Planck's Constant by Photoelectric Effect

Determination of Planck's Constant and Work Function of Materials by Photoelectric Effect

It was observed as early as 1905 that most metals under influence of radiation, emit electrons. This phenomenon was termed as photoelectric emission. The detailed study of it has shown.

1. That the emission process depends strongly on frequency of radiation.

2. For each metal there exists a critical frequency such that light of lower frequency is unable to liberate electrons, while light of higher frequency always does.

3. The emission of electron occurs within a very short time interval after arrival of the radiation and member of electrons is strictly proportional to the intensity of this radiation.

The experimental facts given above are among the strongest evidence that the electromagnetic field is quantified and the field consists of quanta of energy E= hn where n is the frequency of the radiation and h is the Planck's constant. These quanta are called photons.

Further it is assumed that electrons are bound inside the metal surface with an energy ef, where f is called work function. It then follows that if the frequency of the light is such that

hn > ef

it will be possible to eject photoelectron, while if hn < ef, it would be impossible. In the former case, the excess energy of quantum appears as kinetic energy of the electron, so that

hn = ½(mn2 + ef) .....(1)

which is the famous photoelectrons equation formulated by Einstein in 1905.

The energy of emitted photoelectrons can be measured by simple retarding potential techniques as is done in this experiment. When a retarding potential V0 is used to measure kinetic energy of electrons Ee, we have,

Ee = ½(mv2) = eV0

or

V0 = (h/e)(n-f)

So when we plot a graph V0 as a function of n, the slope of the straight line yields h and the intercept of extrapolated point n=0 can give work function f.

THE APPARATUS CONSIST OF THE FOLLOWING:

1. Photo Sensitive Device: Vacuum photo tube.

2. Light source: Halogen tungsten lamp 12V/35W.

3. Colour Filters: 635nm, 570nm, 540nm, 500nm & 460nm.

4. Accelerating Voltage: Regulated Voltage Power Supply,

Output	± 15 V continuously variable through multi-turn pot
Display	3½ digit 7-segment LED
Accuracy	± 0.2%

5. Current Detecting Unit : Digital Nanoammeter

It is high stability low current measuring instrument

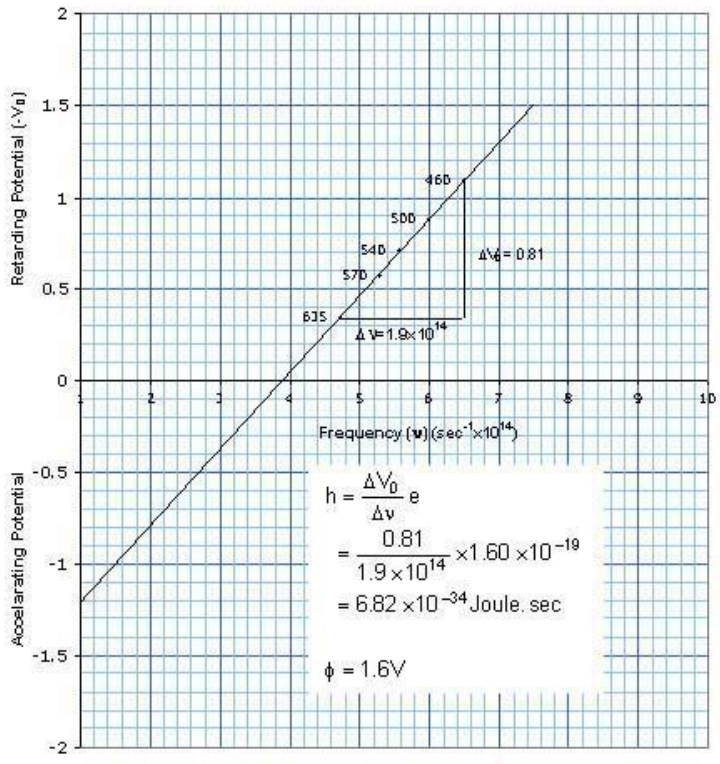
Range	1000 mA, 100 mA, 10 mA & 1mA with 100 % over ranging facility
Resolution	1nA at 1 mA range
Display	3½ digit 7-segment LED
Accuracy	±0.2%

6. Power Requirement: 220V ± 10%, 50Hz.

7. Optical Bench: The light source can be moved along it to adjust the distance between light source and phototube scale length is 400 mm. A drawtube is provided to install colour filter, a focus lens is fixed in the back end.

The set is complete in all respect, no additional accessory required.

Typical graph of V0 (stopping potential) as a function of n0 is given below.



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