1. Oxygen can bond to another atom by all of the following, except _____.

(A) sharing one electron with two other oxygen atoms
(B) taking two electrons from an atom trying to give away two electrons
(C) sharing two electrons with another oxygen atom
(D) sharing one electron with two different hydrogen atoms

Hint: Oxygen needs two electrons to fill its outer ring. It can take or share two electrons with another atom, or it can share one electron with two hydrogen atoms.

Oxygen cannot, however, share one electron with two other oxygen atoms because by sharing just one electron, the other oxygen atoms won't be filling up their outer rings. Such a molecule would be unstable.

2. Two atoms with an electronegativity difference between 0.5 and 2.0 usually share their electrons _____.

(A) ionically
(B) covalently
(C) polar covalently
(D) metallically

Hint: Pauling's electronegativity chart indicates how tightly an atom, when bonded in a molecule, will hold on to electrons. The higher the electronegativity value, the stronger the hold.

The electronegativity difference between two atoms bonded together in a molecule predicts the type of intramolecular bond. A difference of less than 0.5 predicts an equal-sharing covalent bond. A difference between 0.5 and 2.0 predicts an unequal-sharing polar covalent bond. A difference of 2.0 or more predicts a give-and-take ionic bond.

3. In a water molecule, which statement is untrue?

(A) The hydrogen side of the water molecule is more negative than the oxygen side.
(B) The water molecule is dipolar.
(C) The electronegativity difference between oxygen and hydrogen is more than 0.5 and less than 2.0.
(D) Oxygen overpowers hydrogen's pull on its electron because oxygen has more protons than hydrogen.

Hint: In a water molecule, oxygen, with so many protons and only two electron rings, exerts a large pull on each hydrogen's electron.

Hogging hydrogen's electron makes the oxygen side of the water molecule slightly negative and the hydrogen side slightly positive, meaning the water molecule is now dipolar.

4. Water molecules are liquid at room temperature because of all of the following, except _____.

(A) hydrogen bonding
(B) London dispersion forces
(C) their polarity is not great enough to make them stick to each other for more than a brief moment
(D) collisions with other water molecules billions of times a second

Hint: Molecules only seem to understand positive and negative.

Water molecules are somewhat polar which causes its positive hydrogen side to be somewhat attracted to the negative oxygen side of another water molecule.

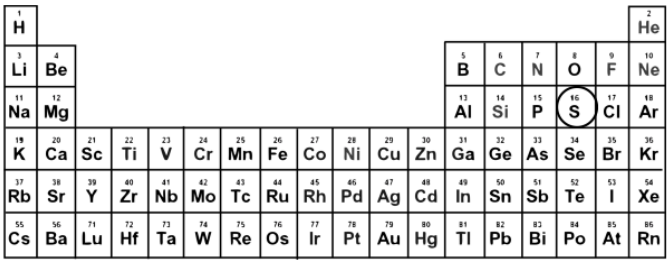
Because water molecules are not strongly polar, they stick to each other for only a tiny fraction of a second before bouncing away and sticking briefly to another water molecule. This happens billions of times a second.

5. Why is water (H_2O) liquid at room temperature but hydrogen sulfide (H_2S) is a gas even though sulfur is right below oxygen in the periodic table?

(A) Hydrogen sulfide molecules are more polar than water molecules
(B) The intermolecular forces between hydrogen sulfide molecules are stronger than those between water molecules
(C) Sulfur has a greater electronegativity value than oxygen
(D) It takes less energy to pull hydrogen sulfide molecules apart than water molecules

Hint: Sulfur has three electron rings while oxygen only has two. Because sulfur's valence electrons in Ring 3 are further from the nucleus than oxygen's valence electrons in Ring 2, and because sulfur's valance electron in Ring 3 is slightly repelled by the electrons in Rings 1 and 2, sulfur's nucleus has a looser grip on its valence electron than oxygen does.

As a result, in a hydrogen sulfide molecule (H_2S), sulfur exerts less of a pull on hydrogen's electron than oxygen does in a water molecule. This makes hydrogen sulfide less polar than a water molecule, and therefore less sticky, meaning at room temperature hydrogen sulfide forms a gas not a liquid.



6. Even though a molecule may consist of one atom bonded with polar bonds to two or more identical atoms, the molecule itself can still be made nonpolar by all of the following, except _____.

(A) by placing the nonpolar intramolecular bonds on opposite sides of the molecule
(B) by arranging the nonpolar intramolecular bonds symmetrically around a central atom
(C) by using unshared electrons to widen the bond angles

Hint: Molecules need a difference in polarity in order to stick together. When molecules are negative on all sides, there is no electrical difference between the molecules, meaning no polarity, and therefore no electrical attraction between them. Their negative sides will, however, be attracted to the positive side of polar molecules, like water.

In a molecule with a central atom bonded to two identical atoms, if the bond angle between the two identical atoms is less than180 degrees, the molecule has to be polar.

In a molecule with three identical atoms bonded to a single central atom, all three atoms must be equidistant from each other in order of the molecule to be nonpolar to other identical molecules.

7. Which of these statements about electrons is untrue?

(A) Electrons orbit the nucleus in pairs.
(B) In each pair of electrons orbiting the nucleus, both electrons spin in the same direction.
(C) An unshared pair of electrons has more repulsive power than a shared pair of electrons.
(D) A pair of unshared electrons can narrow the bond angle between two intramolecular bonds

Hint: Electrons travel in pairs, one spinning clockwise and the other counterclockwise.

A pair of shared electrons revolving around an atom are being shared by that atom and another atom. A pair of unshared electrons revolving around an atom are simply two electrons belonging solely to that atom.

Shared electrons spend some of their time around the other atom. By wandering away from the main atom, shared electrons have less repulsive power than unshared electrons which do not wander away from the main atom.

8. The four intramolecular bonds around carbon's nucleus point _____.

(A) at the four corners of an "X"
(B) north, south, east, and west in 3-dimensional space
(C) north, south, east, and west in a single plane
(D) at the four corners of a pyramid

Hint: Electrons want to be as far away from each other as possible.

For four points situated around a central point, the central point must be in the center of a pyramid and the four points must be at each tip of the pyramid.

9. Narrowing the bond angle between two intramolecular bonds in a molecule _____.

(A) does not affect the polarity of the molecule
(B) increases the polarity of the molecule
(C) decreases the polarity of the molecule
(D) flips the polarity of the molecule

Hint: A pair of unshared electrons revolving around a central atom can repel a pair of shared electrons also revolving around the central atom.

If, in addition to the pair of unshared electrons, there are two pairs of shared electrons, the shared electrons will be pushed together, dragging with them the two atoms sharing their electrons with the central atom.

By sharing their electrons with the central atom, those two atoms are each slightly positive. So, when pushed together, they make that end of the whole molecule somewhat positive.

10. Ammonia's single pair of unshared electrons makes ammonia _____.

(A) more polar than water molecules
(B) more polar than hydrogen fluoride molecules
(C) more polar than methane at room temperature
(D) a liquid at room temperature

Hint: In an ammonia molecule, NH_3, nitrogen shares three of its five valence electrons with three hydrogen atoms, leaving two of its electrons to revolve around the nitrogen nucleus as a pair of unshared electrons.

That single pair of unshared electrons repels the three pairs of shared electrons and their three hydrogen atoms, and pushes them closer together, making the ammonia molecule slightly polar.

Water is more polar than ammonia because water molecules have two pairs of unshared electrons pushing only two pairs of shared electrons and their two hydrogen atoms closer together.

11. Hydrogen bonding _____.

(A) helps fold proteins
(B) can occur between hydrogen atoms and calcium atoms
(C) can occur between hydrogen atoms and molecules of nitrogen gas
(D) increases London dispersion forces

Hint: Hydrogen bonding is an intermolecular bond between a slightly positive hydrogen atom and a slightly negative oxygen, nitrogen, or fluorine atom.

Hydrogen bonding is stronger than London dispersion forces.