Photoelectric effect lab answers

So the light is a wave, these experiments will settle it? Slow down! In this lab, you will perform an experiment that assumes that light is a particle. You will explore the photovoltaic effect. To extract an electron from a metal surface, Φ amount of energy, called metal working function, must be Φ. (If it didn't take energy to release the electrons, they would just leave the usual pieces of metal.) In a wave image, the energy of the light beam depends not on the frequency, but only on the intensity, which is proportional to the square of the amplitude. Einstein explained the photovoltaic effect by postulated that an electron can only get the large amount of energy it needs to exit the metal from the EM wave by absorbing one photon. If this photon has enough energy, the electron is released. Excess energy appears as the kinetic energy of an electron. The maximum kinetic energy of the electron is given by E and hf - Φ. If the photon lacks energy, the electron cannot run out of the metal. In this lab, you will direct yellow, green, blue, purple and ultraviolet light to the metal surface and measure the kinetic energy of photovoltaic stars ejected from metal as a function of the frequency of light used to emit electrons. You will measure the metal and determine the value of Planck's constant from your data. Mercury light source diffraction grille with lens focus on mounting a bracket photovoltaic head with a built-in amplifier tool set of yellow and green filters digital voltmeter Open microsoft Word document to save the log of your experimental procedures, results and discussions. This log will be from your lab report. Address points highlighted in blue. Answer all the questions. Study: Before claiming the experiment, work with online modeling from the University of Colorado PhET Group. Link to the simulation: click Download or Run Now!. Explore the interface. There are some non-obvious controls. You can choose the Show photons in the Options menu to show a light beam consisting of individual photons. You can choose a control photon number instead of the intensity in the Options menu to change the intensity slider to a number of photon sliders. You can use the camera icon to take a snapshot of the graphics, so you can compare the graphics for different settings. You can pause the simulation and then use step for gradual analysis. To discuss the purpose of sodium: For a fixed number of photons and zero battery voltage, how much discarded photovoltaic depends on the wavelength? Every photon emits an electron? Does the probability of a wavelength change with wavelength? Discuss! For fixed wave and zero voltage battery, battery, Does the current depend on the intensity of the light? Discuss! For fixed wavelength and light intensity, how does the current depend on battery voltage? For fixed wavelength and light intensity, do all discarded electrons have the same energy? How to measure the maximum energy of discarded electrons. Now try other goals. What is the longest wavelength (max) light can extract electrons from these targets? What is the function of Φ of these goals? Fill the table and insert it into your journal. (Remember: hc and 1240 eV nm) Target qmax to release electrons (nm) Φ hc/qmax (eV) sodium zinc Copper Platinum Calcium ????? Experiment: The device is shown on the right. The source of light is a mercury vapor lamp. Mercury atoms produce strong radiation lines at different frequencies or colors. Color WaveLenge (nm) Frequency (1014/s) yellow 578-580 5.19 Green 546.1 5.48 Blue 435.8 6.88 Violet 404.7 7.41 Ultraviolet 365.5 8.20 Photons of Different Light Divided By Color Grid which diffracs light different colors in different directions. The lens focuses light on the photovoltaic head, where photons are hit by a metal cathode and electrons are emitted. Electrons are collected on the anode. In the simulation you just explored, the electrons flow back from the anode into the cathode through the wire, and the current in the wire is measured. In our experiment, we combine the cathode and the anode not with the wire, but with the voltmeter. No current flows through the perfect voltmeter. Electrons can't leave the anode. Electrons are negatively charged, and as more and more electrons gather on the anode, the anode becomes more and more negatively charged. Potential difference or tension develops between cathode and anode. Electrons already collected on the anode repel electrons ejected from the cathode later. It is convenient to measure the energy of the electron in units of the electronic volt (eV). In si 1 eV 1.6-10-19J units. If the potential difference between the cathode and the anode has grown to x volts, then electrons thrown out of the cathode need energy of at least x ev to overcome this potential difference and reach the anode. By measuring the maximum voltage between the cathode and the anode, we can determine the maximum energy of the electrons that have reached the anode. The maximum E energy of electrons achieved by the anode in eV has the same numerical value as the maximum voltage in V. Schematic photovoltaic head with the image of the cathode and anode. (a) Setting up the device, as shown in the picture above. The light source must have a slit assembly installed in place with a lens/grid attached to two rods. The lattice should be installed away from the light source and should not be touched by your fingers in any adjustments. Take a look at the machine and identify the following parts: the Mercury lamp; You have to turn this on now (if it's not on yet) so it can start warming up. Light comes out of the mercury lamp through a small rectangular diaphragm measuring 2.4 mm x 27 mm to make a clearly defined beam. The next object in the optical trajectory is a combined lens and a diffraction lattice. The lens is a 100 mm focal length lens that focuses light on the vacuum photodiode inside the photovoltaic effect of the device. It is followed by a diffraction lattice (600 lines/mm). This grille blazes the meaning it produces the brightest spectrum with only one hand. The light then moves to the photovoltaic head. First, he encounters a rectangle with a white reflective mask; This mask allows you to see an ultraviolet line from a source of mercury that is not normally visible. It is made of a special fluorescent material that makes the ultraviolet line look like a blue line and also makes the purple line more blue. Light passes through this aperture into a light shield that you can flip to the side (try). This light shield should always be closed when you make measurements, so that the light of the room does not get into the device. The photovoltaic head also has voltage outputs, and it must be connected to a portable digital voltmeter. The vacuum photodiode you will use in this experiment is found in the screen case inside the photovoltaic head, so you won't be able to see its details. The diagram is shown above. (b) Your mercury lamp should have warmed for at least 10 minutes. Turn the photovoltaic effect head on its swinging bar ties so that the zero-order diffraction grille strikes a white reflective mask on the front of the photovoltaic head. If the light image doesn't look well focused, you can adjust the assembly position of the lens/grid; adjust it by loosening the thumbscrew and sliding it along the rods. (c) Roll the light shield out of the way to show the white photodiode mask inside the machine. Now you need to turn the photovoltaic head on its support web until the input light passes through the input rectangular aperture and striking holes before the photodiode. After you adjust it properly, tighten the thumbscrew into the base of the web support. Unfortunately, even when this thumbscrew tight apparatus can still rotate a bit, so you have to be careful not to hit it. You may also have to adjust the lens/grille assembly a bit to achieve the most dramatic aperture image on the window in a photodiode mask. Then roll the light shield back into place. Whenever you move to a different wavelength of light, you need to open the light shield and double-check that light фототрубку внутри аппарата. d) d) photovoltaic head switch ON. Now rotate the entire photovoltaic head on the pin in a pair of bar until you see the colored maxims in the first order. Swing on either side of the zero order and figure out which side of the first order maxima seems to be brighter on (it will be brighter on the one hand since it erupted the diffraction of the grille). Make sure you can identify all five spectral lines listed in the table below. (e) Select one of the lines in the first order (on the bright side) and make sure it strikes the photodiode after the procedure in a step (c). For green and yellow lines, filters should be used to limit other frequencies of light from entering the machine. Place the appropriate filter (green or yellow) on a white reflective mask. Click the PUSH TO zero button on the side of the photovoltaic head. This will unload any charge configured on the anode. Release the button and then look at the voltage voltage. You'll see it immediately jump up to some non-zero value and then, depending on the intensity of the light, it can take a few (sometimes as long as 30 - 40 seconds) to settle on its final value. The final, stable voltage value per voltemeter is the potential to stop for this wavelength of light. Open Excel and prepare the table shown on the right. Enter the measured maximum electron energy in the eV for the chosen color into the table. Color Frequency (/s) Maximum Electron Energy (eV) Yellow 5.19e14 Green 5.48e14 Blue 6.88e14 Purple 7.41e14 Ultraviolet 8.20e14 Adjust the apparatus and spread the head to measure the stopping voltage for each of the five colors listed in the table and introduce maximum electron energy into the table. (f) Prepare a graph of the maximum energy of the electron compared to the frequency of light. Choose X-Y Scatter. The maximum electron energy on the vertical axis and the frequency on the horizontal axis. Prediction: E and hf - Φ This equation has the shape of y and ax b, with tilt time and b being y-interception. The slope of the E vs. f section will give the plank a permanent and u-interception will give the function of a metal cathode. Add a trend line and insert an equation for the trend line into your storyline. Use the trend line tilt to find the constant h Planck and the interception value to find the working Φ part of the phototube phototubes. If there are data points that seem to deviate far from the trend line, repeat these measurements until you are satisfied that you have done your best. (e) Since the electron energy is measured in eV and frequency in seconds, the permanent h Planck will have an eV s unit and the work function will have an eV unit. Converting the Planck constant into SI units (J s) by multiplying the value received from the slope (g) Repeat all measurements with dim lines from the second-order pattern or from the first-order pattern on the opposite side. Measure the maximum electron energy for these lines and compare the bright patterns you previously received with the first order. Turn the power switch photovoltaic head off. Insert tables obtained using bright lines and dimmer lines, respectively, in your journal and comment on your results. What value did you get for h in eV s and J s units? How does this value relate to the accepted value of h 6.626'10'34 J s and 4.136-10'15 eV s? Describe the effect of different colors of light on the potential of the stop and thus the maximum energy of photoelectrons. Describe the effect of different light intensity on the potential of stopping and thus maximum photovoltaic energy. Do you see the effect? Did you expect the effect? Think about your measuring device. (No current flows through the perfect voltmeter. But the real digital voltmeter measures the voltage by drawing a small amount of current. What can happen if the intensity of light is low and a few photovoltaics are thrown away?) Protect whether this experiment supports a wave or quantum model of light based on your lab's results. Open Microsoft Word and prepare a report. 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