would be pushed down. However, the bottom of the conductor is positive.

If q is positive & with E-field



$$\vec{F}_B = q\vec{v}\hat{i} \times B\hat{k} = -qvB\hat{j}$$

A positive charge will also be pushed down, which matches our observations.

So the mobile charges must have a positive sign and move with the E-field (to the right).