SSM-0032 : Particles and Fields of Modern Physics

Practical Session 2, 17th November 2005

Name of Student : .....

Ask a demonstrator if you are unsure how to use the apparatus.

Hand in answers to Dr.Waters at the end of the session.

Photoelectric Effect

Principle :

Light of frequency f consists of photons with an energy given by :

$$E = hf \quad ,$$

where h is Planck's constant. If the photons are incident on the surface of certain metals, electrons are ejected with a maximum kinetic energy, KE_{max}, given by :

$$E = KE_{\max} + \phi \quad , \qquad [1]$$

where ϕ is a material dependent constant. This experiment measures KE_{max} by supplying an electric field which acts to slow the ejected electrons. The ejected electrons, with charge q , only just reach the anode to form a current when :

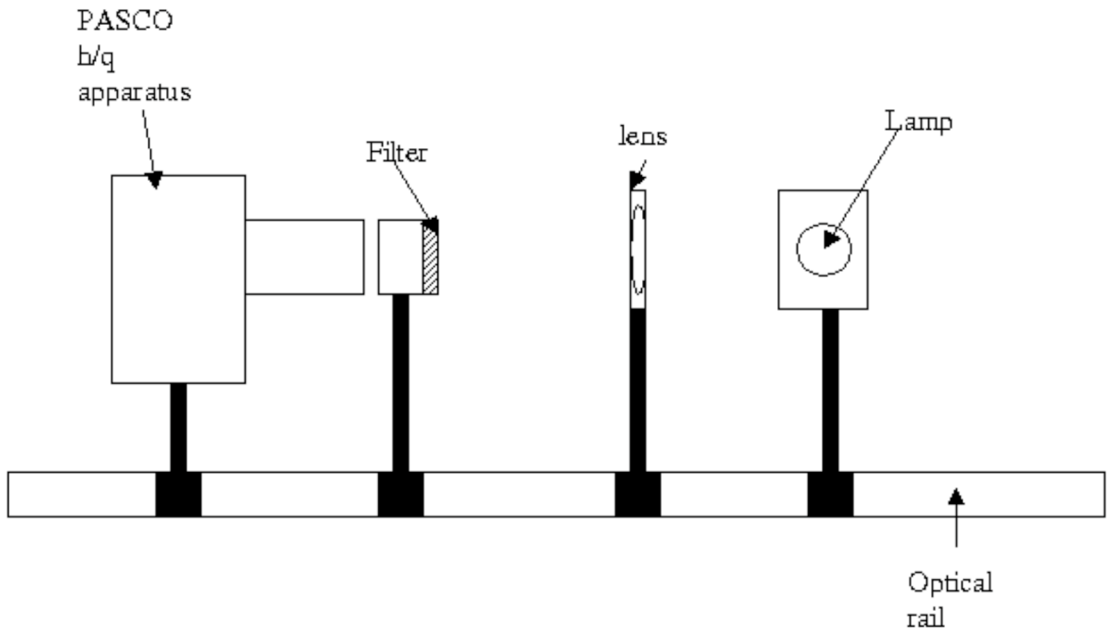
$$KE_{\max} = V_{stop} q \ .$$

Subsituting this expression into equation [1] gives :

$$V_{stop} = \frac{hf}{q} - \frac{\phi}{q} \ .$$

Plotting V_{stop} for different frequencies therefore allows a determination of the ratios h/q and ϕ/q.

Apparatus :



Light from a lamp passes through a lens and a frequency selecting filter placed in front of the photoelectric effect apparatus. That apparatus automatically determines V_{stop}, which can be read from an attached digital volt meter (DVM).

Procedure :

(1)Arrange the apparatus as indicated in the diagram. Place a filter in the clip directly in front of the photoelectric apparatus. Zero the apparatus and make a voltage reading, with the DVM set to the 2V range. Make sure that the readings are stable and reproducible.
(2)Place a series of filters in the clip and, for each, measure the stopping voltage using the volt-meter. Remember to zero the apparatus each time.

Q1 On a piece of graph paper, plot the stopping voltage versus the frequency. Use the graph to obtain the ratios h/q and ϕ/q .

Q2 Given that *q* is equal to 1.602×10^{-19} C, obtain values for Planck's constant h and the work function ϕ .

(3)Adjust the light intensity by using the dimming filters. Take several repeat measurements at various frequencies.

Q3 Do the results depend on the intensity of light ? Can you explain this ?