Quantum Number $n=3$ Analysis

https://gemini.google.com/app/fdfad96ca2ec517a

Response: To determine which statement is **incorrect** for the principal quantum number $n = 3$, let's analyze each option systematically:

Analysis of the Options

- **(1) There are 3 subshells associated with it.**
  - For $n = 3$, the allowed values for the azimuthal quantum number l are $0, 1, \ldots, n-1$, which gives $l = 0$ $(3s)$, $l = 1$ $(3p)$, and $l = 2$ $(3d)$.
  - Thus, there are exactly **3 subshells**.
  - **Status:** Correct statement.
- **(2) There are 9 orbitals.**
  - Total number of orbitals in a shell given by n is calculated using the formula n^2:

$$\text{Total orbitals} = n^2 = 3^2 = 9$$

    - $3s$: 1 orbital ($m_l = 0$)
    - $3p$: 3 orbitals ($m_l = -1, 0, +1$)
    - $3d$: 5 orbitals ($m_l = -2, -1, 0, +1, +2$)
  - Total = $1 + 3 + 5 = 9$ orbitals.
  - **Status:** Correct statement.
- **(3) There can be a maximum of 18 electrons.**
  - The maximum electron capacity of a shell with quantum number n is given by $2n^2$:

$$\text{Max electrons} = 2n^2 = 2(3^2) = 18$$

  - **Status:** Correct statement.
- **(4) There can be a maximum of 10 electrons with angular momentum (azimuthal) quantum number (l), $l = 2$.**
  - $l = 2$ corresponds to the **3d** subshell.
  - The 3d subshell has 5 orbitals, and each orbital can hold up to 2 electrons, making a maximum of $5 \times 2 = 10$ electrons.

- **Status:** Correct statement.

- **(5) There can be a maximum of 8 electrons with magnetic quantum number (m_l), $m_l = 0$.**
  - Let's look at the orbitals in $n = 3$ that have $m_l = 0$:
    - In $3s$ ($l = 0$): $m_l = 0$ (1 orbital)
    - In $3p$ ($l = 1$): $m_l = 0$ (1 orbital)
    - In $3d$ ($l = 2$): $m_l = 0$ (1 orbital)
  - Total orbitals with $m_l = 0$ in $n = 3$ is **3 orbitals**.
  - Since each orbital can hold a maximum of 2 electrons, the maximum number of electrons with $m_l = 0$ is:

$$3 \text{ orbitals} \times 2 \text{ electrons/orbital} = 6 \text{ electrons}$$

  - Therefore, it cannot be 8 electrons.
  - **Status: Incorrect statement.**

Conclusion

The incorrect statement is **(5)**.
