a) What is the value of the **maximum** possible total angular momentum quantum number \( j \) for a configuration with three optically active electrons of quantum numbers \( l_1 = 0, l_2 = 1, l_3 = 2 \)?

**ANSWER:**

The total angular momentum is given by 
\[
j = \ell + s
\]
where \( \ell \) is the orbital angular momentum and \( s \) is the spin angular momentum. (Note that, to an extent, \( \ell \) and \( s \) can be viewed as magnitudes, while \( m_\ell \) and \( m_s \) as directions.)

The maximum total orbital angular momentum is just \( 0 + 1 + 2 = 3 \). 

The maximum spin angular momentum is just \( 1/2 + 1/2 + 1/2 \) because one has three electrons. Electrons are fermions that have spin \( 1/2 \).

Thus, the maximum total angular momentum is \( j = 3 + 3/2 = 9/2 \).

b) What are the possible values of the total electronic angular momentum quantum number in a 3\( ^1 \)D state of the helium atom?

**ANSWER:**

Spectroscopic notation is given by \( n^{2s+1}L_j \), and it’s actually quite useful when one is dealing with multiple particles. Recall, \( L \) is equivalent to \( (S, P, D, F) \), respectively, for orbital angular momentum values of \( 0, 1, 2, 3 \). \( s=1/2 \) for electrons. \( j \) is the total angular momentum.

Knowing the convention, one can plug in numbers to solve \( 1 = 2s + 1 \Rightarrow s = 0 \). Since the main-script is a \( D \), \( \ell = 2 \). The total angular momentum is \( j = s + \ell = 0 + 2 = 2 \). This is the only allowed value.

c) Write down the ground state electron configuration for phosphorus, which has 15 electrons.

**ANSWER:**

Following the conventions we know about electron configuration, and making sure that the superscripts add to 15, we find:

\( 1s^22s^22p^63s^23p^3 \)