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. A formula that can be used to estimate the number of photons emitted by an atom in one second (for the 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 the both transitions). (**vt. http://parsek.yf.ttu.ee/~physics/QM/Lectures/Textbook/qm_12.pdf osa I**)

13. Ehrenfest's theorem. Its connection with the classical equation of motion. Limitations on its application in classical physics.

14. The total energy of a particle in the relativistic case and the transition to the corresponding relativistic "Schrödinger" equation (Klein-Gordon and Dirac equations). Physical justification for the relationship between the Pauli spin matrices and the spin magnetic moment of fermions.
(http://parsek.yf.ttu.ee/~physics/QM/Lectures/Textbook/qm_12.pdf)