CS 198-120 HW2

September 9, 2022

1 CS 198-120 HW2

In this homework, you will derive Bohr's model of simple atoms and particle in a box, but with some twist. You will also be asked to use your intuitions to predict some results that will be used later in the semester. If you are stuck on any problem, or have questions about them, feel free to contact me at binhan_hua@berkeley.edu or post questions on Ed. Make sure to check out the lecture notes for hints.

1.1 Question 1

1.1.1 Part a

Consider an atom with a positively charged nucleus and a negatively charged electron. If the world behaves completely classically (following Newton's Laws and Maxwell's Equations), how would be electron behave? How does the electron behave in the real world?

1.1.2 Part b

If the nucleus carries a charge of Ze, and the electron carries a charge of -e, what will be the force between them?

1.1.3 Part c

Give an equation desribing the speed of the electron by equating the centripetal force and the force between the nucleus and electron.

1.1.4 Part d

By assuming the quantization of angular momentum, $m_e vr = n\hbar$, where n is an integer, what is the equation describing the allowed radius of the electron?

1.1.5 Part e

Qualitatively, draw the energy states of the electron around this nucleus.

1.2 Question 2

1.2.1 Part a

What is "particle in a box" in the quantum world? How might it be unphysical?

1.2.2 Part b

Consider the potential $V(x)$, with $V(x) = 0$ from 0 to $2L$ and $V(x) = \infty$ everywhere else. Write out the Schrodinger's Equation where the potential is 0.

1.2.3 Part c

What are the boundary conditions at $x = 0$ and $2L$

1.2.4 Part d

Consider the set of solution $\psi(x) = Acos(kx) + Bsin(kx)$. Argue why we can get rid of the cosine portion of the solution.

1.2.5 Part e

What conditions must kx satisfy in order to meet the boundary condition at $x = 2L$?

1.2.6 Part f

Using the condition in part e, describe the allowed energy states of this system.

1.2.7 Part g

Qualitatively, draw the energy states of the system.

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