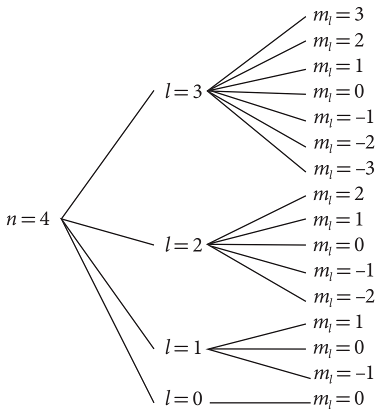
2.



3. The fourth quantum number is the spin quantum number symbolized, m_s (m sub s). The spin quantum number has two possible values, $\frac{1}{2}$ and $-\frac{1}{2}$. It represents the orientation of the axis of the electron. The orientations are called spin up and spin down.

4.

Summary of Quantum Number of Electrons in Atoms

Name	Symbol	Allowed Values	Property
Principal (shell)	n	Positive integers (1, 2, 3, etc.)	Orbital size and energy level
Orbital-shape (subshell)	l	Integers from 0 to (n – 1)	Orbital shape (l values 0, 1, 2, and 3 correspond to *s, p, d,* and *f* orbitals)
Magnetic	m_l	Integers from $-l$ to $+l$	Orbital orientation
Spin	m_s	$+\frac{1}{2}$ or $-\frac{1}{2}$	Spin orientation

5. *Sample answer:* The *s* orbital is like a tennis ball. The fuzzy surface represents the concept that the surface is not precisely defined. The *p* orbitals are shaped like putty that is pulled until the two pieces are almost pulled apart. The first four *d* orbitals are shaped like a four-leafed clover and the fifth is like a *p* orbital with a ring around the centre.

6. Disagree: An orbital simply defines a region in the space around a nucleus. There are no physical barriers. Electrons having a specific amount of energy can exist in that region of space or orbital.

7. **a.** not allowed: When $n = 2$, l can have values of only 0 or 1.
   b. not allowed: When $l = 0$, m_l can have a value of only 0. It cannot be −1.
   c. allowed
   d. not allowed: When $n = 2$, the values of l are restricted to 0 or 1.

8. **a.** 1
   b. 7
   c. 3
   d. 5
   e. 1
   f. infinite

9. Six sets:
$n = 3, l = 1, m_l = 0, m_s = \frac{1}{2}$
$n = 3, l = 1, m_l = 0, m_s = -\frac{1}{2}$
$n = 3, l = 1, m_l = 1, m_s = \frac{1}{2}$
$n = 3, l = 1, m_l = 1, m_s = -\frac{1}{2}$
$n = 3, l = 1, m_l = -1, m_s = \frac{1}{2}$
$n = 3, l = 1, m_l = -1, m_s = -\frac{1}{2}$

10. **a.** The value of n cannot be 0. It has to be at least one more than l. $n = 2, l = 1, m_l = 0$
    b. The magnitude of m_l cannot be larger than l. $n = 3, l = 2, m_l = -2$

11. Hi, So you missed class today. Well, orbitals are really weird. They are just a region in space around a nucleus in which an electron having a specific energy can exist. There is really nothing holding the electron there except its energy.

12. For any given energy level, or shell, the *d* orbitals have five different regions in space that electrons can occupy whereas *p* orbitals have only three and *s* orbitals have only one. The value of l for *d* orbitals is always 2 whereas for *p* orbitals, $l = 1$, and for *s* orbitals, $l = 0$.

13. **a.** The statement assumes that all of the electrons in an atom are always in their ground state. However, electrons can absorb energy and move to higher energy levels. The largest *known* atom has 118 electrons. However, new elements might be found or created experimentally in the future.
    b. Any number of energy levels is possible. If the atom absorbs the right amount of energy, an electron could be in the $n = 1000$ level.

14. The sphere represents the region in space around the nucleus within which two electrons (spin up and spin down) can exist.

15. The Pauli exclusion principle states that no two electrons in the same atom can have the same four quantum numbers. As a consequence, the number of electrons in the atom determines the number of filled orbitals.

16. Yes: The atom would be in an excited state. That means that the electron would have absorbed energy.