

Evaluating Valid Quantum Numbers

<https://gemini.google.com/app/d4fbe7ba5a4479ad>

Response: To determine the valid set of quantum numbers (n, l, m_l, m_s) , each quantum number must follow these rules:

- **Principal quantum number (n):** Must be a positive integer ($n = 1, 2, 3, \dots$).
- **Azimuthal quantum number (l):** Must be an integer ranging from 0 to $n - 1$.
- **Magnetic quantum number (m_l):** Must be an integer ranging from $-l$ to $+l$.
- **Spin quantum number (m_s):** Must be either $+\frac{1}{2}$ or $-\frac{1}{2}$.

Evaluation of Options

- **(1) $(1, 2, -2, 0)$**
 - **Invalid:** $l = 2$ is not allowed for $n = 1$ (maximum allowed value is $l = 0$). Also, $m_s = 0$ is invalid.
- **(2) $(1, 1, 0, 1/2)$**
 - **Invalid:** $l = 1$ is not allowed for $n = 1$ (maximum allowed value is $l = 0$).
- **(3) $(2, 1, 0, 0)$**
 - **Invalid:** $m_s = 0$ is not a valid spin quantum number.
- **(4) $(3, 2, -3, -1/2)$**
 - **Invalid:** For $l = 2$, m_l must be between -2 and $+2$, so $m_l = -3$ is invalid.
- **(5) $(2, 1, -1, -1/2)$**
 - **Valid:**
 - $n = 2$ (positive integer)
 - $l = 1$ ($0 \leq l \leq 1$)
 - $m_l = -1$ (between -1 and $+1$)
 - $m_s = -1/2$ (valid spin value)

Correct Answer: (5)
