Exercise sheet 3

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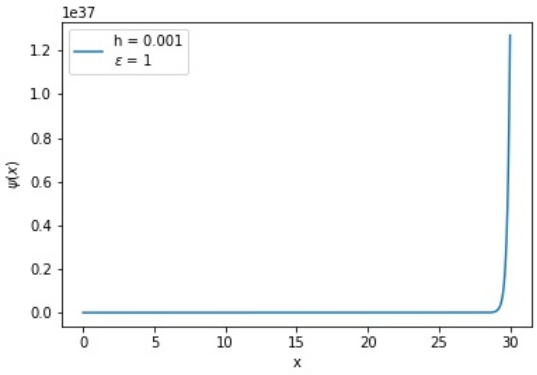
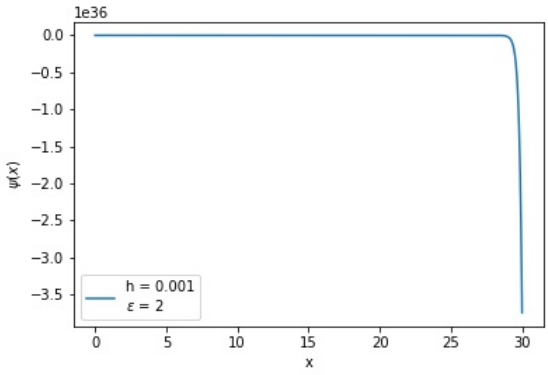
2. Neutrons in the gravitational field

1. Asymptotic behaviour

To observe the asymptotic behaviour of the Numerov-method, we plotted two solutions for $\epsilon = 1$ and $\epsilon = 2$ from $x = 0$ to $x = 30$ with a stepsize of $h = 0.001$. As one can clearly see, the values go to positive or negative infinity, depending on the value of ϵ.





2. Eigenvalues ϵ_n of Schrödinger's equation

In order to determine the eigenvalues ϵ_n of Schrödinger's equation we used the property, that they belong to normalizable eigenfuctions with $\psi(x) \to 0$ for $x \to \infty$. As one can see in part 1 of this exercise, the asymptote changes its sign from $\epsilon = 1$ to 2, this means there is an eigenvalue in between those values. With this approach we could determine the first four eigenvalues ϵ_n to 3 decimals after the comma. The values all have been found with a stepsize of $h = 0.001$ for the algorithm.

$$\epsilon_1 = 1.018$$
$$\epsilon_2 = 3.248$$
$$\epsilon_3 = 4.820$$
$$\epsilon_4 = 6.163$$

Extra: Solution for classical zone