EXCERCISE 107	DETERMINATION OF PLANCK'S CONSTANT USING PLANCK'S LAW OF BLACK-BODY RADIATION

Measurement procedure

1. List of equipment

- Bulb power supply
- DC ammeter
- DC voltmeter
- Bulb
- DC microammeter
- Set of interference filters
- Semiconductor diode
- Electrical wires

2. Goal

- Measurements of spectral emittance of the investigated sample as a function of its temperature, Planck's constant determination.

3. Measurement setup

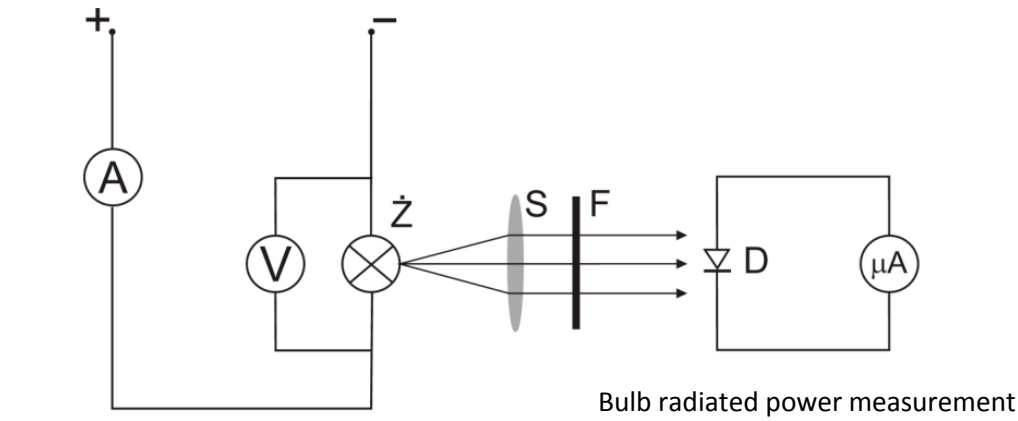

Fig.1. Diagram of electric circuit used in the experiment.
(A – ammeter, S – lens , μA - microammeter, V – voltmeter,
F - interference filter, Ż – bulb , D - semiconductor diode)

Fig.2. Experimental setup

4. Measurements plan

a) Connect electric circuit according to the scheme presented in Fig.1.
b) For one particular wavelength and selected interference filter perform measurements of current I flowing through the bulb and current i flowing through the detector as a function of voltage U applied to the bulb.

   For each filter use appropriate voltage range:

orange filter	$\lambda = 0{,}589 \cdot 10^{-6}$ m	4V – 11V step 0,5 V
green filter	$\lambda = 0{,}500 \cdot 10^{-6}$ m	6V – 13V step 0,5 V
blue filter	$\lambda = 0{,}458 \cdot 10^{-6}$ m	9V – 15V step 0,5 V

c) Repeat measurements described at point (b) for the other interference filters.

5. Results analysis

a) Using the formula $R = U/I$ calculate the dependence of the bulb filament resistance on voltage.
b) Using the relation between temperature T_{cz} of the bulb filament and its resistance, presented in Appendix A, estimate temperature T of the investigated bulb filament corresponding to the obtained resistance R value.
c) Make a plot of ln(i)=f(1/T), where T denotes temperature expressed in [K]. Apply linear regression to estimate the value of b coefficient and calculate its uncertainty.
d) Using the following formula: $h = b\lambda k_B/c$, calculate Planck's constant and the uncertainty $u_c(h)$ (k_B – Boltzmann constant, c – speed of light). Assume, that $u(\lambda) = 1$ nm. Compare the obtained result with values given in table of physical constants.
e) Verify, whether it was justified to assume that exp ($hc/\lambda k_B T$) >> 1.

6. Suggested measurement table (to be approved by the supervisor)

Table 1. Measurements of current I flowing through the bulb and current i flowing through the detector as a function of voltage U applied to the bulb.

lp.	U [V]	$u(U)$ [V]	I [A]	$u(I)$ [A]	R [Ω]	$u_c(R)$ [Ω]	T [K]	$u_c(T)$ [K]	i $\times 10^{-6}$ [A]	b [K]	$u_c(b)$ [K]	h $\times 10^{-34}$ [J·s]	$u_c(h)$ $\times 10^{-34}$ [J·s]
1													
2													
⋮													
n													