QUESTIONS AND ANSWERS

Contributions to this section, both Questions and Answers, are welcomed. Please submit four copies to the editorial office. Please include a *title* for each submission, include name and address at the end, and put references in the standard format used in the American Journal of Physics. For further suggestions, sample Questions and Answers, and requested form for both Questions and Answers, see Robert H. Romer, ''Editorial: 'Questions and Answers,' a new section of the American Journal of Physics,'' Am. J. Phys. **62** (6) 487–489 (1994).

Questions at any level and on any appropriate AJP topic, including the ''quick and curious'' question, are encouraged.

Question #53. Measuring Planck's constant by means of an LED

In a rather widespread lab experiment students determine Planck's constant by means of the $I-V$ characteristic (current versus voltage) of a light emitting diode. The experiment can also be found in the catalog of demonstration experiment producers. The method works as follows: A tangent is applied to the sharply rising part of the $I-V$ line of an LED. The intersection of this tangent with the V axis yields a voltage V_D. It is claimed that V_D is the diffusion voltage of the diode. The diffusion voltage is nearly equal to the bandgap energy divided by the electron charge e. Thus Planck's constant can be determined according to

$$h=\frac{eV_D}{f},$$

where f is the frequency of the emitted light and e the charge of the electron.

We don't understand why the above-mentioned intersection should be the diffusion voltage. The equation of the $I-V$ characteristic is

$$I(V)=I_0\left(\exp\frac{V}{V_t}-1\right),$$

where I_0 depends on the diffusion length of the minority carriers, the diffusion constant and the density of the minority carriers, and V_t stands for kT/e. The only characteristic voltage contained in the equation is V_t, which, of course, is not the diffusion voltage.

Moreover, if the intersection of a tangent at the $I-V$ characteristic with the V axis is calculated, any positive value can be obtained, according to which point on the curve is chosen for the tangent.

The strange thing is that Planck's constant comes out rather correctly. We did not find a reference where the procedure is explained convincingly. Can anybody help us?

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Answer to Question #29 [“
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