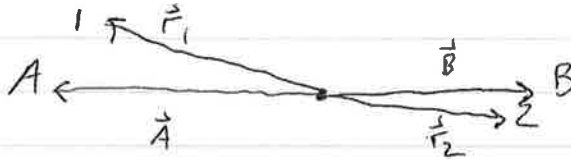


incomplete - need to do part c.

j9921



a.  $\psi_A(r_1)\psi_B(r_2) - \psi_A(r_2)\psi_B(r_1) \otimes \begin{cases} \uparrow\uparrow \\ \uparrow\downarrow + \downarrow\uparrow \\ \downarrow\downarrow \end{cases}$  triplet state

$\psi_A(r_1)\psi_B(r_2) + \psi_A(r_2)\psi_B(r_1) \otimes \begin{cases} \uparrow\downarrow - \downarrow\uparrow \end{cases}$  singlet state

b.  $\mathcal{H} = \frac{p_1^2}{2m} + \frac{p_2^2}{2m} + V(r_1 - A) + V(r_1 - B) + V(r_2 - A) + V(r_2 - B) - V(r_1 - r_2)$

$\mathcal{H}_1 = V(r_1 - B) + V(r_2 - A) - V(r_1 - r_2)$

where  $V(x) = -\frac{2g^2\hbar^2}{4\pi\epsilon_0 x}$

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$E_n^{(1)} = \frac{\langle \psi_n^0 | \mathcal{H}_1 | \psi_n^0 \rangle}{\langle \psi_n^0 | \psi_n^0 \rangle}$

$= \frac{2g^2\hbar^2}{4\pi\epsilon_0} \int (\psi_A^*(1)\psi_B^*(2) \pm \psi_A^*(2)\psi_B^*(1)) \left( \frac{-1}{|r_1 - B|} - \frac{1}{|r_2 - A|} + \frac{1}{|r_1 - r_2|} \right) (\psi_A(1)\psi_B(2) \pm \psi_A(2)\psi_B(1))$

$\int (\psi_A^*(1)\psi_B^*(2) \pm \psi_A^*(2)\psi_B^*(1)) (\psi_A(1)\psi_B(2) \pm \psi_A(2)\psi_B(1))$

$E_n^{(1)} = \frac{\int |\psi_A(1)\psi_B(2)|^2 + |\psi_A(2)\psi_B(1)|^2 \pm 2 \int \psi_A^*(1)\psi_B^*(2)\psi_A(2)\psi_B(1)}{\int \psi_A^*(1)\psi_B^*(2) \pm \psi_A^*(2)\psi_B^*(1)} (V)$

$E_n^{(1)} = \frac{a \pm c}{b \pm \Delta} + \begin{matrix} \text{singlet state} \\ \text{triplet state} \end{matrix}$

$E^S - E^T = \frac{a+c}{b+\Delta} - \frac{a-c}{b-\Delta} = \frac{b(abc) - a(abc) - b(a-c) - a(a-c)}{b^2 - \Delta^2}$

$E^S - E^T = \frac{2c(b+\Delta)}{b^2 - \Delta^2} = \frac{2c}{b-\Delta}$

where  $c = \frac{2g^2\hbar^2}{4\pi\epsilon_0} \int \psi_A(1)\psi_B(2)\psi_A(2)\psi_B(1) \left( \frac{-1}{|r_1 - B|} - \frac{1}{|r_2 - A|} + \frac{1}{|r_1 - r_2|} \right) d^3r_1 d^3r_2$

$\Delta = 2 \int \psi_A(1)\psi_B(2)\psi_A(2)\psi_B(1) d^3r_1 d^3r_2$