

Exam quantum mechanics

June 2016

You can use the book. Be clear, what is not clear cannot be corrected. You can answer in Dutch, French or English. If you want a Dutch translation of the exam questions, feel free to ask. Good luck!

Short questions. [9ptn]

1. Derive that momentum is an hermitian operator both in position space-representation and momentum space-representation. [1pt]
2. If two conserved observables do not commute there is another conserved quantity. Why? Give an example. [1.5 pt]
3. Can the Schrödinger equation be used to explain planetary motion [2pt]?
4. Perturbation theory in quantum mechanics is based on expansions. Do these expansions need to converge. Explain your answer. [2pt]
5. Is the trace of xp_x equal to the trace of $p_x x$? [0.5pt]
6. Imagine a degenerate state and perturb the system with an Hamiltonian that respects the degeneracy. Should one use degenerate or non-degenerate perturbation theory? Explain your answer.[2pt]

Operator formalism [8 ptn].

- Consider a spin 1 particle. At $t = 0$ the system is in the eigenstate of S_x with $s_x = +1$, if subsequently S_y is measured. What is the possibility of finding $S_y = +1, -1$ or $S_y = 0$? [4ptn]
- Consider again that at $t = 0$ the system is in the eigenstate of S_x with $s_x = +1$. Then a constant magnetic field in the Y-direction is switched on with value m such that the Hamiltonian is mS_y with m a measure for the strength of the magnetic field. What is the unit of m ? Compute the exact time evolution of the state. [4ptn]

Perturbation theory [3 ptn]

Prove expression 8.38 in the book. You can make use of the previous equations in the book but refer to their numbers in case you use them.