(MP3-5) Photoelectric Effect

Aim of experiment

1. To understand the phenomenon of photoelectric effect as a whole.
2. To determine the h/e ratio, and work function for cathode material.

Apparatus

Day Light Lamp With a Single Slit, Small Converging Lens, Light Colored Filters, Photocell Apparatus, Voltmeter, Ammeter.

Theory of experiment

In photoelectric emission, light strikes materials, causing electrons to be emitted. The classical wave model predicted that if the intensity of incident light was increased, the amplitude and thus the energy of the wave would increase. This would then cause more electrons to be emitted which were not true.

Einstein's theory of photons, when one of the "energy quanta" strikes a metal surface, it may (if it has enough energy) knock an electron loose from the metal; if there is energy left over, the electron will go flying off at high speed. If there is an electrode to collect these flying electrons, a current will flow between the metal surface (the photocathode) and the collecting electrode. If we think of this speed in terms of "kinetic energy", *KE*, we must have

$$KE = h\nu - W \qquad (1)$$

W is the amount of energy required to knock an electron free from the metal surface; it is a property of the surface. Only if $h\nu > W$ is an electron actually liberated.

If you use a battery to apply a positive charge to the metal plate (or a negative charge to the collecting electrode) you will interfere with this process, by making it harder for an electron to be ejected from the plate (or collected by the collecting electrode). A large enough charge should in fact completely inhibit the photoelectric effect from occurring.

In such case, we use a field which decelerates the charge, and (*V x charge)* therefore measures the loss of kinetic energy.

In light of the above, Einstein concludes that equation (1) can be written

$$V_S \times e = h\nu - W \qquad (2)$$

V_S is the "stopping voltage": in a real experiment, the reading of a voltmeter attached between the two electrodes when the photoelectric effect just barely stops; and $V_S \times e$ is the corresponding energy of one of the electrons. This relationship is illustrated in *figure 1*.

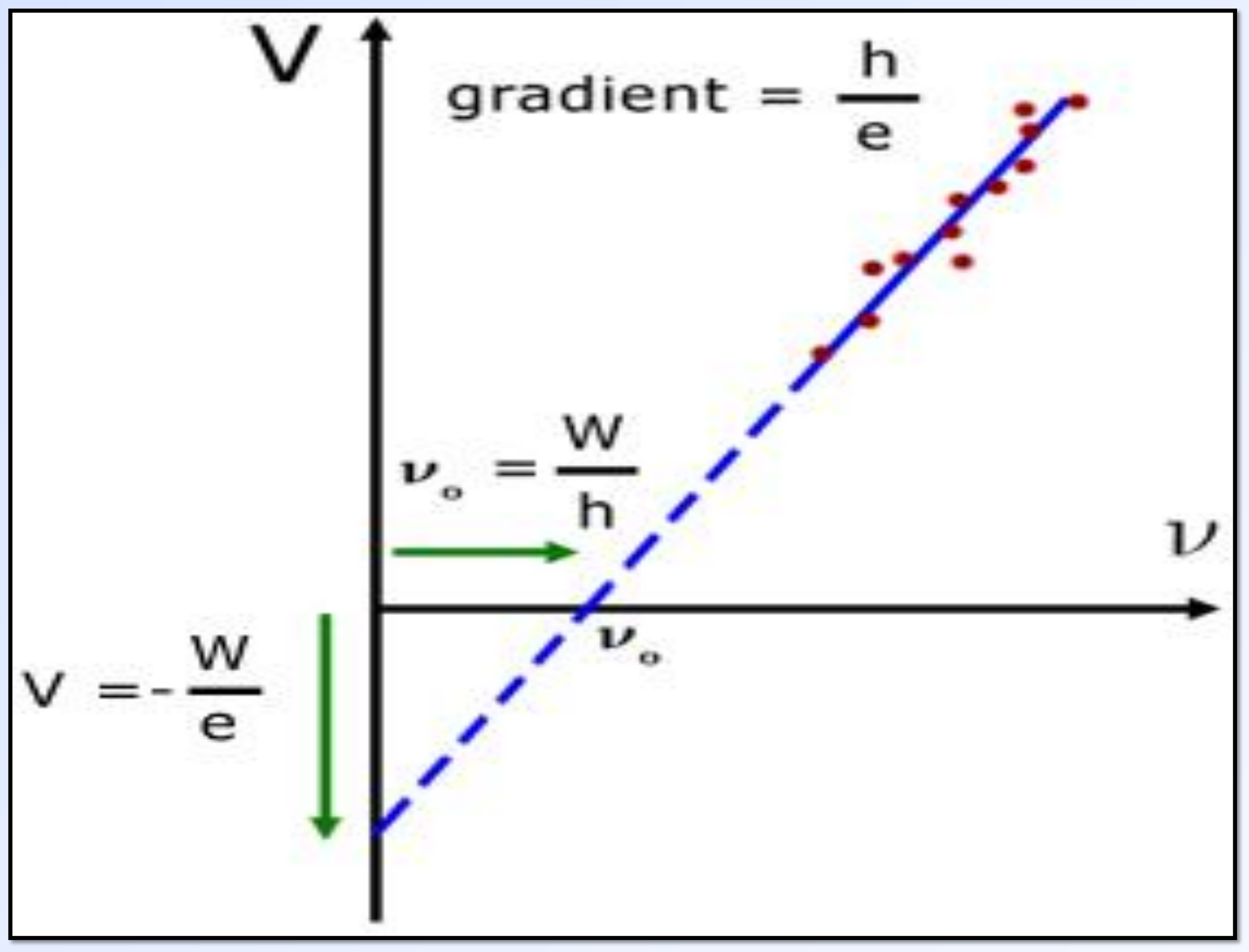

Figure 1. A graphical representation of the relationship between stopping voltage and frequency

Procedure

1. Switch on the day light lamp and leaf to warm few seconds.
2. Switch on the phototube power supply and use the dial to set the applied voltage on the photo cell to zero.
3. Cover the aperture, the current read should be none.
4. Now shine the light into the opening, the ammeter reads currents.
5. Apply reverse voltages on the photo cathode, until the current just stops, and record how much voltage, V_s was required.
6. Repeat the above steps for the other filters.
7. Tabulate the stopping voltages for different light filters
8. Repeat at least extra 2 times and record in the table
9. Draw the relation between the light frequency, ν, and the stopping voltage, V_s
10. Determine the work function, *W*, and Plank`s constant, *h*, from the curve.

Results

λ (nm)	ν (Hz)	V_{s1} (V)	V_{s2} (V)	V_{s3} (V)	$V_{sav}+\Delta V_{sav}$ (V)

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