Name

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Quiz 16

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1. **Non-degenerate Perturbation Theory**

$$E_n = E_n^{(0)} + E_n^{(1)} + E_n^{(2)} = \mathbf{H}_{nn}^{(0)} + \mathbf{H}_{nn}^{(1)} + \sum_m{}' \frac{\mathbf{H}_{nm}^{(1)}\mathbf{H}_{mn}^{(1)}}{E_n^{(0)} - E_m^{(0)}}$$

$$\psi_n = \psi_n^{(0)} + \psi_n^{(1)} = \sum_m{}' \frac{\mathbf{H}_{nm}^{(1)}}{E_n^{(0)} - E_m^{(0)}} \psi_n^{(0)}$$

Quasi-degenerate Perturbation Theory (Van Vleck transformation)

$$\mathbf{H}_P^{(2)} = \sum_{s,P'} \frac{\mathbf{H}_{ns}^{(1)}\mathbf{H}_{sm}^{(1)}}{\frac{E_n^{(0)} + E_m^{(0)}}{2} - E_s^{(0)}}$$ where n,m belong to P and s belongs to P′.

A. Use non-degenerate perturbation theory to find the eigenvalues and eigenvectors of $\begin{pmatrix} 0 & 5 \\ 5 & 20 \end{pmatrix}$.

B. Find the eigenvalues of the 2×2 matrix in part **A** by diagonalization.

C. Perform the Van Vleck transformation on

$$\mathbf{H} = \left(\begin{array}{cc|c} 0 & 0 & 10.02 \\ 0 & 1 & 14.18 \\ \hline 10.02 & 14.18 & 100.5 \end{array}\right)$$

D. If you were successful on part **C**, you would have obtained a matrix of the form

$$\mathbf{H}^{\text{eff}} = \begin{pmatrix} A & B & 0 \\ B & A & 0 \\ 0 & 0 & C \end{pmatrix} \qquad \text{where } |C| >> |A| + |B|.$$

What are the two lowest energy eigenvalues and eigenvectors of $\mathbf{H}^{\text{eff}}$? [**HINT**: You should be able to solve this problem by inspection!]