phys522: HW #3

1. The deutron is weakly bound, so only the ground state exits. Consider a 3D spherical well potential model,

   $V(r) = -V_0$ for $r < a$ and $V(r) = 0$ for $r > a$

   Substitute $R(r) = u(r)/r$ and obtain the radial equation for u. Solve to obtain two transcendental equations. Show that the ground state has $u(r) \to r$ as $r \to 0$. Prove that if this were not the case, ψ would not be a solution to the Schrodinger equation.

   Using a graphical solution, find a condition for a bound state to exist. Assuming that E is only slightly less than zero for the deutron, use the experimental value of $a = 1.7$ fm to determine V_0. Find the value of the exponenial decay length (in nm) for the wave function for $r > a$.

2. The deueron has spin 1 and isospin 0. For the di-nucleon ground state, treat the nucleons as identical particles and write the antisymmetrized wave fuctions.

   Refer to the meson theoretic potential given in class. Show that the deuteron potenial is a factor of three larger than the di-neutron potential. Then since the deuteron binding is weak, the di-neutron is not bound.