I. Time-independent perturbation theory (degenerate case)

1. Task setup for time independent perturbation theory (degenerate case).

2. Write the general Schrodinger equation for perturbation theory in degenerate case. Helping parameter.

3. How is looks like the equation for first order approximation of perturbation theory (degenerate case)? Derive.

4. Derive the system of linear equations for first order corrections for energy and zero order correction for wave-function. Secular equation.

5. Stark effect. Derive a correction of energy and wavefunction.

6. Zeeman effect. Derive a correction of energy and wavefunction.

II. Time dependent perturbation theory

7. For equations $a)\ \hat{H}_0 \varphi_n^0 = E_n^0 \varphi_n^0$, $b)\ i\hbar \frac{d\,\psi_n^0}{dt} = \hat{H}_0\,\psi_n^0$ how is looks like the solution for equation b) in stationary case ? What about the relation for wavefunctions φ_n^0 and ψ_n^0 ? What about the representation of the wave function in the case of a time dependent perturbation $i\hbar \frac{d\,\psi_n}{dt} = (\hat{H}_0 + \hat{H}'(t))\,\psi_n$?

8. Equation for the time dependent expansion coefficients $C_m(t)$ of the total wave function. Representation of the solution of this equation in the form of expansion into a series of perturbation theory approximations. The relationship for these coefficients and the probability of an interlevel transition.

9. Probability of interlevel transitions for first order of perturbation theory approximation. The case of harmonic external perturbation. The "golden rule" of quantum mechanics. Relationship between the "golden rule" and spectroscopy.

10. Formula to can be used to evaluate the number of photons radiated by atom per one second (for transition n -> m). Derive and explain.

11. Calculation the probability of interlevel transition for harmonic oscillator and hydrogen atom in external electromagnetic wave by using “golden rule”. Selecton rules. (**vt. Loide raamat lk.120 §22.**)

12. Basic ideas about Einstein's theory of radiation. Induced and spontaneous transitions. What is the reason for spontaneous transitions? Do spontaneous transitions related to energy emission, absorption, or both? Relation between spontaneous and induced transitions (probabilities of transitions). (**vt. http://parsek.yf.ttu.ee/~physics/QM/Lectures/Textbook/qm_12.pdf osa I**)

13. What is the meaning of the theorem on the relationship between spin and statistics?

14. What the difference between classical Schrodinger and Klein-Gordon equations?

15. What the difference between classical Schrodinger and Dirac equations?

16. What is the point of representing the Dirac equation in matrix form? Why we have to use matrices?

17. How can we obtain a justification for the existence of spin in particles by using the Dirac equation?