An-Najah National University
Faculty of Science-Department of Physics
Nuclear Physics 22462
Summer 2013
1^{st} Exam, June 9^{th} 2013

Name: _____

Number: _____

1. Two spin-$\frac{1}{2}$ particles one has $l_1 = 2$ and the other one has $l_2 = 3$.
   (a) (5 points) What are the possible values of $I = j_1 + j_2$
   (b) (5 points) What is the parity of the system made of the two particles.

2. The binding energy of a nucleus is given through the semi-empirical formula, which is given by the following equation:

$$B.E(Z, A) = a_v A - a_s A^{2/3} - a_c Z(Z-1)A^{-1/3} - a_{sym}\frac{(A-2Z)^2}{A}$$

   (a) (5 points) What is the physical meaning of each term. Give a detailed explanation.
   (b) (10 points) Given that $a_v = 15.5$ MeV, $a_s = 16.8$ MeV, $a_c = 0.72$ MeV and $a_{sym} = 23$ MeV. Calculate the binding energy for $^{19}_{9}$F

3. (a) (5 points) The neutron, although a neutral particle, it still has a non-zero magnetic moment.
   (b) (5 points) What are the observations that support our conclusion that the deuteron wave-function is a linear combination of $l = 0$ and $l = 2$ states.
   (c) (5 points) What does the sign of the phase shift represent.
   (d) (5 points) The deuteron, which is made of one proton and one neutron, has no excited states. Why there is no bound states for a system made of two neutrons or two protons

4. (20 points) Assuming that the following nuclei has a spherical shape; give the predicted one particle shell model spin and parity:
   A. $^{21}_{11}$Na B. $^{17}_{8}$O C. $^{42}_{20}$Ca D. ^{31}P

5. (10 points) Use the following formulas:

$$< \mu >= [g_l(j - \frac{1}{2}) + \frac{1}{2}g_s]\mu_N,\ j = l + \tfrac{1}{2}$$

$$< \mu >= [g_l\frac{j(j+\frac{3}{2})}{(j+1)} - \frac{1}{2}\frac{1}{j+1}g_s]\mu_N,\ j = l - \tfrac{1}{2}$$

   Use $g_{s,n} = -2.29$, $g_{s,p} = 3.348$, to calculate the magnetic dipole moment for the following Nuclei, and what is the value of j and l used fir your calculation.
   (a) (5 points) ^{75}Ge, Z = 32, $I^{\pi} = \frac{1}{2}^{-}$
   (b) (5 points) ^{47}Sc, Z = 21, $I^{\pi} = \frac{7}{2}^{-}$

Question	Points	Score
1	10	
2	15	
3	20	
4	20	
5	20	
Total:	85	

Good Luck