What are the allowed values for each of the four quantum numbers: \( n \), \( l \), \( m_l \), and \( m_s \)?

**Answer**

- \( n \): non-zero integer
- \( l \): 0 to \( n-1 \)
- \( m_l \): -\( l \) to \( l \)
- \( m_s \): \( \frac{1}{2} \) or \( \frac{-1}{2} \)

Describe the properties of an electron associated with each of the following four quantum numbers: \( n \), \( l \), \( m_l \), and \( m_s \).

**Answer**

- \( n \) determines the general range for the value of energy and the probable distances that the electron can be from the nucleus.
- \( l \) determines the shape of the orbital.
- \( m_l \) determines the orientation of the orbitals of the same \( l \) value with respect to one another.
- \( m_s \) determines the spin of an electron.

Identify the subshell in which electrons with the following quantum numbers are found:

a. \( n = 2 \), \( l = 1 \)

**Answer a**

2p

b. \( n = 4 \), \( l = 2 \)

**Answer b**

4d

c. \( n = 6 \), \( l = 0 \)

**Answer c**

6s

Identify the subshell in which electrons with the following quantum numbers are found:

a. \( n = 3 \), \( l = 2 \)

b. \( n = 1 \), \( l = 0 \)
Consider the orbitals shown here in outline.

(a) What is the maximum number of electrons contained in an orbital of type (x)? Of type (y)? Of type (z)?
(b) How many orbitals of type (x) are found in a shell with \( n = 2 \)? How many of type (y)? How many of type (z)?
(c) Write a set of quantum numbers for an electron in an orbital of type (x) in a shell with \( n = 4 \). Of an orbital of type (y) in a shell with \( n = 2 \). Of an orbital of type (z) in a shell with \( n = 3 \).
(d) What is the smallest possible \( n \) value for an orbital of type (x)? Of type (y)? Of type (z)?
(e) What are the possible \( l \) and \( m_l \) values for an orbital of type (x)? Of type (y)? Of type (z)?

**Answer a**

x. 2
y. 2
z. 2

**Answer b**

x. 1
y. 3
z. 0
Answer c

x. \[4 0 0 \frac{1}{2}\]
y. \[2 1 0 \frac{1}{2}\]
z. \[3 2 0 \frac{1}{2}\]

Answer d

x. 1
y. 2
z. 3

Answer e

x. \[l = 0, m_l = 0\]
y. \[l = 1, m_l = -1, 0, \text{ or } +1\]
z. \[l = 2, m_l = -2, -1, 0, +1, +2\]

PROBLEM

How many electrons could be held in the second shell of an atom if the spin quantum number \(m_s\) could have three values instead of just two? (Hint: Consider the Pauli exclusion principle.)

Answer

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PROBLEM

Write a set of quantum numbers for each of the electrons with an \(n\) of 4 in a Se atom.
Answer

\[
\begin{array}{cccc}
  n & l & m_l & s \\
  4 & 0 & 0 & \langle \frac{1}{2} \rangle \\
  4 & 0 & 0 & \langle -\frac{1}{2} \rangle \\
  4 & 1 & -1 & \langle +\frac{1}{2} \rangle \\
  4 & 1 & 0 & \langle +\frac{1}{2} \rangle \\
  4 & 1 & +1 & \langle +\frac{1}{2} \rangle \\
  4 & 1 & -1 & \langle -\frac{1}{2} \rangle \\
\end{array}
\]

PROBLEM \( \PageIndex{8} \)

Answer the following questions:

a. Without using quantum numbers, describe the differences between the shells, subshells, and orbitals of an atom.

b. How do the quantum numbers of the shells, subshells, and orbitals of an atom differ?

**Answer a**

shell: set of orbitals in the same energy level

subshell: set of orbitals in the same energy level and same shape (s, p, d, or f)

orbital: can hold up to 2 electrons

**Answer b**

shell: set of orbitals with same \( n \)

subshell: set of orbitals in an atom with the same values of \( n \) and \( l \)

orbital: shape defined by \( l \) quantum number

PROBLEM \( \PageIndex{9} \)

Sketch the boundary surface of a \( p_z \) and a \( p_y \) orbital. Be sure to show and label the axes.
PROBLEM \( \PageIndex{10} \)

Sketch the \( p_x \) and \( s \) orbitals. Be sure to show and label the coordinates.

**Answer**

![Sketch of \( p_x \) and \( s \) orbitals](image)

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**Contributors**

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**Feedback**

Think one of the answers above is wrong? Let us know [here](http://cnx.org/).