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| **FINAL %** |

**University of Zululand**

**Faculty of Science and Agriculture**

**Department of physics& engineering**

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| **Module Title** | 4PHY322 |
| **Experiment No.** | 3 |
| **Experiment Title** | Photo-electro effect |
| **Due date & time** | 07/10/2022 |

**Title**Photoelectric effect  
**Aim**  
To determine the Planck constant (h).   
**Abstract**Photoelectric effect it’s the process of inducing the electric current using the photon light source shinning in the metal to emit the electron charge. This practical was about the photoelectric effect and the Planck constant was determined by using the photoelectric effect apparatus and light source. The Planck constant was determined by calculating the slop of the graph of the stopping potential verse frequency. The Planck constant was calculated and found to be…

**Theory**

Photoelectric effect is the emission of electrons from the surface of the metal from the electromagnetic radiation by enough frequency shines in a metal to produce electric current, and when the light shines with the high intensity increases the number of electrons emitted at the same time.

Max Planck discovered the theory of radiation in 1901. He state that the oscillators or any similar system, obey this theory which describe set possible the energy levels, energy between these possible energy levels doesn’t occurs. Planck theory is about the absorption and emission of an energy from one energy level to another energy level.

Equation that describe absorption and emission of energy:

E=hv

* E is the radiation energy.
* v is the frequency and h is the Planck constant.

Albert Einstein simple describe the Lenard’s invention using the Planck theory in 1905 of quantized energy. Albert Einstein assumed that the energy are quantized as the Planck theory states that. Einstein model of quantum-base model state that higher the frequency of light, higher the energy of emitted electrons in the metal or any material, and independent to the intensity (brightness) of light. The higher the intensity only increases the number of electrons emitted in the metal. Einstein called the energy of light a Photon that shining on a metal or any material. In photoelectric effect, the quantized energy it is absorbed by one electron. When electron absorbed the energy from the lower energy levels, it will lost the energy to move to the surface of the material and that energy is called work function. If energy is more than the work function the electron will be emitted to the certain kinetic energy from the material.

The developed equation of quantum energy by Einstein:

E=hv=Ek+Wo

* Ek is the kinetic energy and Wo is the work function.

And the kinetic energy expression equation:

Ek=hv-Wo

When the plane is charged negatively to the stopping potential so that the so that the electron do not reach the collector from the emitter the photocurrent will be not induced (means photocurrent is zero).

The kinetic energy will be express as:

Ek=eV , where V is the voltage.

The voltage equation:

V=

**Apparatus**

* Optical filters, Apertures, Caps and screws.
* Mercury light source enclosure.
* Base
* Photodiode enclosure
* Power supply
* Photoelectric effect Apparatus

**Method**  
The window of the mercury light source was covered with the mercury lamp cap and the window of the Photodiode was covered with the photodiode cap. The h/e power supply was then turned on, and the mercury lamp and also Photoelectric effect apparatus. The light source and the apparatus was warmed for 20 minutes. The apparatus voltage was set to the range of -2v to 0v and the current range was 10^-13. The amplifier current was set to zero by first disconnecting the A, k and down arrow cables from the back panel of the apparatus. The phototube signal was then turned in the calibration and the current calibration knob was set to zero. The phototube signal button was pressed to measure and the A, K and the down arrow cables was then reconnected to the back panel of the apparatus.

The window of a photodiode enclosure was uncovered and 4mm diameter of the aperture was placed and the 365nm of the filter was placed on the window of the enclosure. The window of the mercury light source was uncovered and the spectral line of 365nm shined on the cathode of the phototube. The voltage was adjusted until the current was zero. The stopping voltage was then recorded. The mercury light source was the change the filter of 365 by replacing with the 404.7nm, 535.8nm, 546.1nm and 577.0nm to measure the stopping voltage. The 4mm diameter aperture was then replaced by 2mm diameter 8mm diameter apertures. The steps of measuring the stopping voltage was repeated on the 2mm and 8mm diameter apertures, by change the filters.  
**Results**

Stopping Potential of spectral Lines, 4mm diameter Aperture

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| --- | --- | --- | --- | --- | --- |
| Item | 1 | 2 | 3 | 4 | 5 |
| Wavelength(nm) | 365.0 | 404.7 | 435.8 | 546.1 | 577.0 |
| Frequency(×10^14Hz) | 8.214 | 7.408 | 6.879 | 5.490 | 5.196 |
| Stopping Potential(v) | 1.622 | 1.274 | 1.068 | 0.518 | 0.384 |

Stopping Potential of spectral Lines, 2mm diameter Aperture

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Item | 1 | 2 | 3 | 4 | 5 |
| Wavelength(nm) | 365.0 | 404.7 | 435.8 | 546.1 | 577.0 |
| Frequency(×10^14Hz) | 8.214 | 7.408 | 6.879 | 5.490 | 5.196 |
| Stopping Potential(v) | 1.596 | 1.253 | 1.053 | 0.514 | 0.382 |

Stopping Potential of spectral Lines, 8mm diameter Aperture

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Item | 1 | 2 | 3 | 4 | 5 |
| Wavelength(nm) | 365.0 | 404.7 | 435.8 | 546.1 | 577.0 |
| Frequency(×10^14Hz) | 8.214 | 7.408 | 6.879 | 5.490 | 5.196 |
| Stopping Potential(v) | 1.652 | 1.299 | 1.081 | 0.526 | 0.390 |

Calculations:

Part1 (4mm diameter)

1. h=e×slope=1.602××=6.91
2. percent difference=

Part2 (2mm diameter)

h=e×slope=e(= 1.602×(

Part3 (8mm diameter)

h=e×slope=e(= 1.602×(

Questions

1. The Planck constant ‘ho’ is less than by 5.05% which indicate small difference to the calculated value.
2. Yes, it can be accounted because it has the small difference between the accepted value and the calculated value.
3. The work frequency should be calculated by first finding the y-intercept from the graph of the stopping potential verses frequency multiply by e=1.602.

**Discussion**  
A graph of the stopping potential that was plotted forms a straight line graph. The Planck constant was calculated by first finding the slope of the straight line of the graph of the stopping potential verses frequency. The Planck constant was equal to the electron charge multiply by the slope of the graph (h=e×slope). When the frequency increases also the stopping potential increases, therefore they are proportional related to each other. When the intensity was increased the stopping voltage remain the same. The calculated value of h was greater than 5.05% to the accepted value which is the small difference.

The photoelectric effect state that when the frequency of light increases also the also the voltage increase, and when the intensity of light increases only increase the concentration of electrons emitted from the metal. The experimental result also corresponds to the theoretical result. When the ap  
**Conclusion**  
The percent difference is equal to 5.05% which is the small difference from the theoretical value of the Planck constant and experimental value.