OPERATING INSTRUCTIONS

PLANCK'S CONSTANT BLACK BODY

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PLANK'S CONSTANT

(BY WEIN RADIATION LAW)

Introduction :- This experimental set up is designed to determine the Plank's constant by photo voltic cell with the help of 'Wein's radiation law'. the set up cotains one photo voltic cell, one lamp house with tungston lamp 6V/18W, one low voltage dc regulated power supply with digital meter, one digital microammeter.

Brief :- The intensity of radiation emitted by a black body is uniformaly distributed over the whole range of wavelength involved, as the metal heated to incandecent level. At various temperatures not only the energy increases but the wavelength of maximum energy (λmax) moves to the region of shorter wavelength. Analysis of this phenomenon shows that the, λmT = constant. Wein's apply the principle of thermodynamics to the black body radiation and say that 'as the temperature rise, the maximum intensity of radiation emitted, shifts towards shorter wavelengths' hence it becomes the 'Wein's law of energy distribution'.

The value of h, is calculated by following relation

$$h = (e)(\lambda m\ T)(Vs\ T)/c \qquad 1$$

$h = 6.625 \times 10^{-34}$ J s, is the planck constant

$e = 1.6 \times 10^{-19}$ col , the electronic charge

$c = 3 \times 10^{8}\ m\ s^{-1}$, the free space velocity of light in free space

$\lambda m T = 2.9 \times 10^{-3}\ m\ {}^{0}K$, the wein displacement with λm , as the wavelength corrosponding to constant photons of maximum energy emitted by a black body at temperature ,T, in ${}^{0}K$ (absolute temperature).

Vs T = can be termed as stopping potential of photoelectric current at certain temperature T.

T ^{0}K is temperature of black body radiation so incandecent lamp serve the purpose. In present case in the temperature ^{0}C is such that

T_0 ^{0}K = t ^{0}C + 273. 2

The lamp filament temperature is calculated by following relation empirically known parabolic relation between t ^{0}C and resistance Rt ohms.

$Rt = R_0 (1 + 0t + bt^2)$ 3

where R_0 is resistance at zero ^{0}C, b is a coefficient for tungston

$b = 7.00x\ 10^{-7}$ ^{0}C 4

An empirical relation exsists for determining the temperature R0 is

$R_0 = Rg / 3.9$ 5

where Rg is the resistance where filament just glow to visualize red, but no or feeble photocurrent generated. The temperature Rt is than calculated using empirical relation

$Rt/R_0 = [T/ (273 +T_0)]^{(1.2)}$, in ^{0}K 6

The photocell has very low work function, and used to evaluate the Vs T, by measureing photocurrent as Ip and computed by computing terminating resistor (10KΩ). As the photocurrent can be multiply by the meter resistance Rm (10KΩ) , to give the Vs directly so relation 1 can be rewritten as

Vs T = IR = $(Ip^* \times 10^{-6}) x(10.0x10^3)$ or simply Ip# x 10^{-2}. 7

where Ip* is corrosponding photocurrent in microamp.Ip# is direct read value.

Experiment procedure

1. Place the lamp house, photo cell mount close to supply cabinate. Connect them with their respective sockets. Keep DC supply at minimum. (See illustration at page 5). Switch on power.

2. Slowly increase the power supply , for light glow of filament#. Note the corrosponding voltage (1.00V app), Vg & Ig after 5 minute (select dpm switch for V & I alternately).

3. Calculate the filament resistance Rg* using Ohm's law Rg = Vg/Ig.

Note : Rg is lamp resistance at just glow condition for no or feeble photocurrent.

Compute lamp resistance for 0^0C temperature as R0 = Rg / 3.9.

4. Set lamp voltage 3.00V. Note the current for lamp It after 3 to 5 minutes, and voltage Vt. Increase the dc power supply in 1V steps. Note each reading after 3 to 5 minute to stablize temperature of filament.

5. Tabulate the readings. Compute Rt/R0 and finally temperature T^0K (eq 6) or use a graph from given precalculated values in table 4.

6. Compute λm T for given temperature T^0K, = (2.9×10^{-3}) / T^0K.

Compute Vs T from the observation = $(Ip \times 10^{-6})x(10x10^3)$ volt.

7. Compute h, for each set. Deduce mean value.

Note : A graph can be plotted from given table 3 & 4 to find out the transient wave-length and absolute temperature.

In this case very less (< 1 uA) or no photocurrent generated.

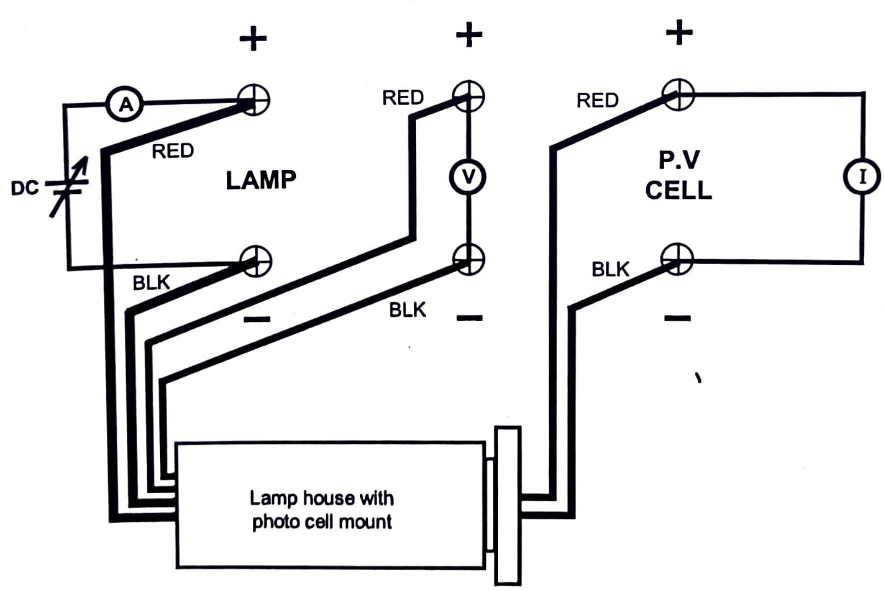
Note : It is quite complex to decide the Ro. However two or three close approximation can be experimented by adjusting voltage within $\pm$0.1V.

Table 3.

T^0K	500^0K	1000^0K	1500^0K	2000^0K
$\lambda m\ T(m)$	58×10^{-7}	29×10^{-7}	19.3×10^{-7}	14.5×10^{-7}

Table 4.

Rt/R_0	1	1.5	2	2.5	3	3.5	4	4.5
T^0K	273^0K	383^0K	486^0K	586^0K	682^0K	775^0K	867^0K	956^0K
Rt/R_0	5	5.5	6	6.5	7	7.5	8	8.5
T^0K	1044^0K	1130^0K	1215^0K	1300^0K	1382^0K	1463^0K	1544^0K	1624^0K
Rt/R_0	9	9.5	10	10.5	11	11.5	12	12.5
T^0K	1704^0K	1782^0K	1860^0K	1937^0K	2014^0K	2090^0K	2165^0K	2240^0K



Planck constant by wein radiation law - 4.

Table 1.

Sr No.	V, volt	I, Amp	Rt, Ω	Rt/R_0	T ^{0}K	
1	3.00V	....	....	....	....	
2	4.00V	....	....	....	....	
3	5.00V	....	....	....	....	
4	6.00V	....	....	....	....	

Table 2.

Sr No.	T ^{0}K	λm T		Vs T
1	....	....		....
2	....	....		....
3	....	....		....
4	....	....		....