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NOTES AND DISCUSSIONS

Comment on the "One-dimensional hydrogen atom"

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The recent note by Gomes and Zimerman[1] misses the essential point about the potential $C|x|^{-1}$, namely, that the singularity at $x = 0$ isolates the region $x < 0$ from the region $x > 0$.[2] The singularity acts as an impenetrable barrier between the two regions so that any attempt to match solutions of the Schrödinger equation in these two regions at $x = 0$, or to talk about even or odd solutions, is futile. The only valid boundary condition to be imposed at $x = 0$ is that the wave functions must vanish there.

These remarks apply to all one-dimensional potentials $V(x)$ with a singularity at x_0 such that the potential is not integrable up to and across the singularity, but not so singular that

$$\int_{x_0} (x - x_0)|V(x)|dx$$

does not exist, in which case it is difficult to interpret the Schrödinger equation at all.

[1]J. F. Gomes and A. H. Zimerman, Am. J. Phys. **48**, 579 (1980).
[2]M. Andrews, Am. J. Phys. **44**, 1064 (1976).

Reply to "Comment on the 'One-dimensional hydrogen atom' "

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In reply to the recent note by M. Andrews,[1] his statement that we can not match the solutions[2] of the Schrödinger equation for the potential $|x|^{-1}$ in the regions $x > 0$, $x < 0$ because of the impenetrable barrier at the origin is not correct. It is a very general property of even potentials that the parity of the wave functions is either even or odd. So the problem of an even potential in the whole space $(-\infty < x < +\infty)$ with the boundary conditions $\psi(x\rightarrow \pm \infty) = 0$ can be considered in the half-space $(x \leq 0)$ or $(x \geq 0)$ with the condition $\psi(0) = 0$ for the odd wave functions and $\psi'(0) = 0$ for the even ones, without loss of generality.

In Ref. 2 we assume that the even function exists and, by making use of the virial theorem, we conclude that its eigenvalue diverges. This wave function is thus not physically acceptable.

[1]M. Andrews, Am J. Phys. **49**, 1074 (1981).
[2]J. F. Gomes and A. H. Zimerman, Am. J. Phys. **48**, 579 (1980).

Large-scale spring experiment

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Almost every undergraduate physics lab has at least one experiment dealing with the properties of springs. One reason for this popularity is that in a spring experiment several physics concepts, such as potential energy, kinetic energy, Hooke's law, and simple harmonic motion, come together. Another reason for the appeal of the spring experiment is that it is both inexpensive and easy to set up. A drawback is that for many students it is a rather dull experiment; it requires repetitious measurements on an often rather delicate piece of apparatus. The spring experiment described in this note is similar to the traditional one, but rather than using a small spring, a large heavy one is used and instead of placing gram weights on a tiny pan, the students themselves are used as weights. After about four years of experimenting with this big spring, the experiment is now a regular part of the lab exercises associated with our

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