5) $\psi^{(0)} = \Psi(0) = \Phi \quad \because \quad \Phi$ IS THE ground-state EIGENFUNCTION OF ZEROTH-ORDER H_0 MODEL

$$E_c^{(0)} = \langle \Phi | H_0 | \Phi \rangle = 0$$

$$E_c^{(1)} = \langle \Phi | V_c | \psi^{(0)} \rangle = \langle \Phi | V_c | \Phi \rangle = 0$$

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

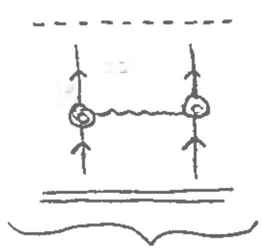
$$= \frac{\partial}{\partial\lambda}\Big(R_0 \lambda V_c \Psi(\lambda) - E(\lambda) R_0 \Psi(\lambda)\Big)\bigg|_{\lambda=0}$$

$$= \Bigg[\left(R_0 V_c \Psi(\lambda) + R_0 \lambda V_c \frac{\partial \Psi(\lambda)}{\partial\lambda}\right) - \left(\frac{\partial E(\lambda)}{\partial\lambda} R_0 \Psi(\lambda) + E(\lambda) R_0 \frac{\partial \Psi(\lambda)}{\partial \lambda}\right)\Bigg]\bigg|_{\lambda=0}$$

$$= R_0 V_c \psi^{(0)} + 0 - \overbrace{E^{(1)}}^{0} \overbrace{R_0 \Psi(0)}^{0} - \underbrace{E(0)}_{0} R_0 \psi^{(1)}$$

$$= R_0 V_c \Phi + 0 - 0 - 0$$

$$= R_0 V_c \Phi =$$



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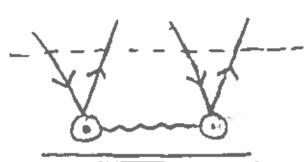
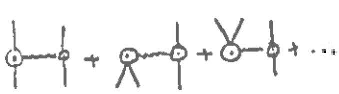


$$= \frac{1}{2^2} \sum_{abij} \frac{\bar{g}_{ab}^{ij}}{\varepsilon_{ab}^{ij}} \underbrace{\tilde{a}_{ij}^{ab} | \Phi \rangle}_{| \Phi_{ij}^{ab} \rangle}$$

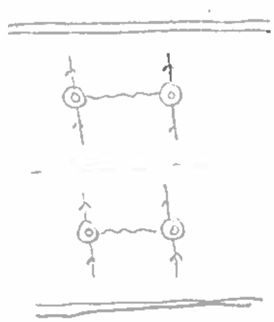


$$E_c^{(2)} = \frac{1}{2!} \left. \frac{\partial^2 E(\lambda)}{\partial \lambda^2} \right|_{\lambda=0}$$

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

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

$=$



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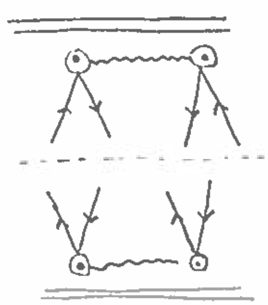

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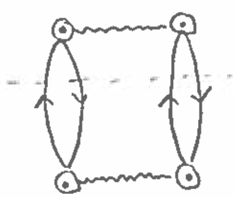


$$= \frac{1}{2^4} \sum_{abij} \frac{\bar{g}^{ij}_{ab} \, \bar{g}^{ab}_{ij}}{\varepsilon^{ij}_{ab}}$$

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

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

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

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

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

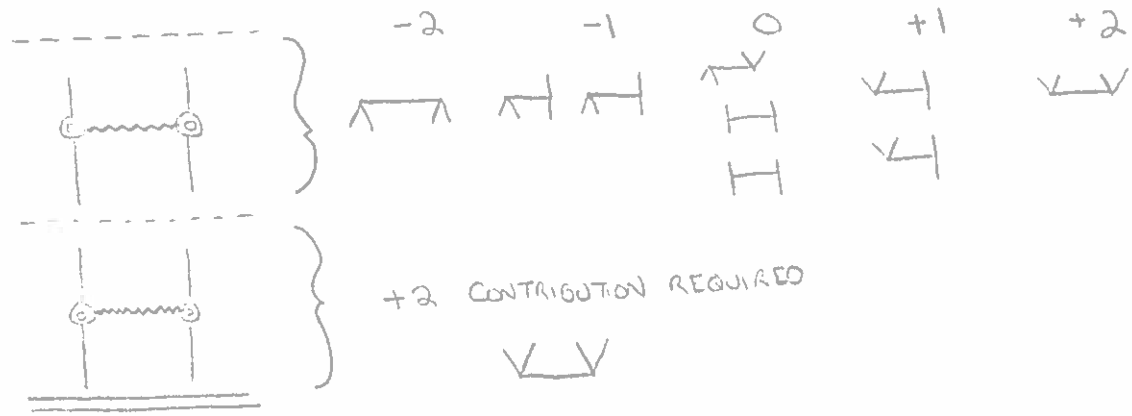
$$= \frac{1}{2!}\left(R_0 V_c \psi^{(1)} + R_0 V_c \psi^{(1)} + 0 - 0 - 0 - 0 - 0\right)$$

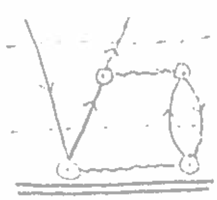
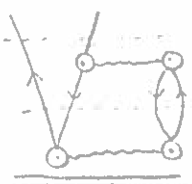
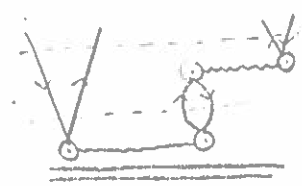
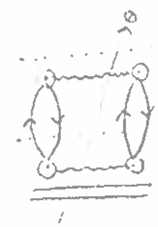
$$= \frac{1}{2}\cdot\left(2 \cdot R_0 V_c \psi^{(1)}\right)$$

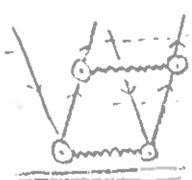
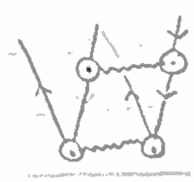
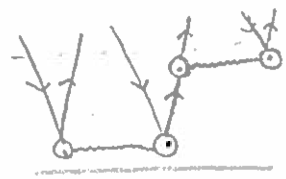
$$= R_0 V_c \psi^{(1)}$$

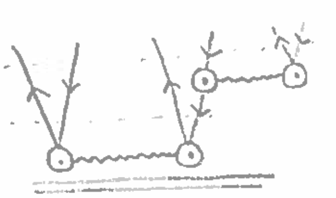
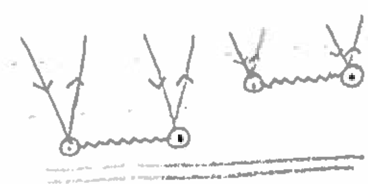
$$= R_0 V_c R_0 V_c \Phi$$

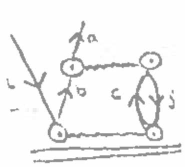
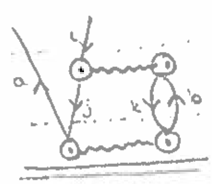
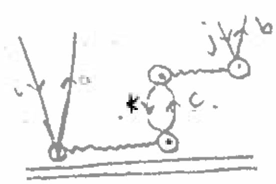
$$\Psi^{(2)} = R_0 V_c R_0 V_c \Phi$$

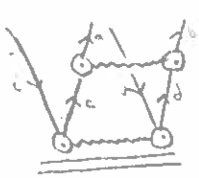
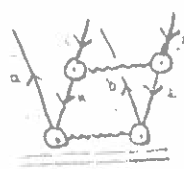
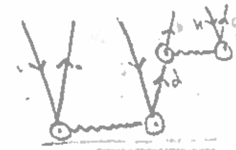
$=$ 

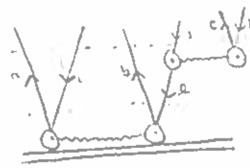
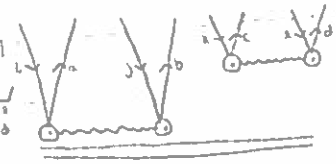
$=$  $+$  $+$  $+$ 

$+$  $+$  $+$ 

$+$  $+$ 

$= \frac{1}{2} \sum_{\substack{abc \\ ij}}$  $+ \frac{1}{2} \sum_{\substack{ab \\ ijk}}$  $+ \sum_{\substack{ijb \\ abc}}$ 

$+ \frac{1}{2^3} \sum_{\substack{abcd \\ ij}}$  $+ \frac{1}{2^3} \sum_{\substack{ab \\ ijkl}}$  $+ \frac{1}{2^2} \sum_{\substack{ijk \\ abcd}}$ 

$+ \frac{1}{2^3} \sum_{\substack{ijkl \\ abc}}$  $+ \frac{1}{2^4} \sum_{\substack{ijkl \\ abcd}}$  $= \longrightarrow$

$$
= \frac{1}{2}\sum_{\substack{abc\\ij}} \frac{\bar{g}^{ij}_{bc}\,\bar{g}^{bc}_{aj}\,\Phi^{a}_{i}}{\varepsilon^{i}_{a}\,\varepsilon^{ij}_{bc}} - \frac{1}{2}\sum_{\substack{ab\\ijk}} \frac{\bar{g}^{jk}_{ab}\,\bar{g}^{ib}_{jk}\,\Phi^{a}_{i}}{\varepsilon^{i}_{a}\,\varepsilon^{ij}_{ab}} + \sum_{\substack{ijk\\abc}} \frac{\bar{g}^{ik}_{ac}\,\bar{g}^{cb}_{kj}\,\Phi^{ab}_{ij}}{\varepsilon^{ik}_{ac}\,\varepsilon^{ij}_{ab}}
$$

$$
+ \frac{1}{2^3}\sum_{\substack{abcd\\ij}} \frac{\bar{g}^{ij}_{cd}\,\bar{g}^{cd}_{ab}\,\Phi^{ab}_{ij}}{\varepsilon^{ij}_{ab}\,\varepsilon^{ij}_{cd}} + \frac{1}{2^3}\sum_{\substack{ijkl\\ab}} \frac{\bar{g}^{kl}_{ab}\,\bar{g}^{ij}_{kl}\,\Phi^{ab}_{ij}}{\varepsilon^{ij}_{ab}\,\varepsilon^{kl}_{ab}} + \frac{1}{2^2}\sum_{\substack{ijk\\abcd}} \frac{\bar{g}^{ij}_{ad}\,\bar{g}^{dk}_{bc}\,\Phi^{abc}_{ijk}}{\varepsilon^{ijk}_{abc}\,\varepsilon^{ij}_{ad}}
$$

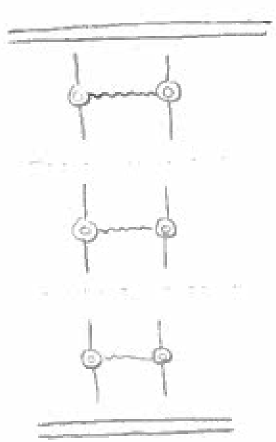
$$
- \frac{1}{2^2}\sum_{\substack{ijkl\\abc}} \frac{\bar{g}^{il}_{ab}\,\bar{g}^{jk}_{lc}\,\Phi^{abc}_{ijk}}{\varepsilon^{ijk}_{abc}\,\varepsilon^{il}_{ab}} + \frac{1}{2^4}\sum_{\substack{ijkl\\abcd}} \frac{\bar{g}^{ij}_{ab}\,\bar{g}^{kl}_{cd}\,\Phi^{abcd}_{ijkl}}{\varepsilon^{ijkl}_{abcd}\,\varepsilon^{ij}_{ab}}
$$

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

$$E^{(3)} = \langle \Phi | V_c | \Psi^{(2)} \rangle$$

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

=



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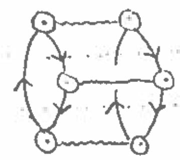

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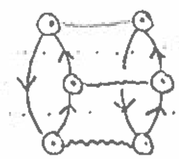

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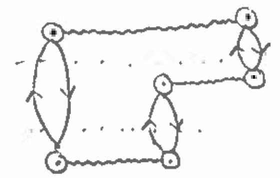
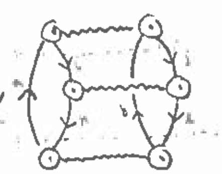
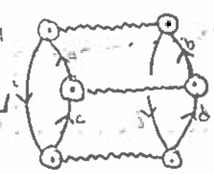


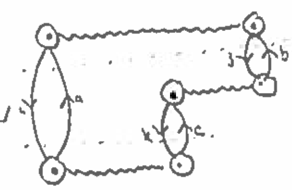
$= \frac{1}{2^3} \sum_{\substack{ijkl \\ ab}}$



$+ \frac{1}{2^3} \sum_{\substack{abcd \\ ij}}$



$+ \sum_{\substack{ijk \\ abc}}$



$$= \frac{1}{2^3} \sum_{\substack{ijkl \\ ab}} \frac{\bar{g}^{kl}_{ab} \bar{g}^{ij}_{kl} \bar{g}^{ab}_{ij}}{\varepsilon^{ij}_{ab} \varepsilon^{kl}_{ab}} + \frac{1}{2^3} \sum_{\substack{ijkl \\ ab}} \frac{\bar{g}^{ij}_{cd} \bar{g}^{cd}_{ab} \bar{g}^{ab}_{ij}}{\varepsilon^{ij}_{ab} \varepsilon^{ij}_{cd}} + \sum_{\substack{ijk \\ abc}} \frac{\bar{g}^{ik}_{ac} \bar{g}^{cj}_{kb} \bar{g}^{ab}_{ij}}{\varepsilon^{ij}_{ab} \varepsilon^{ik}_{ac}}$$