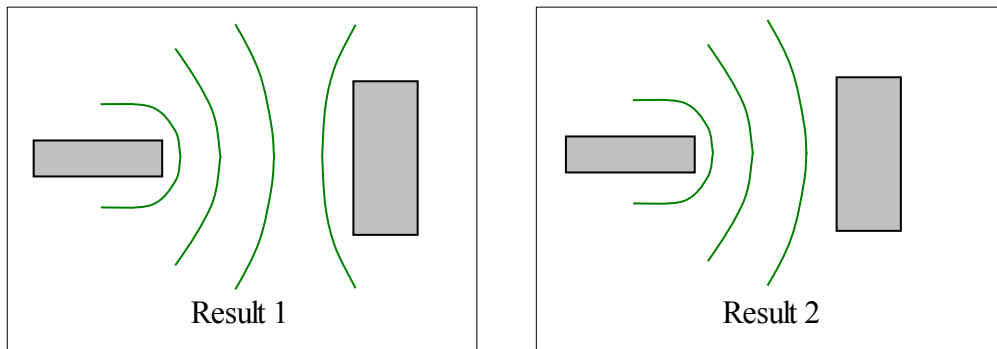


Quiz # 1
Physics 222, Section 009
Jan. 25, 2007

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1. You are given a circuit with several (resistive) elements in it, and a VOM. The circuit is connected to a power supply. To measure the resistance of an element, you need to apply Ohm's law by measuring the voltage ΔV difference across that element, and the current I passing through it, then find the resistance as the ratio $R = \Delta V/I$. In practically doing so, indicate how you are supposed to connect the VOM in order to get ΔV and I (*in each pair, take the first choice to be that for the voltage measurement, and the second to belong to current*):
- (a) In series with the element, in parallel with it.
 - (b) In parallel with the element, in series with it.
 - (c) In series with the element, also in series with it.
 - ✓(d) In parallel with the element, also in parallel with it.
 - (e) Doesn't matter if you connect in series or parallel, since the VOM is a meter an not an actual part of the circuit.
2. In two separate runs of the *Electric Field Lines* experiment, the following two results are obtained. Explain the difference between the two briefly.



Solution

1. **(5 points)** The main point in connecting the VOM as voltmeter or ammeter has to do with the idea that as a measuring device, it should modify the quantity being measured as little as possible, so:
 - (a) When used to measure **voltage**, this is achieved by connecting it in **parallel** to the element whose voltage is being measured, and the reason for that is that in the parallel configuration, it draws very little current if it's internal resistance is very high, and therefore does not affect the current moving into the element itself, and by Ohm's law it will measure a voltage drop very close to what it really is in the absence of the VOM.
 - (b) In the case of **current** measurement, we should connect the VOM (whose internal resistance is now very low) in **series** with the element, so that the voltage drop across the VOM's resistance is negligible, and all the voltage is still on the element, and so again, by Ohm's law, the current through the element measured by the VOM is very nearly what it really is in the absence of the VOM.
2. **(5 points)** In the experiment, one electrode is connected to the positive terminal of the battery, and the second to the (earthed) negative. This means that under ideal conditions we should get a closed circuit whereby the current passes through the water in between. When this happens electric field lines (and subsequently equipotentials) will follow the expected patterns when the electrodes are conductors. In Result 1, the equipotentials curve in the expected manner, and there's nothing to explain about it. In Result 2, however, the pattern appears as though the electrode on the right is not there. To explain this result we need to look at our assumptions about the situation. One way this situation can happen is when the electrode on the right is not connected to the circuit at all, or when the wires used to connected are bad. Another reason would have to do with our assumption that it is a conductor. We know it is metallic, but is it a good conductor? The answer is ideally yes, but we should recall that conduction is taking place in an tap water which has more than just H₂O, and this other stuff is what's actually carrying the current between the two conductors. These charge carriers can affect the way the equipotentials form in two (related) ways:
 - (a) **Shielding**: where ions of a given charge are attracted to the electrode with opposite polarity, thereby lowering in effect the potential of that electrode.
 - (b) **Oxidation layers**: which can form as a result of chemical reactions between the electrode and water, and (to a lesser extent) air. Such layers can reduce conduction and should be removed with sandpaper before the circuit is wired.

So, there are actually enough lines to create the expected pattern, but not detectably.