

Homework 3

Due in class Wednesday, Feb. 8

From the text: 3-20

1. Consider two ground state hydrogen atoms interacting via

$$V(r) = De^{-\alpha(r-r_0)}[e^{-\alpha(r-r_0)} - 2].$$

This is a Morse potential and only approximates the real H+H interaction for

$$D = 0.174$$

$$\alpha = 1.1$$

$$r_0 = 1.4.$$

All of these quantities are given in atomic units (*i.e.* $\hbar = e = m_e = 1$). Make sure all calculations below are accurate to at least 0.1%.

- (a) Is its asymptotic behavior physical — that is, does it correctly reproduce the real asymptotic behavior expected for the H+H potential?
- (b) What are the conditions for circular orbits for $\ell=0$ and $\ell > 0$ where ℓ is the orbital angular momentum? Describe the orbit for each case.
- (c) For small displacements from circular orbits, what is the period of radial oscillations? Are the resulting orbits closed?
- (d) For an energy of $-D/4$, plot orbits corresponding to $\ell=0$ and one value of ℓ such that $\ell > 0$.