REPURPOSING OF A CATHODE RAY TUBE TO DEMONSTRATE THE PHOTOELECTRIC EFFECT

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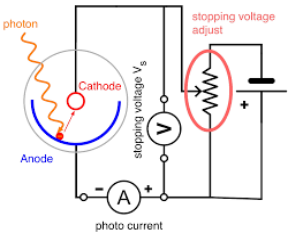
PROBLEM:

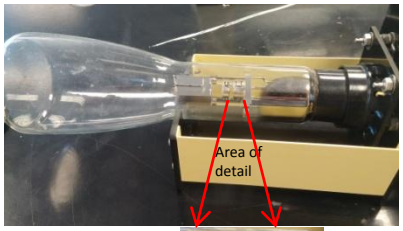
The photoelectric effect , in many levels of high school physics instruction is held out as demonstration of quantized energy, a way of looking into the model of the atom and as yet another example of the Law of Conservation of Energy, but…….

It can come across as a difficult abstraction to envision.



Computer simulations and the like can be engaging ways to explore the idea, but there is nothing like seeing it happen in front of your eyes …. But when you consider how big a part of the curriculum the photoelectic effect often is (i.e. "not very") and how large a typical high school's budget for such limited-use demo equipment (i.e "quite small"), a repurposed device could be a perfect solution.

When looking for such a device, I came across this solution….. a cathode ray tube has near vacuum and parallel plates…. So I thought….. "maybe"?

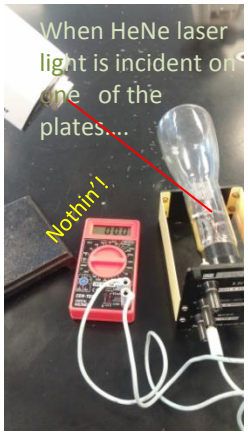


Parallel Plates

Leads to the parallel plates

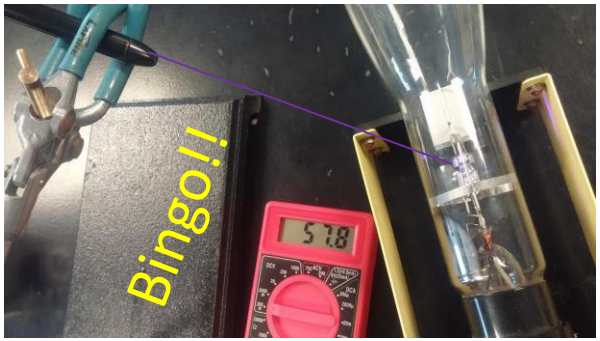
Why not connect a multimeter to the leads for the parallel plates and see what happens……

If electrons move through the gap from one plate to another, perhaps a measurable potential difference will develop between the plates. Multimeter is set to 200 mV range.



Let's try the visibly brighter green laser pointer…

Maybe with this dim violet laser pointer…….



How else can this drive the point home?

1) Direct the violet laser at the opposite plate and get the **opposite sign** for ΔV due to the movement of electrons away from the incident plate, but now in other direction.

2) Direct the violet laser so that it reflects from one plate to the other and note how ΔV is much less than if only one plate…. Why……?

3) Direct a higher powered violet laser at a single plate and……

LIMITATIONS: This only shows that photoelectron emission requires a high enough frequency of light. I have attempted, with no luck, to try to find the work function of the emitter plates experimentally. It seems the application of a stopping potential across the plates results in a motion of electrons that would flow opposite the photoelectron motion. Perhaps this is due to the presence of too much gas in the CRT, allowing a small current across the gap that I cannot distinguish from the (also small) photoelectric current that flows in the opposite direction? Would love to know if anyone can make this work as a fully functioning photoelectric effect demonstration piece!

Also, to use readily available equipment, I am measuring the potential difference (in mV) between the plates that the migration of electrons results in, not the current, as that is far too small to measure with the type of meters in a typical high school setting.

Finally, obviously, the work function of the CRT plates must "cooperate". With this model, we got lucky, but, for example, the "grid" plates on the same model do not allow you to see the effect with a violet laser. So your results may vary depending upon the materials of construction for your CRT.