Answer on Question #83313 – Chemistry – General Chemistry

Compare and contrast the three types of bonding found in a molecule.

Solution:

- A **covalent bond** is the strong electrostatic force of attraction between two positively charged nuclei and the shared pair of electrons between them. Of course there can be more than one shared pair of electrons between two atoms, hence why there are double bonds (two shared pairs of electrons) and triple bonds (three shared pairs of electrons). Triple bonds are stronger than double bonds, which are stronger than single bonds. A single bond consists of a strong sigma bond. A double bond consists of a sigma bond (good head on overlap between two s orbitals) and a pi bond (poor sideways overlap between two p orbitals, thus this bond is weaker than a sigma bond). Covalent bonds form between two non metal atoms of similar electronegativities and are the strongest type of bond in chemistry. Many organic aliphatic, aromatic, and natural compounds, and inorganic compounds contain covalent bonds. These bonds are most commonly found in **organic products**, and as such are a key aspect of organic chemistry.
- An **ionic bond** is the strong electrostatic force of attraction between two oppositely charged ions (an anion and a cation) of elements with significantly different electronegativities, thus they often form between metal ions and non metal ions. The greater the difference in electronegativities of the two elements in the bond, the more ionic the bond. Ionic bonds can have covalent character if the difference in electronegativities between the two atoms is not as high (this could be due to the presence of a cation with a high charge density and polarising power such as Al^{3+} and/or a larger anion that is highly polarisable such as I^-) causing the bond to be more polar covalent (the electrons are drawn away from the anion towards the centre of the bond) and therefore stronger (as more energy is required to break it down). These bonds are most commonly found in inorganic compounds, e.g. between a cation and an anion to form a **salt**.
- A **dative covalent bond** is a covalent bond in which both of the electrons in the shared pair come from one atom. This can occur when a nucleophile (electron rich species with a lone pair of electrons that it can donate to an electrophile forming a dative covalent bond) such as NH_3 bonds to an electrophile (an electron deficient species that accepts a pair of electrons from a nucleophile) such as H^+. These bonds also form between transition metal cations and monodentate/bidentate/polydentate ligands.
- **Metallic bonding** is the strong electrostatic force of attraction between metal cations/atoms and delocalised electrons in the metallic lattice of a metallic substance (e.g. the elements in group 1 and 2 of the periodic table). This type of bonding only exists in metallic substances (as they consist of metal cations arranged in a regular lattice structure). The higher the potential charge on the metal cation the stronger the metallic bonding as there are more delocalised electrons per metal atom, so the bond strength increases commensurately with charge. As the metallic radius (half the distance between two adjacent metal ions in the metallic lattice) of the metal atom decreases the strength of the metallic bonding increases as there is less distance between the positively charged nucleus of the cations (technically atoms, as the atoms haven't lost their valence electrons, they are just delocalised) in the lattice and the delocalised electrons meaning that the electrostatic forces of attraction are stronger

and require more energy to break down, increasing the strength of the metallic lattice, causing it to have a higher melting point. Thus, as **charge density increases** the **strength**of the metallic substance **increases.**