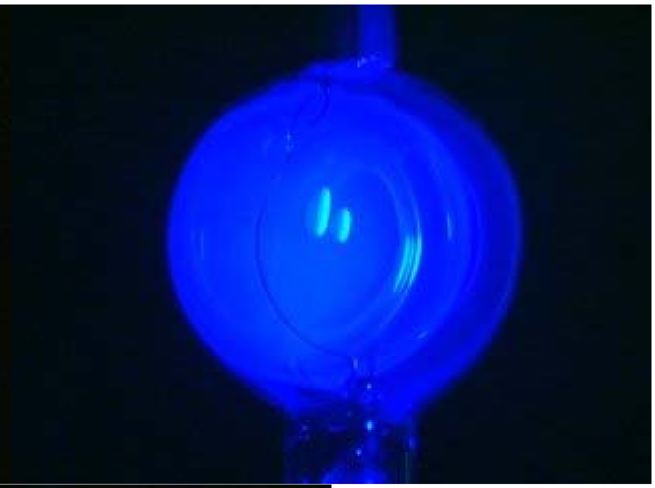
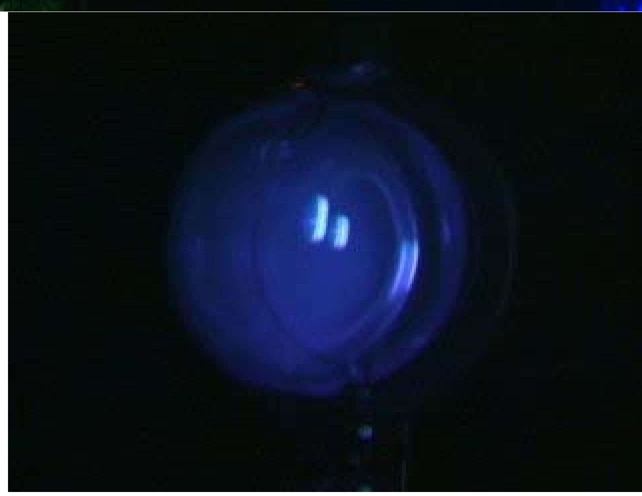
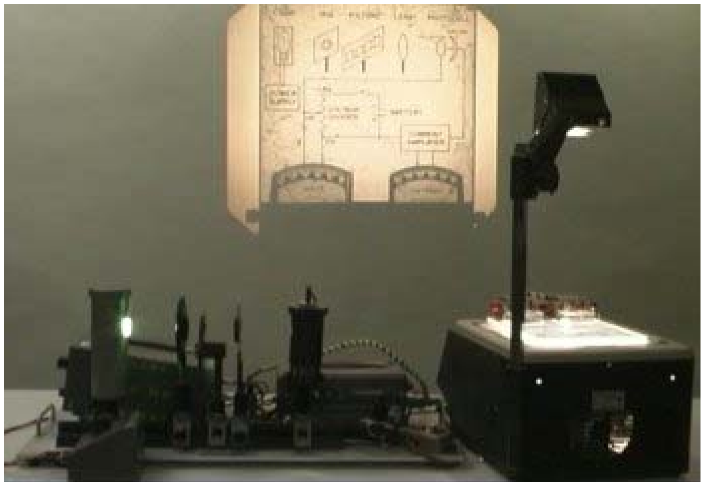
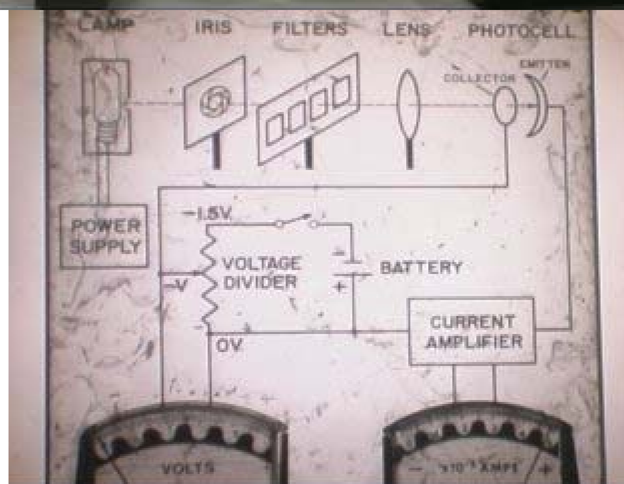
Question #250

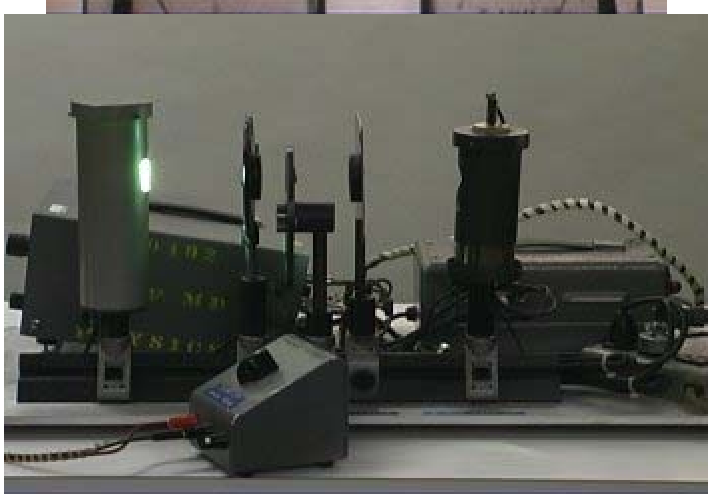
A monochromatic beam of light shines into a photoelectric cell, seen in the photographs below. The three photographs show green, blue, and deep violet light striking the cell; the three colors of light are obtained using a mercury line spectrum source and a set of three filters that remove all light except that from one of the three lines: green, blue, or violet. Let us concentrate on the blue light in the center below.

When the light strikes the photocell material it emits electrons whose kinetic energy is equal to the photon energy minus the work function for the material, which is a the same for all photons. The entire experimental setup is seen in the photograph at the left below. The mercury source at the left creates a line spectrum that is filtered by rotating one of the three color filters into the beam, and the light of that color then strikes the photocell. The projectual on the screen behind the experiment shows the components as well as the electric circuit.







Electrons emitted by the photoelectric surface strike the wire ring seen in the photographs circling the cell, creating an electric current that is displayed on the ammeter, at the right in the projected photo. If we place an opaque material in the light path, the current goes away, as seen in an mpeg video by clicking on the photograph of the circuit diagram at the left above.

The circuit seen on the projectual allows us to put a negative voltage on the wire relative to the photoemitter surface using the voltage divider seen in front of the apparatus in the photograph at the right above.

If we apply a negative voltage onto the wire relative to the plate, as seen in the electric circuit on the projection board, we can reduce the current, because the negative charge on the wire repels the electrons leaving the photoemissive surface and moving toward the wire. When the magnitude of the applied voltage reaches the kinetic energy of the emitted electrons in electron-volts, the electron current passing from the emitting surface to the wire is stopped, as can be seen in an mpeg video by clicking your mouse on the photograph at the right above. For a monochromatic blue light, that voltage is about 0.95 V, as seen on the voltmeter at the left on the projection.

Part (1) Suppose that we do the same experiment with a violet light, seen in the photograph at the top right. Will the voltage required to stop all electric current from the emission surface to the ring be:

- (a) greater than that for blue light.
- (b) less than that for blue light.
- (c) the same as that for blue light.

Part (2) Now suppose that we do the same experiment with a green light, seen in the photograph at the top left. Will the voltage required to stop all electric current from the emission surface to the ring be:

- (a) greater than that for blue light.
- (b) less than that for blue light.
- (c) the same as that for blue light.

Click here for Answer #250 after April 24, 2006.

For questions and comments regarding the *Question of the Week* contact
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given on the Lecture-Demonstration Home Page.