# What are Orbital Shapes and Angular Nodes?

Worksheet

Orbital shape is determined by the angular momentum quantum number (l). s (l=0) is spherical; p (l=1) has one angular node; d (l=2) has two angular nodes; f (l=3) has three angular nodes. Electron density increases with principal quantum number n.

## Questions

1. The s orbital (l = 0) has which shape?

A) Dumbbell
B) Sphere
C) Cloverleaf
D) Toroid

2. How many angular nodal planes does a p orbital have?

A) 0
B) 1
C) 2
D) 3

3. Which orbital is larger: 2p or 3p?

A) 2p
B) 3p
C) Same size
D) Cannot compare

4. An f orbital (l = 3) has how many angular nodal planes?

A) 1
B) 2
C) 3
D) 4

5. An electron in a 2p orbital has quantum numbers n = 2 and l = 1. How many angular nodal planes does the 2p orbital have, and what is the angular shape?

6. Compare the radial extent (size) of 1s, 2s and 3s orbitals. Which is largest?

7. A d orbital (l = 2) has how many angular nodal planes and what is its angular shape?

8. Define: What is an atomic orbital?

9. Define: What does the angular momentum quantum number (l) determine?

10. Define: What is an angular node?

# Answer Key

1. B) Sphere - s orbitals have no angular momentum (l=0), so they are spherically symmetric around the nucleus.

2. B) 1 - p orbital: l = 1 1 nodal plane. d orbital: l = 2 2 nodal planes.

3. B) 3p - n = 3 is farther from nucleus than n = 2, so 3p orbital extends further (larger radial size).

4. C) 3 - Angular nodes = l. So f orbital has 3 nodal planes and a complex shape with 8+ lobes.

5. Angular nodes = l = 1 (one nodal plane) 2p orbitals are dumbbell-shaped with electron density in two lobes on opposite sides of the nucleus The nodal plane passes through the nucleus, perpendicular to the axis of the two lobes

6. Radial extent increases with principal quantum number n 1s < 2s < 3s The 3s orbital is largest because it has the highest n value Each higher s orbital has more radial nodes (0 for 1s, 1 for 2s, 2 for 3s)

7. Angular nodes = l = 2 (two nodal planes) d orbitals have complex 4-lobed or cloverleaf shapes Example: dz has two lobes along the z-axis + a torus-like band in the xy-plane dx-y has four lobes along the x and y axes

8. A region of space around the nucleus where an electron is likely to be found (90% probability boundary).

9. The shape of the orbital and the number of angular nodal planes: l = 0 (s), 1 (p), 2 (d), 3 (f).

10. A plane where electron probability density is zero, dividing orbital lobes.