DYSPROSIUM ELECTRON CONFIGURATION

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The rare-earth element dysprosium has atomic number 66, and its ground state is listed as \( ^5I_8 \). This means that \( S = 2 \), \( L = 6 \) (since after \( F = 3 \), the labels go in alphabetical order, so \( G = 4 \), \( H = 5 \) and \( I = 6 \)), and \( J = 8 \). This isn’t enough information on its own to determine the electron configuration since the outer shells don’t fill in strict order of \( n \) and \( L \) due to shielding effects. For these shells, the \( s \) shell of level \( n + 1 \) is filled before the \( p \) shell of level \( n \), and the \( d \) shell of \( n + 1 \) before the \( p \) of \( n \) and so on. Given the maximum populations of the various shells (\( s \) has a maximum of 2, \( p \) of 6, \( d \) of 10 and \( f \) of 14), a possible configuration for dysprosium is

\[
\begin{align*}
(1s)^2 & \quad (2s)^2 & \quad (2p)^6 & \quad (3s)^2 & \quad (3p)^6 & \quad (4s)^2 & \quad (4p)^6 & \quad (3d)^{10} & \quad (4p)^6 & \quad (5s)^2 & \quad (4d)^{10} & \quad (5p)^6 & \quad (6s)^2 & \quad (4f)^{10}
\end{align*}
\]

We can check this against the given values. The last shell \((4f)\) contains 10 out of a possible 14 electrons. According to Hund’s first rule, these should be arranged to give the maximum possible spin, which would mean 3 pairs and 4 unpaired electrons with parallel spin. This gives \( S = 4 \times \frac{1}{2} = 2 \) which matches the listing above. The value of \( L \) is difficult to check, since it depends on symmetry requirements which would be difficult (though possible, if you’re persistent) to calculate for the 4 unpaired electrons. However, the 4 unpaired electrons in the \(4f\) shell have a maximum possible \( L \) of \( L = 12 \), so \( L = 6 \) is certainly possible. Having \( L \) and \( S \), we can apply Hund’s third rule which in this case says that \( J = L + S \) since the last shell is more than half full.