For the problems below use three-dimensional Gaussian wavefunctions $\phi_a(x) \simeq e^{(x-a)^2/2\sigma^2}$. Define $\Psi_\pm(x,y) = \frac{1}{\sqrt{2}}((\phi_a(x)\phi_b(y) \pm \phi_a(y)\phi_b(x)))$.

1. Compute

$$\int d^3x \int d^3y \quad \Psi_\pm(x,y) (x-y) \Psi_\pm(x,y)$$

Plot the ratio of the exchange integral to the direct integral as a function of $|b-a|/\sigma$.

2. Compute

$$\int d^3x \int d^3y \quad \Psi_\pm(x,y) \frac{1}{|x-y|} \Psi_\pm(x,y)$$

Plot the ratio of the exchange integral to the direct integral as a function of $|b-a|/\sigma$. 