Error analysis is required for all relationships that use experimental data with error bars.

1. What is the minimum photon energy required to dissociate $^2$H? You must account for recoil! Discuss what happens to the electron.

\[
B_D = 2.224526624(39) \text{ MeV} \quad \text{Binding energy of the Deuteron}
\]
\[
M(^2H) = 2.014101778(4)u \quad \text{MeV/c}^2 \quad \text{Atomic Mass of (H)}
\]
\[
u = 931.494061(21) \quad \text{MeV/c}^2 \quad \text{Atomic Mass Unit}
\]

2. Solve the Schrödinger equation for the deuteron, and obtain its normalized wavefunction. Assume it has no orbital or spin angular momentum, and that it has a single bound state in a potential of the form:

\[
V(r) = -V_0 \theta(R_N - r).
\]

What the expression used to determine $\langle r^2 \rangle$. Please leave it in the form of two integrals. For extra credit, prove the that solution for $\langle r^2 \rangle$ given on Slide 21 of the Lecture 11 notes is either correct, or incorrect.

From the typeset notes, Lecture 11, Slides 17 – 21. The complete solution can be seen there.

3. Using the potential and wavefunctions from the previous problem, find an expression for $\langle V \rangle$.

4. Prove each one of these steps, directly, for extra credit (This is a "pretty tough" problem.):

\[
\langle T \rangle = \frac{\hbar^2}{2m} \int_0^\infty d\vec{x} \left| \frac{d\psi}{dr} \right|^2 = \frac{\hbar^2}{2m} \int_0^\infty dr \left| \frac{du(r)}{dr} \right|^2 = |A|^2 R_N \frac{\hbar^2 k^2}{2m} = \beta \left( \frac{\hbar^2}{1 + \beta^2 \frac{2mR_N^2}{\alpha^2}} \right)
\]

Then, show that

\[
\langle T \rangle + \langle V \rangle = E,
\]

as expected.

5. Krane, Problem 5.1, p. 157. Verify your results with the spin and parity assignments given by Krane, and/or databases. Discuss.
