QM Spring98B

Consider the three-level system defined by the Hamiltonian H_0 with distinct eigenvalues ε_A, ε_B and ε_C, corresponding to the eigenstates $|A\rangle$, $|B\rangle$ and $|C\rangle$, respectively. This system is subject to a time-independent perturbation, H_1, with real matrix elements:

$$\langle A|H_1|A\rangle = \langle B|H_1|B\rangle = \langle C|H_1|C\rangle = 0$$

and

$$\langle A|H_1|B\rangle = \langle B|H_1|C\rangle = M; \text{ and } \langle A|H_1|C\rangle = 0$$

(a) Calculate the energy eigenvalues of the full Hamiltonian H_0+H_1 to second order in M (i.e., including terms of order M^2).

(b) Calculate the corrections to the state vectors $|A\rangle$, $|B\rangle$ and $|C\rangle$, to order M.

(c) Suppose now that the unperturbed states are degenerate, so that $\varepsilon_A, = \varepsilon_B = \varepsilon_C = \varepsilon$. Calculate the eigenvalues and eigenvectors of the full Hamiltonian to leading order in M.