Task 48	Determination of the Planck constant using electroluminescent diodes

Instruction

1.The list of necessary equipment

- Tunable power supply
- Electroluminescent diode
- Digital multimeters
- Monochromator
- Photoresistor

2.Goals

- Measurement of the current-voltage characteristic for different diodes in forward direction (forward bias)
- Determination of the emission wavelength for investigated diodes
- Calculation of Planck constant and related uncertainties.

3.Experimental setup

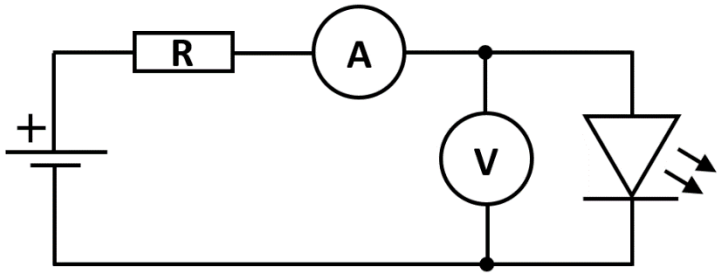

Fig. 1. The electrical circuit used to measure the current-voltage characteristic for forward-biased diodes.

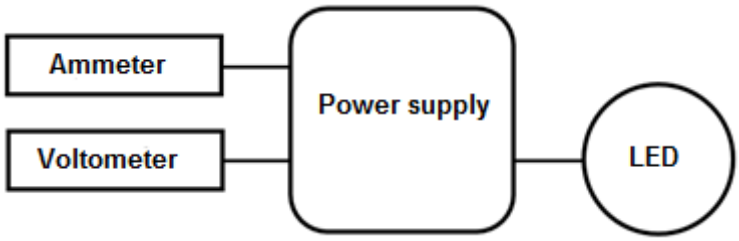

Fig. 2. The block-diagram of the experimental setup used for determination of the current-voltage characteristic of a LED diode.

4. Measurements

a) Connect the required elements according to Fig. 2.
b) Set the power supply potentiometer to the lowest position (turn potentiometer to the left).
c) Set the power supply to forward bias.
d) Measure the current-voltage characteristic. Use the potentiometer to increase the applied voltage. Conduct these measurements in as wide range of voltages as possible. Write down the measured voltage U and current I. You should have at least 20 data points measured.
e) Determine the emission wavelength of a diode using one of the following methods:
    i. By eye:
        - Set the power supply to maximum.
        - Place the diode at the rear entrance of the monochromator.
        - Change the wavelength of light transmitted to the exit slit of the monochromator (by turning the selection knob) so that its intensity is the highest.
        - Read the wavelength λ from the selection knob.
        - Assume $\Delta\lambda = 10\ \mathrm{nm}$ for the uncertainty.
    ii. Photoresistor:
        - Set the power supply to maximum.
        - Place the diode at the rear entrance of the monochromator.
        - Place the photoresistor in front of the monochromator.
        - Change the wavelength of light transmitted to the exit slit of the monochromator (by turning the selection knob) so that the resistance magnitude is the lowest.
        - Read the wavelength λ from the selection knob.
        - Assume $\Delta\lambda = 5\ \mathrm{nm}$ for the uncertainty.
f) Repeat the measurements for other diodes.

5. Calculations for report

a) Plot current-voltage characteristics for measured diodes.
b) Using linear regression method, fit a straight line $y = ax + b$ to the linear part of the measured current-voltage characteristic (forward direction only).
c) Calculate the potential barrier U_b of the diode, according to equation: $U_\mathrm{b} = -\frac{b}{a}$.
d) Estimate the uncertainty ΔU_b related to U_b
e) Calculate the Planck constant using the following equation

$$\mathrm{h} = \frac{\mathrm{e}}{\mathrm{c}}\lambda U_\mathrm{b}$$

where e is the elementary charge and c is the velocity of light in vacuum.
f) Calculate the uncertainty Δh related to the determined Planck constant.

6. Table for measurements of the current-voltage characteristic

Table 1. Results of your experiment.

lp.	U [V]	$u(U)$[V]	I [mA]	$u(I)$[mA]	λ [nm]	$u(\lambda)$[nm]	U_b[V]	$u_c(U_b)$[V]	h[J·s]	u_c(h)[J·s]
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										