QUANTUM MECHANICS II

PHYS 517

Problem Set # 2

Distributed: April 10, 2015

Due: April 17, 2015

1. Atomic Physics: Write down the electronic ground state configuration of:

a. He

b. Ne

c. Ar

d. O

e. Fe

2. Nuclear Physics: Write down the nuclear ground state configuration of:

a. ${}^{4}_{2}He$

b. ${}^{16}_{8}O$

c. ${}^{40}_{20}Ca$

d. ${}^{56}_{26}Fe$

e. ${}^{13}_{6}C$

3. Nuclear Isobars: Write down the nuclear ground state configurations of Fe, Co, Ni with $A = N + Z = 57$. For each, what is the ground state spin and parity? What do these quantum numbers tell you about the Nuclear Shell Model?

4. Particles: Here are some particle data:

	(2010)	(1970)
Δ^{++}	1231.2 ± 0.6	1231 ± 10
Δ^{+}	1233.0 ± 1.5	1233 ± 10
Δ^{0}	1233.7 ± 0.6	1235 ± 10
Δ^{-}	1244.1 ± 2.0	1237 ± 10
Σ^{+}	1382.8 ± 0.4	1381 ± 11
Σ^{0}	1383.7 ± 1.0	1385 ± 11
Σ^{-}	1387.2 ± 0.5	1389 ± 11
Ξ^{0}	1531.8 ± 0.3	1530 ± 15
Ξ^{-}	1535.0 ± 0.6	1540 ± 15
Ω^{-}	1672.4 ± 0.3	1670 ± 10

a. Plot the lightest nine particles in an energy level diagram in a 'sensible' way.

b. Before 1964 the tenth particle had not been observed. Assuming you were writing your Ph.D. thesis in 1963, and your thesis advisor demanded that you earn a Nobel in a couple of years, what physical parameters would you guess for this as-yet unobserved particle?

c. Assume that you could associate each of these particles with a state in a 3D harmonic oscillator with three excitations ($|n_1, n_2, n_3\rangle, n_1+n_2+n_3 = 3$), how might you make this assignment?

d. Propose a simple hamiltonian to account for this spectrum of levels.

e. Use the 1970 data to fit the parameters of your model.

f. Use a simple statistical test to reject or "accept" (*much* better: fail to reject) your model.