A Level Physics A

H556/02 Exploring physics

Question Set 17

1 **(a)** An approximate value of the Planck constant h can be determined in the laboratory using light-emitting diodes (LEDs). An LED suddenly starts to conduct and emit monochromatic light when the potential difference across an LED exceeds a minimum value V_0.
The potential difference V_0 and the wavelength λ of the emitted light are related by the equation

$$V_0 = \left(\frac{hc}{e}\right) \times \frac{1}{\lambda}$$

where e is the elementary charge and c is the speed of light in a vacuum.

Fig. 20.1 shows some data points plotted by a student on a V_0 against $\frac{1}{\lambda}$ graph for five different LEDs.

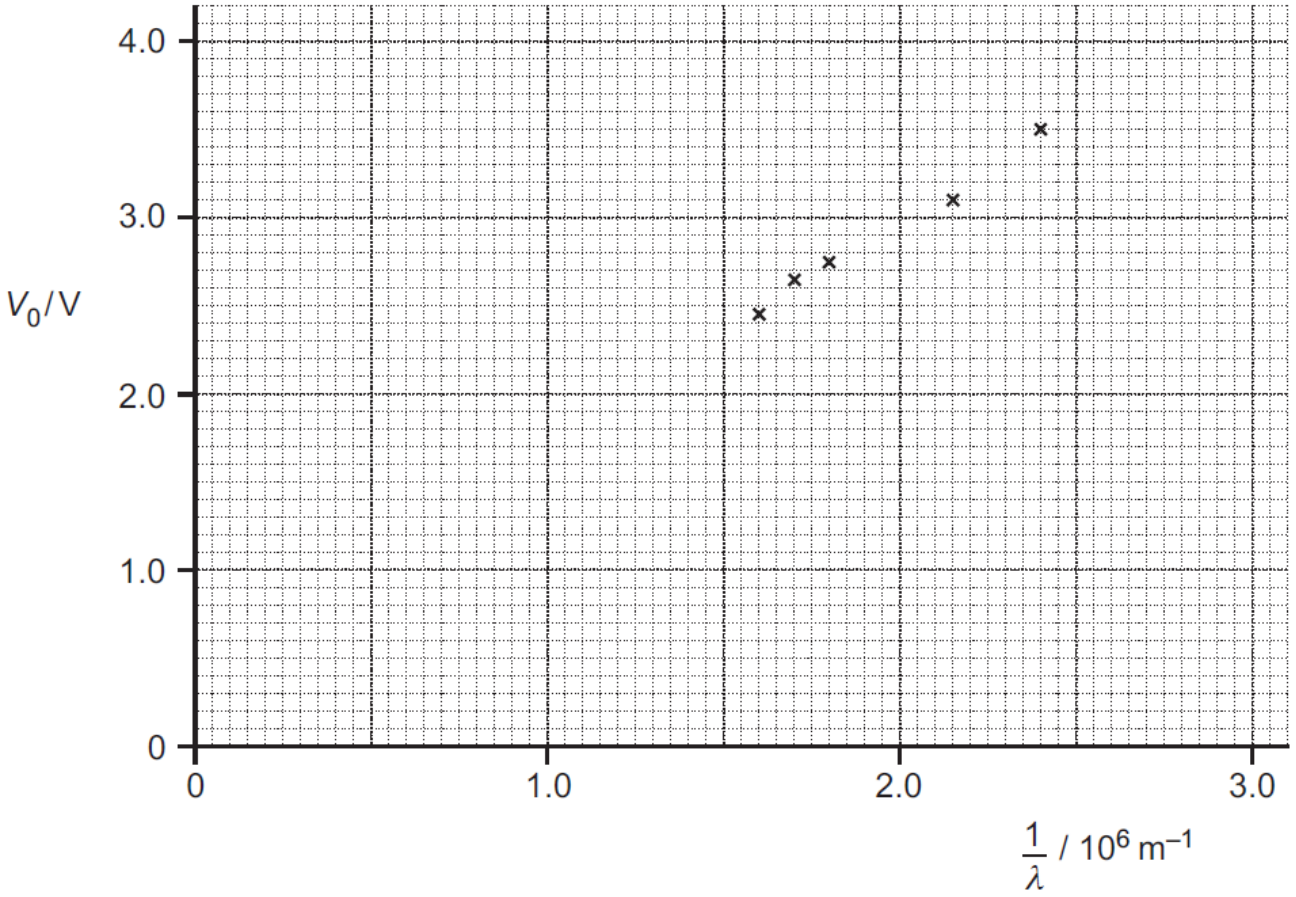

Fig. 20.1

The potential difference across each LED was measured using a digital voltmeter with divisions ± 0.01 V. The values for the wavelengths are accurate and were provided by the manufacturer of the LEDs.

The value of V_0 was determined by directly observing the state of the LED in the **brightly** lit laboratory.

(i) Draw the straight line of best fit on Fig 20.1 and determine the gradient of the line.

gradient = ... V m **[2]**

(ii) Use your answer in **(i)** and the equation on the page above to determine a value for h to 2 significant figures. Show your working.

h = ... J s **[3]**

(iii) Calculate the percentage difference between your value in **(ii)** and the accepted value of the Planck constant.

difference = ... % **[1]**

(iv) Identify the two types of errors shown by the data in Fig. 20.1 and suggest how you could have refined the experiment to reduce or eliminate these errors.

[4]

(b) Fig. 20.2 shows a gold-leaf electroscope with a clean zinc plate.

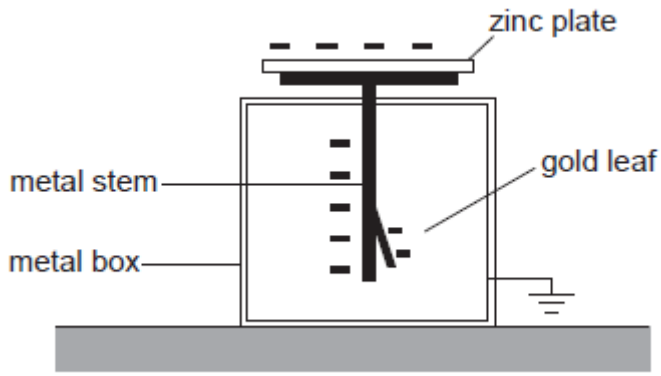

Fig. 20.2

The zinc plate, metal stem and the gold-leaf are given a negative charge by briefly connecting the zinc plate to the negative electrode of a high-voltage supply.

The gold leaf is fully diverged.

The position of the leaf is not affected by intense white light from a table lamp incident on the zinc plate. The gold leaf collapses very quickly when low-intensity ultraviolet radiation from a mercury lamp is incident on the zinc plate.

Explain these observations in terms of photons.

[4]

Total Marks for Question Set 17: 14

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