Q: For ℓ=0, how does $\langle 1/r_{nl} \rangle$ scale with n

A. n^{-1}
B. n^{-2}
C. n^{-3}

Q: For ℓ=0, how does $|\psi(0)|^2$ scale with n

A. n^{-1}
B. n^{-2}
C. n^{-3}
D. n^{-6}

Q: In helium, for the same electronic configuration, are triplet or singlet states more tightly bound

A: Singlet
B: Triplet

Q: The difference between triplet and singlet binding energy (exchange energy) has its origin in

A: Magnetic energy
B: Spin-spin interactions
C: Electrostatic interactions

Q: Which interaction reflects that the potential between nucleus and electron is not exactly an 1/r potential?

A. The Darwin term
B. The Lamb shift
C. The volume isotope effect
D. A, B, C
E. B, C

Q: The fine structure adds a term ( )LS to the Hamiltonian and affects only states with L $\neq$0.

A. True
B. False

Q: For L$\neq$0, the orbiting electron creates a magnetic field. Spin-orbit interaction is the energy of the electron's spin in this magnetic field.

A. True
B. False

Q: In Dirac theory, which states are degenerate?

A. 2 $P_{1/2}$ and 2 $P_{3/2}$
B. 2 $S_{1/2}$ and 2 $P_{3/2}$
C. 2 $S_{1/2}$ and 2 $P_{1/2}$

Q: The degeneracy is lifted by

A. The Lamb shift
B. The size of the proton
C. The mass of the proton
D. A and B
E. A, B, C

Hyperfine structure of hydrogen

Q: At high magnetic fields, what are the magnetic moments of those HF states in units of μ_B?

A: 1, 1, -1, -1
B: 1, 0, -1, 0
C: ½, 0, 0, ½
D: 0, 0, 0, 0

Q: At low magnetic fields, what are the magnetic moments of those HF states?

A: 1, 1, -1, -1
B: 1, 0, -1, 0
C: ½, 0, 0, ½
D: 0, 0, 0, 0

Hyperfine structure of positronium

Q: How many hyperfine states does the 1s state have?

A: 1
B: 2
C: 3
D: 4

Q: At high magnetic fields, what are the magnetic moments of those HF states in units of μ_B?

A: 1, 1, -1, -1
B: 1, 0, -1, 0
C: 2, 1, -1, -2
D: 2, 0, 0, -2

Q: At low magnetic fields, what are the magnetic moments of those HF states?

A: 0, 0, 0, 0
B: 1, 0, -1, 0
C: 2, 1, -1, -2
D: 2, 0, 0, -2