

Photon energy, work function and matter waves

Physics grades 11-12 (A Level · IB · Class 11-12) · Lab answers

The sample data lie on a straight line with a gradient close to hc/e , giving a value of h near the accepted one. Your own value will depend on how well you judge the point at which each LED just glows, but it should be within about 10 percent.

Level: Physics grades 11-12 (A Level · IB · Class 11-12) · **Curriculum:** IB E.2

Question 1 Plotting

The five points lie on a straight line rising with $1/\lambda$: **the shorter the wavelength, the larger the turn-on voltage.**

Question 2 Gradient

Using least squares, gradient = **1.24 V per 10^6 m^{-1}** , i.e. $1.24 \times 10^{-6} \text{ V m}$.

Question 3 Planck's constant

$eV = hc/\lambda$ gives $V = (hc/e)(1/\lambda)$, so gradient = hc/e . $h = \text{gradient} \times e / c = 1.24 \times 10^{-6} \times 1.60 \times 10^{-19} / 3.00 \times 10^8 = \mathbf{6.61 \times 10^{-34} \text{ J s}}$.

Question 4 Comparison

Difference = $|6.61 - 6.63| / 6.63 \times 100 \% = \mathbf{0.4 \%}$.

Question 5 The intercept

The line crosses the V axis at about **-0.07 V** , so the observed turn-on voltages are a little below $hc/(e\lambda)$. An LED emits a spread of wavelengths around its quoted value, and the eye notices the faint longer-wavelength light before the LED is fully on.

Question 6 Evaluation

The judgement of when the LED just glows is subjective, and the LED wavelengths are only nominal values. **Use a light sensor or a photodiode to detect the onset**, and check the wavelengths with a spectrometer or diffraction grating.