

### Exercise 8: Orbital shapes

1. Recall that a **node** is where the **wavefunction** has a value of zero (for instance, the wavefunction of an electron at infinite distance from the nucleus). Given the relationship between an electron's wavefunction and the **probability** of that electron to exist at a given point in time and space, what is the probability that an electron can be found at a node at any time?

A nodal surface is a locally two-dimensional surface (doesn't have to be a plane, though it can be) where there is zero probability that an electron can exist there.

Go to <http://undergrad-ed.chemistry.ohio-state.edu/H-AOs/index.html>

Click on any and all of the s orbital diagrams.

2. How many nodal **planes** are there in any s orbital?

3. Are there any other types of nodal **surfaces**? Hint: looking at the **radial distribution plot** will probably be more helpful. In which **principal quantum number n** s-orbitals do they exist? How would you describe them?

4. What is the mathematical relationship between the number of nodal surfaces in a given s orbital and n?

Click on any and all of the p orbital diagrams.

5. How many nodal planes are there in any p orbital?

6. Are there any other types of nodal **surfaces**? Hint: looking at the **radial distribution plot** will probably be more helpful. In which **principal quantum number n** s-orbitals do they exist? How would you describe them?

7. What is the mathematical relationship between the number of nodal surfaces in a given p orbital and n?

Click on any d orbital diagram, except for the  $d_{z^2}$  orbitals.

8. How many nodal planes are there in any d orbital?

9. What is the relationship between the number of nodal planes in a d orbital and the **angular momentum quantum number l**?

10. Now look at the  $3d_{z^2}$  orbital. This orbital does not seem to follow the rule you determined in the previous question; however, go back to the idea of nodal surface, and you should be able to see the two nodal surfaces. Hint: think of a dog after surgery.

Draw the  $3d_{z^2}$  orbital below, and sketch, as best as you can, the nodal surfaces.