Chemistry – Bonding Essay, Research Paper

Electron Pair Repulsion Theory:

The electron pair repulsion theory states that the electron pairs in the valence energy level of an atom repel each other, and therefore are arranged as far apart as possible. For example, H2O:

Due to this theory, different molecules with different amounts of pairs of electrons have different shapes.

Shapes of Molecules:

Some common shapes of molecules include linear, trigonal planar, tetrahedral, trigonal pyramidal and v-shaped (bent) molecules. Examples are drawn below-

a) linear (CO2)

b) tetrahedral (CH4)

c) v-shaped/bent (H2O)

d) trigonal planar (BF3)

e) trigonal pyramidal (NH3)

The electron dot diagrams must be drawn first in order to work out the shape of the molecule.

Molecular Polarity:

The polarity can be determined from the shape of the molecule. In essence, a molecule is polar if there is an overall electronegativity difference in the molecule. This can be determined using some basic rules, which state that:

If a molecule is of the form AB2 and is linear, it is non-polar.

If a molecule is of the form AB3 and is trigonal planar, it is non-polar

If a molecule is of the form AB4 and is tetrahedral, it is non-polar.

All other molecules are polar. Using these rules, we can determine the polarity of the earlier used examples.

a) AB2 ? b) AB4 ? c) AB2 ? d) AB3 ? e) AB3 ?

linear ? tetrahedral ? bent X trigonal planar ? trigonal pyramidal ?

\non-polar \non-polar \polar \non-polar \polar

Intermolecular Forces:

As we have just seen, it is easy to determine the molecular polarity of a particular molecule after seeing the shape. Knowing the polarity and the nature of the molecule, we can then work out the type and strength of intermolecular force in the substance. Non-polar molecules exhibit dispersion forces, and these are very weak. The higher the molecular mass of the substance, the stronger the dispersion forces because in the larger molecule, electrons are more likely to be influenced by external forces that cause the distribution of electrons in the molecule to suddenly become uneven. Polar molecules exhibit dipole-dipole intermolecular forces, and the strength of this force is increased with a greater electronegativity difference between atoms in the molecule. The last type of intermolecular forces shown is a sub-division of dipole-dipole bonding, and that is hydrogen bonding. Hydrogen bonding is the strongest form of intermolecular force and occurs only between H and O, N or F. So, to predict the type of intermolecular forces shown in a particular substance, determine whether it is polar or non-polar, and then whether it exhibits hydrogen bonding. We can do this for the examples introduced earlier.

a) dispersion forces b) dispersion forces c) dipole-dipole forces (hydrogen bonding)

d) dispersion forces e) dipole-dipole forces (hydrogen bonding)

Therefore, we can see that the three dimensional structure of a covalent molecule can be used to predict molecular polarity and intermolecular forces in that substance, thus proving that the shape is an important property of any molecule.