

5) $\psi^{(0)} = \psi(0) = \Phi \quad \because \Phi \text{ IS THE } \wedge \text{ EIGENFUNCTION OF ZERO-ORDER } H_0$
 $E_c^{(0)} = \langle \Phi | H_0 | \Phi \rangle = 0$ ground-state MODEL
 $E_c^{(1)} = \langle \Phi | V_c | \psi^{(0)} \rangle = \langle \Phi | V_c | \Phi \rangle = 0$

$$\begin{aligned} \psi^{(1)} &= \frac{1}{1!} \frac{\partial \psi(\lambda)}{\partial \lambda} \Big|_{\lambda=0} = \frac{1}{1!} \frac{\partial}{\partial \lambda} \left(\bar{\Phi} + R_0 (\lambda V_c - E(\lambda)) \psi(\lambda) \right) \Big|_{\lambda=0} \\ &= \frac{\partial}{\partial \lambda} \left(R_0 \lambda V_c \psi(\lambda) - E(\lambda) R_0 \psi(\lambda) \right) \Big|_{\lambda=0} \\ &= \left[\left(R_0 V_c \psi(\lambda) + R_0 \lambda V_c \frac{\partial \psi(\lambda)}{\partial \lambda} \right) - \left(\frac{\partial E(\lambda)}{\partial \lambda} R_0 \psi(\lambda) + E(\lambda) R_0 \frac{\partial \psi(\lambda)}{\partial \lambda} \right) \right] \Big|_{\lambda=0} \\ &= R_0 V_c \psi^{(0)} + 0 - \underbrace{\overset{0}{E^{(1)}}}_{\overset{0}{E^{(1)}}} \underbrace{R_0 \psi(0)}_{\overset{0}{R_0 \psi(0)}} - \underbrace{E(0)}_{\overset{0}{E(0)}} \underbrace{R_0 \psi^{(1)}}_{\overset{0}{R_0 \psi^{(1)}}} \\ &= R_0 V_c \bar{\Phi} + 0 - 0 - 0 \\ &= R_0 V_c \bar{\Phi} = \end{aligned}$$

$$\underbrace{\text{Diagram 1}}_{\text{Diagram 2} + \text{Diagram 3} + \dots} = \text{Diagram 4} = \frac{1}{2^2} \sum_{abij} \frac{\bar{g}_{ab}^{ij}}{\epsilon_{ab}^{ij}} \underbrace{\tilde{a}_{ij}^{ab} | \bar{\Phi} \rangle}_{| \bar{\Phi}_{ij}^{ab} \rangle}$$

Diagram 1: A horizontal line with two vertical lines intersecting it. Each intersection has a circle with a dot. Arrows point upwards from the bottom line to the circles.

Diagram 2: A horizontal line with two vertical lines intersecting it. Each intersection has a circle with a dot. Arrows point downwards from the top line to the circles.

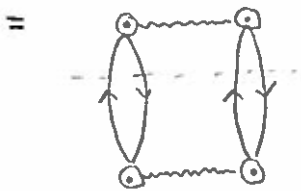
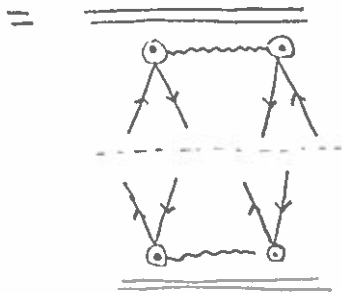
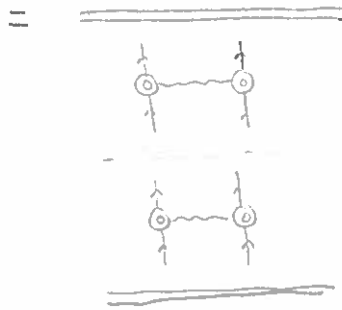
Diagram 3: A horizontal line with two vertical lines intersecting it. Each intersection has a circle with a dot. Arrows point upwards from the bottom line to the circles.

Diagram 4: A horizontal line with two vertical lines intersecting it. Each intersection has a circle with a dot. Arrows point downwards from the top line to the circles.

$$E_c^{(2)} = \frac{1}{2!} \left. \frac{\partial^2 E(\lambda)}{\partial \lambda^2} \right|_{\lambda=0}$$

$$= \langle \Phi | V_c | \Psi^{(1)} \rangle$$

$$= \langle V_c R_0 V_c \rangle$$



$$= \frac{1}{2^4} \sum_{ab, ij} \frac{\bar{g}_{ab}^{ij} \bar{g}_{ij}^{ab}}{\epsilon_{ab}^{ij}}$$

$$\psi^{(2)} = \frac{1}{2!} \frac{\partial^2}{\partial \lambda^2} \psi(\lambda) \Big|_{\lambda=0} = \frac{1}{2!} \frac{\partial^2}{\partial \lambda^2} \left(\Phi + R_0(\lambda V_c - E(\lambda)) \psi(\lambda) \right) \Big|_{\lambda=0}$$

$$= \frac{1}{2!} \frac{\partial}{\partial \lambda} \left(\frac{\partial}{\partial \lambda} \left(\Phi + R_0(\lambda V_c - E(\lambda)) \psi(\lambda) \right) \right) \Big|_{\lambda=0}$$

$$= \frac{1}{2!} \frac{\partial}{\partial \lambda} \left(R_0 V_c \psi(\lambda) + R_0 \lambda V_c \frac{\partial \psi(\lambda)}{\partial \lambda} - \frac{\partial E(\lambda)}{\partial \lambda} R_0 \psi(\lambda) - E(\lambda) R_0 \frac{\partial \psi(\lambda)}{\partial \lambda} \right) \Big|_{\lambda=0}$$

$$= \frac{1}{2!} \left(R_0 V_c \frac{\partial \psi(\lambda)}{\partial \lambda} + \left[R_0 V_c \frac{\partial \psi(\lambda)}{\partial \lambda} + R_0 \lambda V_c \frac{\partial^2 \psi(\lambda)}{\partial \lambda^2} \right] - \left[\frac{\partial^2 E(\lambda)}{\partial \lambda^2} R_0 \psi(\lambda) + \frac{\partial E(\lambda)}{\partial \lambda} R_0 \frac{\partial \psi(\lambda)}{\partial \lambda} \right] - \left[\frac{\partial E(\lambda)}{\partial \lambda} R_0 \frac{\partial \psi(\lambda)}{\partial \lambda} + E(\lambda) R_0 \frac{\partial^2 \psi(\lambda)}{\partial \lambda^2} \right] \right) \Big|_{\lambda=0}$$

$$= \frac{1}{2!} \left(R_0 V_c \psi^{(1)} + R_0 V_c \psi^{(1)} + R_0 \cdot 0 \cdot V_c \psi^{(2)} - E_c^{(2)} \cdot \underbrace{R_0 \cdot \psi^{(0)}}_0 - \underbrace{E_c^{(1)} \cdot R_0 \cdot \psi^{(1)}}_0 - \underbrace{E_c^{(1)} \cdot R_0 \cdot \psi^{(1)}}_0 - \underbrace{E_c^{(0)} \cdot R_0 \cdot \psi^{(2)}}_0 \right)$$

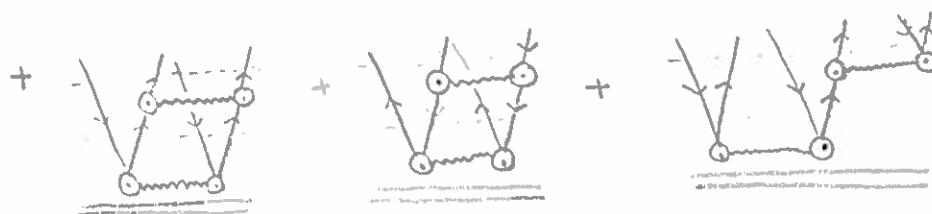
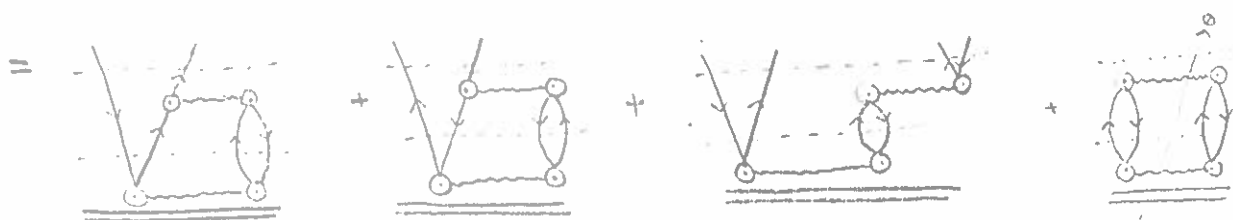
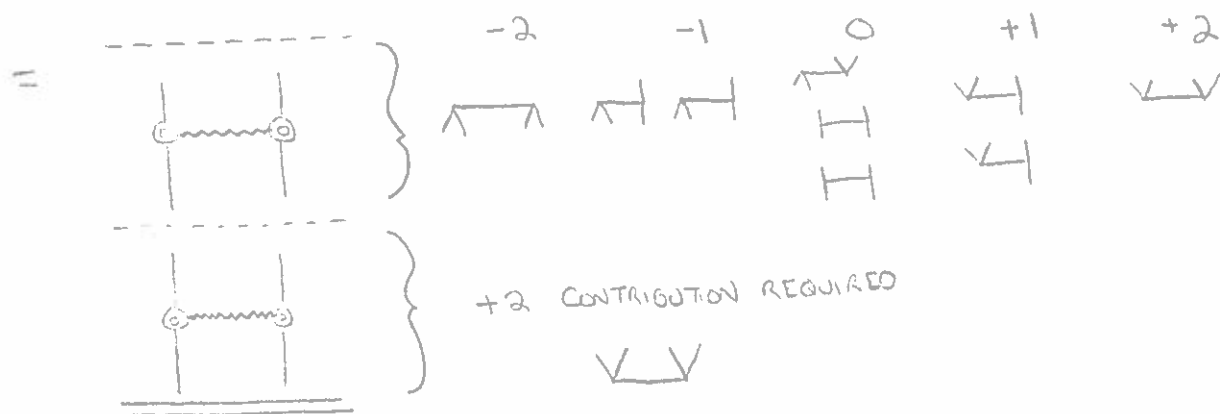
$$= \frac{1}{2!} \left(R_0 V_c \psi^{(1)} + R_0 V_c \psi^{(1)} + 0 - 0 - 0 - 0 - 0 - 0 \right)$$

$$= \frac{1}{2} \cdot (2 \cdot R_0 V_c \psi^{(1)})$$

$$= R_0 V_c \psi^{(1)}$$

$$= R_0 V_c R_0 V_c \Phi$$

$$\Psi^{(2)} = R_0 V_c R_0 V_c \bar{\Psi}$$



$$= \frac{1}{2} \sum_{\substack{a,b,c \\ \text{all}}} \text{diagram} + \frac{1}{2} \sum_{\substack{a,b,c \\ \text{all}}} \text{diagram} + \sum_{\substack{a,b,c \\ \text{all}}} \text{diagram}$$

$$+ \frac{1}{2^3} \sum_{\substack{a,b,c,d \\ \text{all}}} \text{diagram} + \frac{1}{2^3} \sum_{\substack{a,b,c,d \\ \text{all}}} \text{diagram} + \frac{1}{2^2} \sum_{\substack{a,b,c,d \\ \text{all}}} \text{diagram}$$

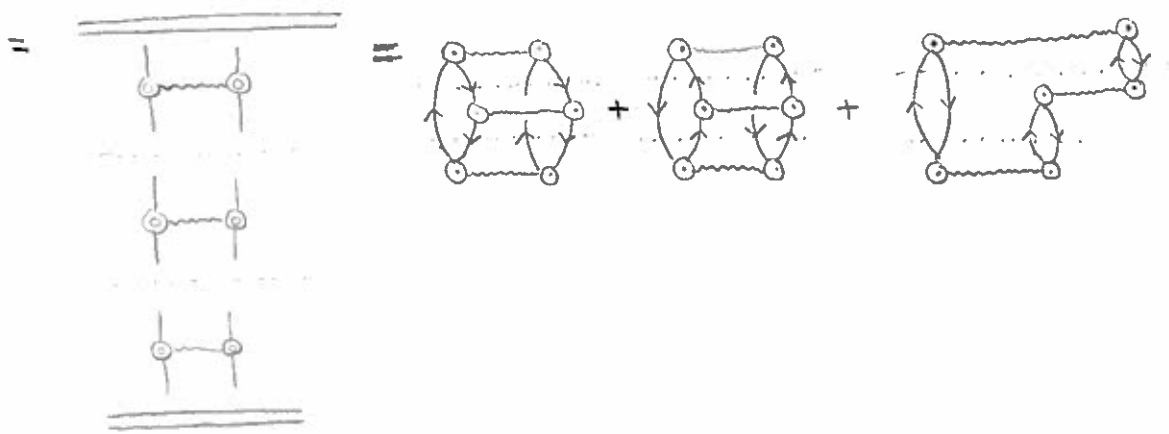
$$+ \frac{1}{2^2} \sum_{\substack{a,b,c,d \\ \text{all}}} \text{diagram} + \frac{1}{2^4} \sum_{\substack{a,b,c,d \\ \text{all}}} \text{diagram} = \longrightarrow$$

$$\begin{aligned}
&= \frac{1}{2} \sum_{\substack{abc \\ j}} \frac{\bar{g}_{bc}^{ij} \bar{g}_{aj}^{bc} \Phi_i^a}{\epsilon_a^i \epsilon_{bc}^{ij}} - \frac{1}{2} \sum_{\substack{ab \\ ijk}} \frac{\bar{g}_{ab}^{jk} \bar{g}_{jk}^{ab} \Phi_i^a}{\epsilon_a^i \epsilon_{ab}^{ij}} + \sum_{\substack{ijk \\ abc}} \frac{\bar{g}_{ac}^{ik} \bar{g}_{kj}^{cb} \Phi_{ij}^{ab}}{\epsilon_a^i \epsilon_c^k \epsilon_{ab}^{aj}} \\
&+ \frac{1}{2^3} \sum_{\substack{abcd \\ j}} \frac{\bar{g}_{cd}^{ij} \bar{g}_{ab}^{cd} \Phi_{ij}^{ab}}{\epsilon_a^i \epsilon_b^j \epsilon_{cd}^{cd}} + \frac{1}{2^3} \sum_{\substack{ijk \\ ab}} \frac{\bar{g}_{ab}^{jk} \bar{g}_{jk}^{ab} \Phi_{ij}^{ab}}{\epsilon_a^i \epsilon_b^j \epsilon_{ab}^{ab}} + \frac{1}{2^3} \sum_{\substack{ijk \\ abc}} \frac{\bar{g}_{ad}^{ij} \bar{g}_{bc}^{dk} \Phi_{ijk}^{abc}}{\epsilon_{abc}^{ijk} \epsilon_{ad}^{ad}} \\
&- \frac{1}{2^2} \sum_{\substack{ijkl \\ abc}} \frac{\bar{g}_{ab}^{ij} \bar{g}_{cd}^{kl} \Phi_{ijkl}^{abcd}}{\epsilon_{abc}^{ijk} \epsilon_{ab}^{ab}} + \frac{1}{2^4} \sum_{\substack{ijkl \\ abcd}} \frac{\bar{g}_{ab}^{ij} \bar{g}_{cd}^{kl} \Phi_{ijkl}^{abcd}}{\epsilon_{abcd}^{ijkl} \epsilon_{ab}^{ab}}
\end{aligned}$$

$E^{(n+1)}$ DEPENDS ONLY ON DOUBLES CONTRIBUTIONS TO $\Psi^{(n)}$

$$E^{(2)} = \langle \Phi | V_C | \Psi^{(2)} \rangle$$

$$= \langle V_C R_0 V_C R_0 V_C \rangle$$



$$= \frac{1}{2^3} \sum_{\substack{ijkl \\ ab}} \text{diagram 1} + \frac{1}{2^3} \sum_{\substack{ijkl \\ abc}} \text{diagram 2} + \sum_{\substack{ijkl \\ abc}} \text{diagram 3}$$

$$= \frac{1}{2^3} \sum_{\substack{ijkl \\ ab}} \frac{\bar{g}_{ab}^{kl} \bar{g}_{kl}^{ij} \bar{g}_{ij}^{ab}}{\epsilon_{ab}^{ij} \epsilon_{ab}^{kl}} + \frac{1}{2^3} \sum_{\substack{ijkl \\ abc}} \frac{\bar{g}_{ab}^{cd} \bar{g}_{cd}^{ab} \bar{g}_{ij}^{ab}}{\epsilon_{ab}^{ij} \epsilon_{cd}^{ij}} + \sum_{\substack{ijkl \\ abc}} \frac{\bar{g}_{ab}^{cd} \bar{g}_{kl}^{ij} \bar{g}_{ij}^{ab}}{\epsilon_{ab}^{ij} \epsilon_{ac}^{kl}}$$