Quantum Numbers of Aluminium Ionization

https://gemini.google.com/app/d13b47fef19a3176

Response: Element X has 13 protons, which corresponds to Aluminium (Al).

Ground-State Electron Configuration

- Neutral Al ($Z = 13$): $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^1$

Order of Electron Removal

- **1st Ionization:** Removes the outermost electron from the $3p$ subshell ($3p^1 \rightarrow 3p^0$).
- **2nd Ionization:** Removes the first electron from the $3s$ subshell ($3s^2 \rightarrow 3s^1$).
- **3rd Ionization:** Removes the second electron from the $3s$ subshell ($3s^1 \rightarrow 3s^0$).
- **4th Ionization:** Removes an electron from the core $2p$ subshell ($2p^6 \rightarrow 2p^5$).

Quantum Numbers for the 4th Removed Electron Since the 4th ionization removes an electron from a $2p$ orbital:

- Principal quantum number: $n = 2$
- Azimuthal quantum number: $l = 1$ (for a p orbital)
- Magnetic quantum number: $m_l \in \{-1, 0, +1\}$
- Spin quantum number: $m_s = +\frac{1}{2}$ or $-\frac{1}{2}$

Evaluating the given options:

- **(1)** $n = 3, l = 0, m_l = 0, m_s = +\frac{1}{2}$ — Represents a $3s$ electron (2nd or 3rd ionization).
- **(2)** $n = 2, l = 1, m_l = 2, m_s = +\frac{1}{2}$ — Invalid set because m_l cannot exceed l ($m_l = 2$ is impossible when $l = 1$).
- **(3)** $n = 2, l = 1, m_l = 0, m_s = +\frac{1}{2}$ — Valid set representing a $2p$ electron.
- **(4)** $n = 3, l = 2, m_l = 1, m_s = +\frac{1}{2}$ — Represents a $3d$ electron.
- **(5)** $n = 2, l = 0, m_l = 0, m_s = -\frac{1}{2}$ — Represents a $2s$ electron.

The correct choice is **(3)**.
