Electronegativity Chemistry Questions with Solutions

Q1: What is Fajan's rule?

Answer: The covalent character of the ionic bonds was explained by Fajan's rule. The Fajan's rule states that: when a cation approaches the anion, the electron cloud of the anion gets attracted towards the cation. The more these electron clouds are attracted towards the cation, the more will be the neutralization of these charges. As a result, the ionic character decreases and covalent character increases.
This effect is favoured by the small size of the cation and the large size of the anion.

Q2. Indicate whether the given bonds are ionic (I), polar covalent bond or non-polar covalent bond.

a. C–P
b. N–H
c. Fe–O
d. S–O

Answer: The classification of the given bonds is hereunder.

a. Both carbon and phosphorus are non-metals and have a very less electronegativity difference. Hence, they form non-polar covalent bonds.
b. According to the Fajan's rule, Nitrogen and Hydrogen form a covalent bond. Although, both of these have an electronegativity difference of 0.8 which is why the bond is a polar covalent bond.
c. A metal and a non-metal generally form an ionic bond owing to the large electronegativity difference in between them. This is why Fe–O is an ionic bond.
d. Just like N–H, Sulphur and oxygen form a polar covalent bond.

Q3. Explain the difference between a polar bond and polar compound by the means of the following examples: $CHCl_3$ and CCl_4.

Answer: The atoms of two non-metals with considerable electronegativity difference (<1.7) form a polar covalent bond. The electronegativity of carbon as measured on Pauling's scale is 2.55; while that of chlorine is 3.16. This difference leads the shared pair of electrons to be inclined towards Chlorine. Since the electron density gets slightly shifted towards chlorine, the bond becomes polar.
Dipoles can be drawn from positive end to negative end in between two bonded atoms. Since CCl_4 has a regular tetrahedral geometry, all the 4 dipoles face outside and get cancelled out. However in $CHCl_3$, in the C–H bond, C is more electronegative, hence the C–H dipole faces inside rather than outside as in the case of CCl_4. Hence, a net dipole moment is observed in the compound $CHCl_3$. This is why $CHCl_3$ is a polar compound.

Q4. Discuss the periodic trend of electronegativity.

Answer: As we move from left to right in a period, the size of the elements decreases and the nuclear charge increases. This is why the electronegativity of the elements increases as we move from left to right in a period.
As we go down the group, the size of the atoms decreases, hence, electronegativity decreases.

Q5. The Electronegativity is related to the ionization energy of an element and

a. Atomic radius
b. Ionic radius
c. Nucleus
d. Electron affinity

Answer: (d.)

Explanation: Electron affinity is the tendency of an element to gain electrons.

Q6. Out of PH_3 and NH_3, which one is covalent and why?

Answer: Both nitrogen and phosphorus belong to group 15. Electronegativity decreases down the group. Hence, Phosphorus and hydrogen form a covalent bond. PH_3 is a covalent compound.

Q7. A mutual electrical attraction between the nucleus of one atom and the valence electrons of another atom is called:

a. Dipole
b. London force
c. Chemical bond
d. Electronegativity

Answer: (c.)

Explanation: A chemical bond is formed when the nucleus of an atom attracts the valence electron of another atom.

Q8. What is the Inductive effect?

Answer: It is the shifting of electrons along the bonds within a compound due to the effect of a nearby electronegative atom. It is represented by I.

Q9. How does hybridization affect Electronegativity?

Answer: With an increase in the s-character of the hybridization of the carbon, the electronegativity increases. This means that sp hybrid carbon is the most electronegative followed by the sp^2 hybrid carbon; while sp^3 hybrid carbon is the least electronegative.
This can be explained as due to the more s-character, the concerned hybrid orbital is found to be closer to the nucleus. And hence, the electronegativity of this orbital increases.

Q10. What is the basic difference between electron gain enthalpy and electronegativity?

Answer: The electron gain enthalpy and electronegativity both refer to the tendency of atoms to attract an electron towards it. However, the basic difference between the two is that electron gain enthalpy refers to the electron gaining tendency of an isolated gaseous atom to form a negative gaseous ion. Electronegativity is the electron attracting tendency of an atom within a covalent bond.

Q11. Comment on the statement: the electronegativity of nitrogen on Pauling's scale is 3.0 in all the nitrogen compounds.

Answer: This statement is incorrect. The electronegativity of an element may vary depending on the oxidation state and the hybridization of the element. The electronegativity increases with the increase in the oxidation state of the element and in the percentage s-character of the concerned hybrid orbital of the element.

Q12. Why is the Electron gain enthalpy of noble gases positive?

Answer: This is because noble gases have stable electronic configurations and therefore, they have no tendency to gain or lose an electron.

Q13. F is more electronegative than Cl because:

a. F has higher electron affinity than Cl.
b. F has a greater tendency to attract the shared pair of electrons in a covalent bond.
c. F has higher electron gain enthalpy than Cl.
d. F lies above Cl in the same group within the periodic table.

Answer: (b.)

Explanation: Electronegativity is the atom's ability to attract the shared pair of electrons within a covalent bond.

Q14. Arrange the following elements in the increasing order of electronegativity: C, N, Si and P.

Answer: The electronegativity increases within a period and decreases on going down the group. Hence, the increasing order of electronegativity is: Si < P < C < N.

Q15. Arrange the following in the decreasing negative electron gain enthalpy: O, S and Se.

Answer: The negative electron gain enthalpy is the amount of energy released when a neutral gaseous atom gains an electron. This may be related to the electronegativity of the atoms. The negative electron gain enthalpy decreases from top to bottom in a group.
However, due to the small size of oxygen atoms, some electronic repulsions may lead to a less negative electron gain enthalpy of O than that of S. The decreasing order of negative electron gain enthalpy is: Se > O > S.

Practise Questions on Electronegativity

Q1. Give the relation between the Pauling scale and the Mulliken scale.

Answer: The electronegativity ($\mathcal{X}$) is measured on both- the Pauling scale and the Mulliken scale. The relationship between the two is as:

$$\mathcal{X}_{\text{Paulng}} = \mathcal{X}_{\text{Mulliken}} / 2.8$$

Where $\mathcal{X}_{\text{Paulng}}$ is the electronegativity measured on Pauling scale and $\mathcal{X}_{\text{Mulliken}}$ is the electronegativity measured on the Mulliken scale.

Q2. What is the electronegativity difference between H and Cl.

Answer: The electronegativity of H is 2.2; while that of Cl is 3.16. Hence, the difference between the electronegativity of H and Cl is: $\mathcal{X}_{\text{Cl}} - \mathcal{X}_{\text{H}} = 3.16 - 2.2 = 0.96$.

Q3. Write the electronic configuration of the most and least electronegative elements.

Answer: The most electronegative element is Fluorine (F). The electronic configuration of F is [He] $2s^2$ $2p^5$. While Cesium (Cs) is the least electronegative element. The electronic configuration of Cs is [Xe] $6s^1$.

Q4. Among HF, HCl, HBr and HI, HF has the highest ionic character because:

a. F has the highest electron affinity
b. F^- ion has the highest ionic radius
c. Atomic orbitals of H and F have similar energy
d. The electronegativity difference is the highest in HF

Answer: (d.)

Explanation: The electronegativity of H is 2.2, while that of F is 3.98. The difference between the two is greater than 1.7. Hence, the HF bond is ionic in nature.

Q5. What type of bond would you expect from atoms of high electronegativities? Give an example.

Answer: Since both the elements have high electronegativities, there must be less difference in the electronegativities of the two and hence form covalent bonds.