Quantum Technologies

Homework Solutions

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9th December, 2022

UNIVERSITÀ
DEGLI STUDI
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EMIMEO Programme

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Explanation and Introduction of this Document

I wrote this document for the students studying Quantum Technologies to have a nice set of notes, and correct reference code and graphs for the module. I hope that it is sufficient for this task and it helps all of your studies.
I spent have spent a lot of time developing the template used to make this LaTeX document, I want others to benefit from this work so the source code for this template is available on GitHub [?].

1 Homework One

1. In the Bohr's model of the Hydrogen atom, give an expression for:
   (a) The electron speed as a function of the orbit radius.
   (b) The total energy as a function of the orbit radius.
2. How many different photons could be emitted upon a transition from the n=5 down to the fundamental n=1 of an H atom.
   (a) Compute the exact frequency for one of the transitions.
3. A commercial (green) laser pointer has a max/output power, $P \leq 1mW$, and a beam spot, $w_0 = 1.1mm$, if $\lambda = 532nm$ is the wavelength of the light source, compute the following:
   (a) The pointer photon's flux; and,
   (b) The number of photons emitted in 10 sec when you purposely cover half of the exit hole with your finger. (Neglect divergence).
4. (a) Give the potential energy of a charge, q_2, located at point, r_2, due to the presence of a charge, q_1, located at a point, r_1.
   (b) Derive the force exerted on the charge, q_2, as due to the charge, q_1.
   (c) Discuss the two charge possibilities.
   (d) Apply the above results to the case of an electron placed at a distance, r, from a nucleus of a Hydrogen atom (Bohr's model).
   (e) Redo part (d.) for a nucleus of charge Z_e.

Extra: In a photoelectric experiment Ca is used as photo-cathode and the following values of stopping potential, V_s, vs wavelength, λ, are measured, using these values calculate the Planck constant, $\hbar$, and the work function, Φ.

2 Homework One

2.1 •

3 Homework Two

3.1 •

4 Homework Three

4.1 •

5 Homework Four

5.1 •

6 Homework Five

6.1 •

7 Homework Six

7.1 •

8 Homework Seven

8.1 •