

Ph.D. Quals Question

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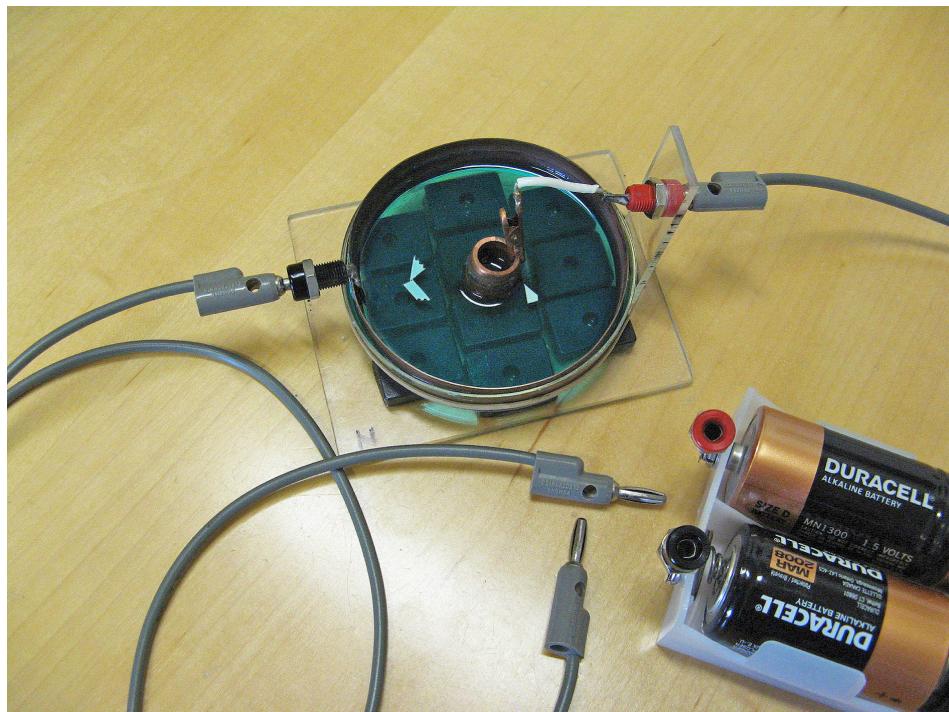
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Liquid Cyclotron

The figure below shows the liquid cyclotron that was shown to each student. It consisted of a little plastic dish (actually a petri dish) containing distilled water, “laced” with some copper sulphate to make it electrically conducting, and with a copper ring inside its outer circumference and a much smaller copper ring at its center. Both of these copper rings are immersed the copper sulphate solution and both can be separately connected to a battery pack (4 D-cell batteries, giving 6 V), part of which can be seen at the bottom right (the connections to the inner and outer copper rings can also be seen). The little dish sits on top of a number of black rectangular items with holes in their centers that are glued to an underlying piece of flat plastic sheet. The examiner assembled this demonstration equipment and, originally for his own information, marked the enigmatic “N” on the plastic sheet, which can be seen in the photo.

For the next step in the exam process the examiner connected the wires to the battery pack, thus driving a current between the copper rings, which we might now refer to as electrodes. Lo and behold, the copper sulphate solution begins to rotate. This rotation is made more obvious by some small pieces of white plastic floating on top of the solution, which can be seen in the photo and which rotate along with the fluid. It appears that the fluid rotates more quickly near the central electrode. Next, the examiner swaps the wires to the battery pack. The rotating solution slows down, stops, and reverses its direction of rotation. At this stage the examiner asks the students what is going on and states that he is prepared to answer any questions about the equipment.



Liquid cyclotron demonstration

One key question that the examiner was looking for was “what are the black rectangular items?” This generally indicated that the student was already on the right track. The answer