Name: **Hydrogen Atomic Orbitals Assessment**

1. Determine how many different orbitals can correspond to the given quantum numbers.

   (a) $n = 1$, $l = 0$ _____

   (b) $n = 2$, $l = 1$ _____

   (c) $n = 3$, $l = 1$ _____

   (d) $n = 3$, $l = 2$ _____

   (e) $n = 3$, $l = 2$, $m = -1$ _____

2. The wavefunctions for a hydrogen atom are labeled with three quantum numbers n, l, and m in the form $\phi_{n,l,m}$, where m is also sometimes called m_l.

   (a) How many total nodes are there for the wavefunction $\phi_{2,1,1}$? _____

   (b) How many angular nodes are there for a wavefunction $\phi_{2,1,1}$? _____

   (c) How many radial nodes are there for a wavefunction $\phi_{2,1,1}$? _____

   (d) How many total nodes are there for the wavefunction $\phi_{4,2,0}$? _____

   (e) How many angular nodes are there for a wavefunction $\phi_{4,2,0}$? _____

   (f) How many radial nodes are there for a wavefunction $\phi_{4,2,0}$? _____

3. Which of the quantum numbers n, l, or m or some combination of these quantum numbers determine the energies of the orbitals for a hydrogen atom without an applied electromagnetic field?

4. What quantum number(s) can be used to determine how many nodal planes are perpendicular to the $x-y$ plane?

5. On the following coordinate axes, draw a projection of the hydrogen wavefunctions $\phi_{n,l,m}$ with the quantum numbers $n=2$, $l=1$ and $m=\pm 1$ (the $2p_x$ and $2p_y$ orbitals). Be sure to indicate regions of differing phase.