Ph.D. Quals Question
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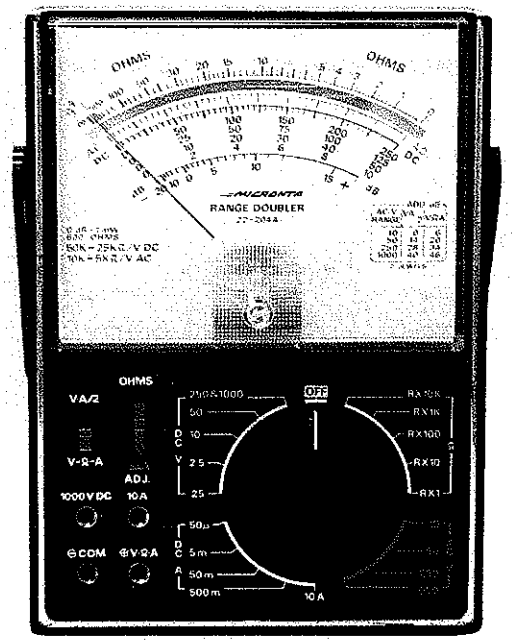
Multimeter

The figure below shows the analog multimeter that was shown to each student. Two leads were also on hand – sometimes inserted in the two sockets on the bottom left (in picture) – sometimes not, but terminating in two pointed probes. The multimeter was not plugged in to a power socket (it was quite clearly not intended to be plugged in) and it had no obvious power source. There was no easily removable panel on the back for a battery; in fact, the back was attached by two not very obvious screws. The students were told that the multimeter was about 40 years old and still worked perfectly, enabling its user to measure DC current, DC voltage and resistance. There were also a few switch settings for measuring AC voltage, but the student was told not to bother about AC. **First question**: Look inside the multimeter in the region where the pointer pivots and explain what electromagnetic principles and mechanical tricks are involved in making it work. One hint was given: Start with its measurement of current.



Simple analog multimeter

The answer to this question usually involved two steps: (i) identification of the key components of the device, and then, closely related to this first step, (ii) an explanation for how these components worked to give a measurement.

A number of students immediately recognized that they were dealing with a galvanometer; some even mentioned a D'Arsonval galvanometer, which was encouraging, but which did not necessarily lead to a correct explanation for how it worked! Although the complete mechanism surrounding the pivot of the pointer was not particularly easy to see, all its important features could be seen. With a little prodding from the examiner, if necessary, the student usually – but not always – ended up sketching out something approximating the mechanism shown below: