Quantum II HW2

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April 21, 2015

1 Problem 1

Electronic configurations of
a. He(Z=2) $1s^2$
b. Ne(Z=10) $1s^2 2s^2 2p^6$
c. Ar(Z=18) $1s^2 2s^2 2p^6 3s^2 3p^6$
d. O (Z=8) $1s^2 2s^2 2p^4$
e. Fe (Z=26) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^6$

2 Problem 2

Nuclear configuration of:
a) ${}^{4}_{2}He$: Protons(2):$1s^{(2)}_{1/2}$ Neutrons(2): $1s^{(2)}_{1/2}$
b) ${}^{16}_{8}O$: Protons(8): $1s^{(2)}_{1/2}\ 1p^{(4)}_{3/2}\ 1p^{(2)}_{1/2}$ Neutrons(8): $1s^{(2)}_{1/2}\ 1p^{(4)}_{3/2}\ 1p^{(2)}_{1/2}$
c) ${}^{40}_{20}Ca$ Protons (20): $1s^{(2)}_{1/2}\ 1p^{(4)}_{3/2}\ 1p^{(2)}_{1/2}\ 1d^{(6)}_{5/2}\ 2s^{(2)}_{1/2}\ 1d^{(4)}_{3/2}$
Neutrons (20):$1s^{(2)}_{1/2}\ 1p^{(4)}_{3/2}\ 1p^{(2)}_{1/2}\ 1d^{(6)}_{5/2}\ 2s^{(2)}_{1/2}\ 1d^{(4)}_{3/2}$
d) ${}^{56}_{26}Fe$ Protons (26): $1s^{(2)}_{1/2}\ 1p^{(4)}_{3/2}\ 1p^{(2)}_{1/2}\ 1d^{(6)}_{5/2}\ 2s^{(2)}_{1/2}\ 1d^{(4)}_{3/2}\ 1f^{(6)}_{7/2}$
Neutrons (30): $1s^{(2)}_{1/2}\ 1p^{(4)}_{3/2}\ 1p^{(2)}_{1/2}\ 1d^{(6)}_{5/2}\ 2s^{(2)}_{1/2}\ 1d^{(4)}_{3/2}\ 1f^{(8)}_{7/2}\ 2p^{(2)}_{3/2}$
e) ${}^{13}_{6}Ca$ Protons (6): $1s^{(2)}_{1/2}\ 1p^{(4)}_{3/2}$ Neutrons (7): $1s^{(2)}_{1/2}\ 1p^{(4)}_{3/2}\ 1p^{(1)}_{1/2}$

3 Problem 3

The ground state configurations for the three atoms are:
a) ${}^{57}_{26}Fe$: Protons (26) valence $1f^{(6)}_{7/2}$ Neutrons (31): valence $2p^{(3)}_{3/2}$

b) ${}^{57}_{27}Co$ Protons (27) valence $1f^{(7)}_{7/2}$ Neutrons (30): valence $2p^{(2)}_{3/2}$
c) ${}^{57}_{28}Ni$ Protons (28) "valence" $1f^{(8)}_{7/2}$(full) Neutrons (29): valence $2p^{(1)}_{3/2}$

So ${}^{57}_{26}Fe$ has a nuclear spin of $\frac{3}{2}$ and a parity of $(-1)^\ell = -1$ determined by the highest odd nucleon (the last neutron).
${}^{57}_{27}Co$ has a nuclear spin of $\frac{7}{2}$ and a parity of $(-1)^\ell = -1$ determined by the highest odd nucleaon (the last proton).
${}^{57}_{28}Ni$ has a nuclear spin of $\frac{3}{2}$ and a parity of $(-1)^\ell = -1$, determined entirely by the single valence neutron.

4 Problem 4