**Quantum & electronic structure of the atom superconcepts**

*This material is presented in chapter 6 of Brown et al. 12/e*

**Superconcepts**

1. An atom’s bonding & reactive properties are determined by electron configuration.
2. The behavior of electrons in atoms is dictated by quantum mechanics.

**Concepts**

1. Newtonian physics don’t accurately describe the behavior of matter at the subatomic level.
2. Both light and electrons behave as waves and particles; dualistic behavior.
3. Electrons occupy orbitals, likely three-dimensional shapes with distinct energy levels and orientations. Orbitals are wave functions and therefore probabilities.

**Details**

1. Elements in the same group (or column) have the same valence electron configuration and similar physical and chemical properties.
2. Elements in the same row have their valence electrons in the same principle energy level; dissimilar physical and chemical properties.
3. Planck and Einstein demonstrated the quantum aspect of light in blackbody radiation and the photoelectric effect, respectively. Light is discrete energy bundles.
4. Bohr found that electrons also exhibit quantum behavior; electrons in atoms inhabit discrete energy levels.
5. Particles are the least possible amount of matter; have mass and size.
6. Waves are an oscillation exhibiting wavelength, amplitude and frequency.
7. Young’s double-slit experiment demonstrated that light behaved as a wave in 1801.
8. Einstein found that light behaved as particles (photons) in the photoelectric effect in 1905.
9. De Broglie found that electrons behaved as waves in diffraction experiments in 1924.
10. Schrödinger showed that atomic wave spectra (electrons) could be predicted by wave functions in 1926.
11. Heisinger found that atomic properties were ‘indeterminant’ or uncertain in 1927.
12. When the double-slit experiment was repeated with electrons, the results confirmed that electrons behave both as particles and waves (‘waveicles’).
13. Bohr’s postulates: 1) electrons occupy only discrete quantum levels; 2) electrons in their allowed quantum levels don’t radiate energy; and 3) added energy can transiently increase their energy level, and release photons when they return to their assigned quantum level.
14. Orbitals can hold a maximum of two electrons each.
15. S orbitals are spherical. P orbitals are dumbbell shaped and occur in threes. D orbitals are four-bladed propeller shaped and occur in fives.
16. Not all principle energy levels have all orbitals: 1 = s; 2 = s, p; 3 = s,p,d; 4 = s,p,d,f.
17. The order of orbital filling (aufbau) is not as expected after level 2: 1s2s2p3s3p4s3d4p5s5p4d….
18. Pauli’s exclusion principle states that if two electrons occupy the same orbital they must have opposite spin.
19. Hund’s rule states that orbitals at exactly the same energy level must be filled one electron at a time.