

What Are Quantum Numbers?

Worksheet

Quantum numbers are four values that specify an electron's state: n (principal, energy level/shell), l (azimuthal, subshell shape: s,p,d,f), m (magnetic, orbital orientation), and m_s (spin, + or -).

Questions

1. For $n = 2$, which values can l take?

- A) 0 only
- B) 0 and 1
- C) 0, 1, and 2
- D) 1 and 2

2. What is the maximum number of electrons in a p subshell ($l=1$)?

- A) 2
- B) 6
- C) 10
- D) 14

3. Which quantum number describes electron spin?

- A) n
- B) l
- C) m
- D) m_s

4. According to the Pauli exclusion principle, two electrons in the same orbital must have

- A) The same n and l only
- B) Different m values
- C) Opposite spin (m_s) values
- D) The same m value

5. For an electron with $n = 3$, what values can l take, and what subshells does this give?

6. How many electrons can maximum fit in a 3d subshell?

7. For $l = 1$ (a p subshell), list all possible m values and count the orbitals.

8. Define: What does the principal quantum number n represent?

9. Define: What does l determine?

10. Define: What values can m take?

Answer Key

1. B) 0 and 1 - l ranges from 0 to $n-1$, so for $n=2$, l can be 0 or 1 (giving 2s and 2p subshells).
2. B) 6 - $\text{Electrons}_{\text{max}} = 2(2l+1) = 2(2(1)+1) = 6$.
3. D) m - m is the spin quantum number, with values + or -.
4. C) Opposite spin (m) values - Electrons sharing an orbital (same n , l , m) must have opposite spins to satisfy the Pauli exclusion principle.
5. l ranges from 0 to $n-1$, so for $n = 3$: $l = 0, 1, 2$. That gives subshells 3s ($l=0$), 3p ($l=1$), and 3d ($l=2$). So the $n=3$ shell has three types of subshells: s, p, and d.
6. For d orbitals, $l = 2$. Use $\text{Electrons}_{\text{max}} = 2(2l+1) = 2(2(2)+1) = 10$. So the 3d subshell holds a maximum of 10 electrons.
7. m ranges from $-l$ to $+l$ in integer steps: for $l=1$, $m = -1, 0, +1$. That's 3 values, so there are 3 p orbitals (p_x, p_y, p_z). Each orbital holds 2 electrons (spin + and -), matching $2(2l+1) = 2(3) = 6$ total electrons in the p subshell.
8. The electron's shell and overall energy level; $n = 1, 2, 3$ - higher n means higher energy and farther from the nucleus.
9. The subshell's shape (s, p, d, f); l ranges from 0 to $n-1$.
10. Integers from $-l$ to $+l$, describing the orbital's orientation in space.

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