PRAADIS EDUCATION

CHEMISTRY XI

CHEMICAL BONDING & MOLECULAR STURCTURE

OBJECTIVE QUESTIONS

Kossel-Lewis Approach to Chemical Bonding

1. Atoms obtain octet configuration when linked with other atoms. This is said by _____
a) Lewis
b) Kossel
c) Langmuir
d) Sidgwick

Answer: a
Explanation: The above statement says that the atoms achieve a stable octet configuration when joined with other atoms through chemical bonds as postulated by Lewis. An example of this is the formation of NaCl molecule where Na and Cl transfer electrons to each other forming Na^+ and Cl^-.

2. Find out the correct Lewis symbol for the atom carbon among the following options.
a) .C:
b) :C.
c) :C:
d) .C.

Answer: c
Explanation: An American chemist G.N. Lewis created Lewis symbols as a notation to represent the valance electrons in an atom. As the carbon

atom has 4 electrons in its outer shell, it is represented by 4 dots around it.

3. What's the group valance of atoms in the halogen family?
a) 2
b) 1
c) 9
d) 7

Answer: b
Explanation: The group valance can be calculated from Lewis symbols either by subtracting it from eight (more than 4) or having it equal (less than 4). The halogen family has 7 electrons in their outer orbit. So 8 – 7 = 1. Therefore the valency of the halogen family is 1.

4. Highly electropositive Alkali metals are separated from highly electronegative halogens by _____
a) noble gases
b) oxygen family
c) f-block elements
d) 7^{th} period

Answer: a
Explanation: According to Kossel, Highly electropositive Alkali metals are separated from highly electronegative halogens by noble gases. This is because Alkali metals are the 1^{st} group and halogens the 17^{th} group. Elements in 18^{th} group i.e. nobles are preceded by group 17 elements and succeeded by group 1 elements.

5. Sharing or transfer of electrons from one atom to the other to attain stable octet configuration follows _____
a) Duet rule
b) Triplet rule
c) Octet rule
d) Septet rule

Answer: c
Explanation: As per the electronic theory of chemical bond that's put forth by Lewis &Kossel states that the atoms follow the octet rule by sharing or transfer of electrons from one atom to the other to attain stable octet configuration.

6. In the covalent bond, atoms share electrons to achieve octet configuration.
a) True
b) False

Answer: a
Explanation: In the year 1919, Langmuir postulated the theory of covalent bond and its formation by combining with Lewis theory. An example of this is the formation of Cl_2, Two atoms of Cl combine by sharing the 7^{th} electron in its outer shell.

7. Which of the following molecule doesn't involve covalent bond?
a) H_2O
b) CCl_4
c) NaCl
d) O_2

Answer: c
Explanation: The formation of NaCl molecule where Na and Cl transfer electrons to each other forming Na^+ and Cl^-. There is no sharing of electrons i.e. no covalent bond. Whereas the molecules H_2O, Cl_2 and O_2 involve sharing of electrons.

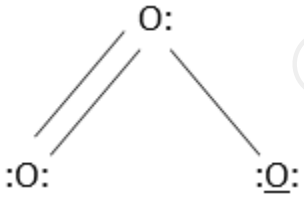
8. Calculate the formal charge of C in CH_4.
a) 4
b) 1
c) -4
d) 0

Answer: d
Explanation: The formula for finding out the formula charge of an in a molecule = total number of valence electrons – total number of non-bonding electrons – 1/2(total number of bonding electrons). So here, formal charge of C = 4 – 0 – 8/2 = 0.

9. Which of the following doesn't follow octet rule?
a) CH_4
b) CCl_4
c) HCl
d) NO_2

Answer: d
Explanation: Though octet rule is widely known, it does have a few limitations. The compound nitrogen dioxide NO_2 doesn't follow the octet rule. It's a molecule with an odd number of electrons. Even the nitric oxide NO doesn't follow.

10. Calculate the formal charge of the middle atom in the ozone molecule.



a) 1
b) -1
c) 0
d) -2

Answer: a
Explanation: The formula for finding out the formula charge of an in a molecule = total number of valence electrons – total number of non-bonding electrons – 1/2 (total number of bonding electrons). So here, a formal charge of central O is 6 – 2 – 6/2 = 1.

Ionic or Electrovalent Bond

1. A chemical bond formation that involves the complete transfer of electrons between atoms is _____
a) ionic bond
b) covalent bond
c) metallic bond
d) partial covalent bond

Answer: a
Explanation: Ionic bond, which is otherwise known as electrovalent bond forms between two atoms by the transfer of electrons between them. It generates oppositely charged ions. Positively charged ions are mostly metals and the vice-versa.

2. Formation of a compound through ionic bond _____ the ionization energy of the metal ion.
a) does not depends on
b) depend on
c) is independent regarding
d) may or may not depend on

Answer: b
Explanation: For the formation of the ionic bond, the metal ion has to overcome to energy for the removal of an electron from its outer shell in order to become a cation, that is ionization energy. Therefore Formation of a compound through ionic bond depends on the ionization energy of the metal ion.

3. The enthalpy change that occurs when an atom in the ground state gains an electron, is electron gain enthalpy.
a) True
b) False

Answer: a
Explanation: Yes. electron gain enthalpy is the enthalpy change for an

atom in the ground state to gain an electron. An atom gains an electron, thus forming negatively charged ion also known as a cation. Symbolic representation is as follows: $A_{(g)} + e^- \rightarrow A_{(g)}^-$.

4. Electron gain enthalpy may be _____
a) exothermic
b) endothermic
c) both exothermic and endothermic
d) always zero

Answer: c
Explanation: Electron gain enthalpy is the enthalpy change for an atom in the ground state to gain an electron. In the case of an exothermic reaction, the value of electron gain enthalpy is negative, which means that it is releasing energy and vice-versa when it's positive.

5. Ionic bonds easily form when electron when ionization energy of the metallic atom is _____ comparatively.
a) negative
b) constant
c) more
d) less

Answer: d
Explanation: The rate of formation of an ionic bond mainly depends on the tendency to become cation and anion from their original ground states. The tendency is maximum for metallic atoms whose ionization energy is less than the other atoms.

6. What is the energy that is released upon the formation of an ionic compound known as?
a) Ionization energy
b) Lattice energy
c) Electron gain enthalpy
d) Electropositivity

Answer: b
Explanation: When the ions are combined to form an ionic compound that is a crystalline solid, a certain amount of energy is released and this is known as the lattice energy. Solubility, volatility, and hardness can be predicted from lattice energy.

7. What's the amount of lattice energy of NaCl?
a) 788 KJ mol^{-1}
b) 688 KJ mol^{-1}
c) 588 KJ mol^{-1}
d) 488 KJ mol^{-1}

Answer: a
Explanation: NaCl's lattice enthalpy is given by 788 KJ mol^{-1}. To disassociate one mole of NaCl into one mole of Na^+ and one mole of Cl^- ^{1} into an infinite distance, we need 788 KJ mol^{-1} of energy. When the ions are combined to form an ionic compound that is a crystalline solid, a certain amount of energy is released and this is known as the lattice energy.

8. Which of the following molecule's formation doesn't include ionic bond?
a) LiCl
b) MgO
c) $SnCl_4$
d) H_2O

Answer: d
Explanation: The molecules LiCl, MgO, and $SnCl_4$ are formed by ionic bonds as they transfer electrons from an electropositive atom, that donates to the electronegative atom, that accepts. Whereas H_2O has covalent bonds as it shares electrons.

9. Ionization energy is always endothermic in nature.
a) False

b) True

Answer: b
Explanation: Ionization energy is the minimum amount of energy that is required to remove an electron from a neutral isolated gaseous atom. The symbolic representation is given by $A_{(g)} \rightarrow A_{(g)}^{+} + e^{-}$. It is always negative as it requires energy that is endothermic in nature.

10. Ionic bond formation depends on the arrangement of _____
a) molecule
b) atom
c) lattice
d) kernal

Answer: c
Explanation: Lattice of the crystalline compound is the arrangement of positive and the negative ions inside a substance. It is dependent on the ease of formation of ionic bonds as per Kossel and Lewis Ionic bond formation.

Bond Parameters

1. Which of the following cannot be used to measure bond lengths?
a) Spectroscopy
b) X-ray diffraction
c) Electron diffraction
d) Young’s Double-slit method

Answer: d
Explanation: The equilibrium distance between the nuclei of two bonded atoms in a molecule is known as bond length. It can be measured by spectroscopy, X-ray diffraction, and electron diffraction. Young’s double slit method is used for determining electromagnetic spectra.

2. The covalent radius in a chlorine molecule and van der Waal's radius between chlorine molecules respectively can be _____ & _____
a) 99pm, 198pm
b) 198pm, 99pm
c) 198pm, 198pm
d) 99pm, 99m

Answer: a
Explanation: The half of the distance between two covalently bonded similar atoms in the same molecule is called covalent radius, whereas the half of the distance between two similar atoms of different molecules in a solid is known as van der Waal's radius. Therefore covalent radius is smaller than the van der Waal's radius.

3. What are the units of measuring the bond angle?
a) meters
b) kilograms
c) degree
d) mole

Answer: c
Explanation: The angle between two bonds from the same atom that is bonded to different atoms is called the bond angle. It expressed in the units of degree experimentally by spectroscopic methods. It depicts the shape of the molecule in a 3D dimension.

4. The bond angle between the hydrogen atoms is _____
a) 104.5°
b) 104°
c) 105.4°
d) 105°

Answer: a
Explanation: The water molecule is the V-shape, so the angle between hydrogen through oxygen is given → by 104.5°. As we know the angle

between two bonds from the same atom that is bonded to different atoms is called the bond angle.

5. Strength of the bond between the two atoms can be known from bond dissociation enthalpy.
a) True
b) False

Answer: a
Explanation: Yes, it's true. The energy that is used to break a molecule into atoms is bond dissociation enthalpy. The higher the bond dissociation energy, the stronger the bond between the atoms. So the strength of the bond between the two atoms can be known from bond dissociation enthalpy.

6. The bond enthalpy of H_2O and OH are 502 KJ mol^{-1} and 427 KKJ mol^{-1}. Then what is the average bond enthalpy?
a) 502 KJ mol^{-1}
b) 464.5 KJ mol^{-1}
c) 427 KJ mol^{-1}
d) 75 KJ mol^{-1}

Answer: b
Explanation: We know that $H_2O_{(g)} \rightarrow H_{(g)} + OH_{(g)}$; ΔH_1 = 502 kJ mol^{-1} and $OH_{(g)} \rightarrow H_{(g)} + O_{(g)}$; ΔH_2 = 427 kJ mol^{-1}. So the average bond enthalpy is given by their mean that is 427 + 502/2 = 464.5 KJ mol^{-1}. This method is used for polyatomic molecules like water.

7. What is the bond order of CO?
a) 3
b) 2
c) 1
d) 4

Answer: a
Explanation: The number of bonds that are created between two atoms

in a molecule is the bond order of that bond. The molecule carbon monoxide CO has a triple bond between the carbon and oxygen, so it's bond order is 3.

8. All the _____ species(molecules and ions) have the same bond order.
a) isotopic
b) isoelectronic
c) isobaric
d) isoneutronic

Answer: b
Explanation: The molecules and ions that contain the same number of electrons are called isoelectronic species. They all have the same bond order. For example, the molecules and ions like N_2, CO and NO^+ have the bond order 3 and 14 electrons.

9. Resonance does stabilize the molecule.
a) False
b) True

Answer: b
Explanation: Resonance stabilizes the molecule as the resonance hybrid comprises of less energy than other canonical structures. Resonance is made of many structures that change frequently in molecules in order to maintain stability in the molecule.

10. Which of the following molecules may have a dipole movement?
a) N_2
b) CH_4
c) BeF_2
d) H_2O

Answer: d
Explanation: The dipole movement is given by the product of charge and the distance of separation between atoms. It is expressed in Debye units

(D). For the molecules N_2, CH_4 and BeF_2 the net dipole movement is zero as they cancel each other due to symmetry. But water molecule due to its V-shape exhibits dipole movement.

Valence Shell Electron Pair Repulsion (VSEPR) Theory

1. Which of the following is correct regarding repulsive interaction?
a) Lone pair-Lone pair is greater than Lone pair-Bond pair is greater than Bond pair-Bond pair
b) Lone pair-Lone pair is less than Lone pair-Bond pair is less than Bond pair-Bond pair
c) Lone pair-Bond pair is greater than Lone pair-Lone pair is greater than Bond pair-Bond pair
d) Lone pair-Lone pair is greater than Lone pair-Bond pair is less than Bond pair-Bond pair

Answer: a
Explanation: The repulsive interactions follow the above order. The lone pairs are localized on the central atom, each bonded pair is shared between two atoms. So, the lone pair electrons in a molecule occupy more space as compared to the bonding pairs of electrons.

2. The shape of the molecule depends on the _____
a) adjacent atom
b) valence electrons
c) surroundings
d) atmosphere

Answer: b
Explanation: As the postulate of Valence Shell Electron Pair Repulsion Theory (VSEPR), the shape of the molecule depends on the number of valence shell electron pairs around the atom (both bonded and non-bonded).

3. The shape a molecule occupies allows to minimize repulsions among them and maximize the space between them.
a) True
b) False
View Answer
Answer: a
Explanation: As the postulate of Valence Shell Electron Pair Repulsion Theory (VSEPR), a molecule tends to form a shape or orientation that has little repulsion comparatively and the higher distance between the electron pairs comparatively.

4. What is the shape of the molecule NH_3?
a) Square pyramidal
b) V-shape
c) Triagonal pyramidal
d) Tetrahedral

Answer: c
Explanation: The molecule NH_3 has a lone pair and 3 bond pairs. As we know that the repulsion order is as follows: Lone pair-Lone pair is greater than Lone pair-Bond pair is greater than Bond pair-Bond pair. So the shape of molecule NH_3 is trigonal pyramidal, where the lone pair is away from the 3 bond pairs.

5. How many orbitals are included in sp^3d hybridization?
a) 5
b) 4
c) 3
d) 6

Answer: a
Explanation: The concept of mixing of atomic orbitals and formation of new hybridized atomic orbitals for the pairing of electrons through chemical bonds. Therefore sp^3d hybridization included 5 orbitals namely 1 s-orbital, 3 p-orbitals, and 1 d-orbital.

6. A double bond is made up of _____
a) Two sigma bonds
b) Two pi bonds
c) One sigma and one pi bond
d) Two sigmas and one pi bond

Answer: c
Explanation: A double bond is formed chemically between two atoms that involve the bonding of four electrons. A double bond is formed with one sigma and one pi bond. The formation of molecules like ethane, oxygen involve double bonds.

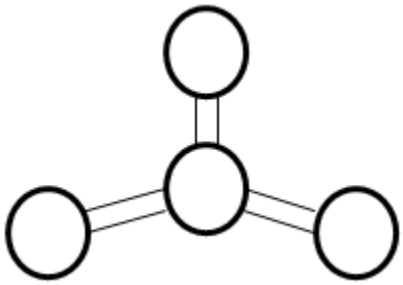
7. Which of the following molecules geometry is true?
a) BrF_5 – Triagonal pyramidal
b) ClF_3 – T-shape
c) PCl_5 – See-saw
d) SF_4 – Triagonal bipyramidal

Answer: b
Explanation: The molecule ClF_5 has T-shape as it 3 bonding pairs and 2 lone pairs, so it's true. The molecules BrF_5, PCl_5, and SF_4 have the shapes square pyramidal, trigonal bipyramidal and see-saw respectively.

8. What is the shape of water?
a) Triagonal
b) Triagonal bipyramidal
c) Bent
d) Square planar

Answer: c
Explanation: The water molecule H-O-H has an arrangement of electrons in a tetrahedral. As it contains two bond pairs and lone pairs in the form of the molecule of type AB_3E_2, it's shape is bent i.e. neglecting the lone pairs.

9. What is the name of the below-given shape?



a) Triagonal planar
b) Tetrahedral
c) Square planar
d) Octahedral

Answer: a
Explanation: In the above shape, each bond from the center is separated by 120°. So the above shape is trigonal planar. Few examples of the trigonal planar are boron trifluoride, sulfur trioxide, and borane with sp^2 hybridization.

10. The angle between two bonds in a linear molecule is _____
a) 108°
b) 180°
c) 74.5°
d) 90°

Answer: b
Explanation: A linear molecule has a hybridization sp, in which the bonds between the central atom and other atoms are separated by 180°. For example, let's take carbon dioxide, it's shape is given by O=C=O

Valence Bond Theory

1. The bond enthalpy of _____ molecule is 435.8 kJ mol^{-1}.
a) Hydrogen
b) Oxygen

c) Nitrogen
d) Helium

Answer: a
Explanation: The amount of energy that is required to break a chemical bond in a molecule into individual atoms is known as bond enthalpy. 435.8 kJ mol^{-1} is required to dissociate a hydrogen molecule into two hydrogen atoms.

2. The strength of covalent _____ extent of overlapping of orbitals.
a) may be or may not be related
b) is independent on
c) is dependent on
d) is not related to

Answer: c
Explanation: As per the concept of valence bond theory, the partial merging of atomic orbitals id knowns as overlapping. The extent of overlapping is directly proportional to the strength of the covalent bond, i.e. it is dependent.

3. What is the electronic configuration of carbon in it's excited state?
a) $1s^2 2s^2 2p^4$
b) $1s^2 2s^2 2p^3$
c) $1s^2 2s^2 2p^5$
d) $1s^2 2s^1 2p^4$

Answer: b
Explanation: The electronic configuration of carbon in its ground state is given by $1s^2 2s^2 2p^4$. When it's in an excited state, that is when it loses an electron, that would be from 2p-orbital. So the excited state's electronic configuration is $1s^2 2s^2 2p^3$.

4. Which type of bond is present between hydrogens in hydrogen molecule?

a) Sigma bond
b) Pi bond
c) Ionic bond
d) Metallic bond

Answer: a
Explanation: The head-on or end to end type of overlapping is present in sigma bond. A sigma bond is a type of covalent bond. It may also be called an axial overlap. In case of the hydrogen molecule, its s-s overlapping.

5. The pi-bond involves _____
a) axial overlapping
b) side-wise overlapping
c) end to end type of overlapping
d) head-on overlapping

Answer: b
Explanation: A pi-bond is a type of covalent bond in which the internuclear axes of the atoms are parallel to each other and for side-wise overlapping. The bond formed here is perpendicular to the internuclear axes.

6. A pi bond is stronger than a sigma bond.
a) True
b) False

Answer: b
Explanation: A sigma bond is always stronger than the pi bond. As we know that the bond strength is decided by the extent of orbital's overlapping. The extent of overlapping is more in sigma bond than in a pi-bond.

7. A _____ overlap doesn't result in the formation of a bond.
a) positive
b) negative

c) zero
d) rational

Answer: c
Explanation: Zero overlap means that the orbitals don't overlap at all. When there is no overlapping the bond formation doesn't occur. As we all know that the extent of overlapping is dependent on the strength of the bond.

8. A positive overlap is same as _____
a) out-phase overlap
b) negative overlap
c) zero overlap
d) in-phase overlap

Answer: d
Explanation: A positive overlap results in bond formation. When 2 p-orbitals are in phase, both the positive lobes overlap, thus creating a positive overlap and result in the bond formation, thus it is called in-phase overlap.

9. Valence bond theory explains the overlapping of atomic orbitals.
a) True
b) False

Answer: a
Explanation: Valence bond theory was initially introduced by London and Heitler and was developed by Pauling and others. It's a chemical bonding theory that explains the overlapping the atomic orbitals in order to form chemical bonds between atoms.

10. Which of the following is not a homonuclear diatomic molecule?
a) H_2
b) N_2
c) O_2

d) HCl

Answer: d
Explanation: The molecule that is formed from the same element is known as a homonuclear molecule and the molecule that is made up of 2 atoms is called a diatomic molecule. But HCl is not a homonuclear diatomic molecule as it has different atoms.

Molecular Structure – Hybridisation

1. Who introduced the concept of hybridization?
a) Pauling
b) London
c) Sidgwick
d) Alexander

Answer: a
Explanation: In order to explain the bonding and shapes of every polyatomic atomic molecule like methane, carbon tetrachloride, water, boron trifluoride, etc, Pauling put-forth the concept of hybridization.

2. The phenomenon of forming completely new atomic orbitals by intermixing them is known as _____
a) Allocation
b) Hybridization
c) Chemical bond formation
d) Electron configuration

Answer: b
Explanation: The exact meaning of hybridization is the intermixing of different orbitals in order to form a new set of equivalent orbitals otherwise known as hybridized orbitals. These hybrid orbitals are used in bond formation.

3. The orbitals that are resulted from sp hybridization have _____% s-character and _____% p-character.
a) 25, 75
b) 75, 25
c) 20, 80
d) 50, 50

Answer: d
Explanation: When one s-orbital and p-orbital undergo hybridization, 2 sp orbitals are formed. One sp-orbital has 50% s-character and 50% p-character. They possess linear geometry and it's also called diagonal hybridization.

4. What type of hybridization does a BCl_3 molecule undergo?
a) sp
b) sp^2
c) sp^3
d) sp^3d

Answer: b
Explanation: In the BCl_3 molecule, one s-orbital and two p-orbitals intermix and form three equivalent hybrid orbits. Therefore it undergoes sp^2 hybridization and forms trigonal planar shape, like B in the center and Cl in the 3 corners.

5. What is the bond angle of H-C-H in methane molecule?
a) 104.5°
b) 109.5°
c) 108°
d) 120°

Answer: b
Explanation: The molecule of methane i.e. CH_4 had undergone sp^3 hybridization (1 s-orbital and 3 p-orbitals combine to give 4 sp^3 orbitals). It exhibits tetrahedral geometry. In tetrahedral geometry,

the angle between the bonds of corner atoms and the central atom is 109.5°.

6. What do you think is the number of sigma bonds in an ethene molecule?
a) 6
b) 7
c) 4
d) 5

Answer: d
Explanation: The formula of ethene molecule is C_2H_4. There is one sigma bond between two carbon atoms and 2 sigma bonds between each of the carbon and the hydrogens. So in total, it's five (one pi-bond is present between the 2 carbon atoms).

7. Mention the types of orbitals that undergo hybridization in order to get octahedral geometry?
a) s-orbital only
b) s-orbital and p-orbital
c) s-orbital, p-orbital, and d-orbital
d) d-orbital and p-orbital

Answer: c
Explanation: Octahedral geometry is possible when the atomic orbitals under undergoing sp^3d^2 or d^2sp^3 hydration only. So it involves one s-orbital, three p-orbitals, and two d-orbitals. An example of this is SF_6.

8. What is the geometry of PCl_5 molecule?
a) Square pyramidal
b) V-shape
c) Trigonal bipyramidal
d) Tetrahedral

Answer: c
Explanation: As the PCl_5 molecule undergoes sp^3d hybridization, it

posses the geometry the trigonal bipyramidal. In the shape, the central atom is Phosphorous and the atoms at the five corners are Chlorine.

9. The orbitals formed after hybridization have equal energy.
a) True
b) False

Answer: a
Explanation: The hybridization is the intermixing of different orbitals in order to form a new set of equivalent orbitals otherwise known as hybrid orbitals. All the hybrid orbitals those have undergone the same hybridization have the same amount of energy.

10. Which of the following statement is true regarding hybrid orbitals?
a) The amount of orbitals formed after the hybridization is not equal to the number of orbitals before hybridization
b) The hybrid orbitals don’t have equal energy
c) They can form more stable bonds than the pure orbitals
d) Hybridization doesn’t indicate geometry

Answer: c
Explanation: The true statements of the incorrect ones are the number of orbitals formed after the hybridization is equal to the number of orbitals before hybridization, the hybrid orbitals have equal energy and the hybridization indicates geometry.

Molecular Orbital Theory

1. Combination of two atomic orbitals results in the formation of two molecular orbitals namely _____
a) one bonding and one non-bonding orbital
b) two bonding orbitals
c) two non-bonding orbitals
d) two bonding and non-bonding orbitals

Answer: a
Explanation: F. Hund and R.F. Mullikan proposed Molecular orbital theory in the year 1932. According to this theory, the combination of two atomic orbitals results in the formation of two molecular orbitals namely one bonding and one non-bonding orbital.

2. Stability increases, as the energy _____
a) increases
b) doesn't change
c) decreases
d) increases and then decreases

Answer: c
Explanation: As the stability increases, the energy of that substance decreases. The higher the energy, the less stable the molecule. So stability is inversely proportional to the energy. This can be seen in any part of the universe.

3. $\psi_{MO} = \psi_A + \psi_B$.
a) True
b) False

Answer: a
Explanation: The linear combinations like additions and subtractions of wave functions of individual atomic orbitals indicate the formation of molecules mathematically, as given i.e. $\psi_{MO} = \psi_A + \psi_B$.
Where ψ represents the wavefunctions of atomic orbitals.

4. Which of the following is a condition for the combination of atomic orbitals?
a) Combining atomic orbitals need not have equal energy
b) Combining atomic orbitals must have symmetry as per molecular axis
c) Combining atomic orbitals must overlap to a minimum extent
d) For combining atomic orbitals, X-axis should be taken as a molecular axis

Answer: b
Explanation: Combining atomic orbitals must have symmetry as per molecular axis is true. The corrected statements are combining atomic orbitals must have equal energy, must overlap to the maximum extent and Z-axis should be taken as the molecular axis.

5. Sigma molecular orbitals are not symmetrical around the bonding axis.
a) True
b) False

Answer: b
Explanation: According to the nomenclature, sigma molecular orbitals are symmetrical around the bonding axis and the pi molecular orbitals are not symmetrical around the bonding axis. So the given statement is false.

6. Which of the bonding orbital has greater energy comparatively?
a) Both Bonding molecular orbital and Anti-bonding molecular orbital have the same energy
b) The energy of Bonding molecular orbital and Anti-bonding molecular orbital depends on the situation
c) Bonding molecular orbital
d) Anti-bonding molecular orbital

Answer: d
Explanation: An electron that enters bonding orbitals stabilizes the molecule as it' in between two nuclei. Whereas when an electron is entered into the anti-bonding orbital, it needs to pull an electron away from the nucleus.
7. Take N_A as the number of Anti-bonding molecular orbitals and N_B as the number of Bonding molecular orbitals. The molecule is stable when N_A _____ N_B.
a) is greater than
b) is equal to
c) is less than

d) is greater than or equal to

Answer: c
Explanation: When a molecule consists both bonding molecular orbitals and anti-bonding molecular orbitals, the higher the number of bonding orbitals, the more the bonding influence and the more stable the molecule will be and vice-versa.

8. What's the bond order of Oxygen?
a) 3
b) 2
c) 1
d) 0

Answer: b
Explanation: The formula of bond order is given by $\frac{1}{2}(N_B - N_A)$ When N_B is bonding orbitals and N_A is the number of anti-bonding orbitals. In Oxygen, bond order = 1/2(10-6) = 2. When it's zero the molecule cannot be formed.

9. What do you think is the relationship between bond order and bond length?
a) Directly proportional
b) Indirectly proportional
c) No relation
d) Cannot predict

Answer: b
Explanation: The bond length has defined the distance between two atoms in a molecule. The bond order depends on the bond length between two atoms in a molecule. As the bond length increases the bond decreases and vice-versa.

10. Which of the following molecule is not true about paramagnetic molecules?
a) Attracted by the magnetic field

b) A molecular orbital is singly occupied
c) An example is oxygen molecule
d) Repelled by the magnetic field

Answer: d
Explanation: Paramagnetic molecules are attracted by the magnetic field and orbitals are singly occupied. O_2 is an example. Whereas diamagnetic molecules are repelled by the magnetic field, so the option is wrong

Bonding in Some Homonuclear Diatomic Molecules

1. What is the electronic configuration of hydrogen molecule?
a) $\sigma 1s^2$
b) $\sigma 1s^1$
c) $\sigma 1s$
d) $\sigma^* 1s$

Answer: a
Explanation: In a hydrogen atom, each hydrogen shares an electron from 1s orbital, so in total there are two electrons present in 1s bonding orbital of the molecule. So the electronic configuration of the hydrogen molecule is $\sigma 1s^2$.

2. What is the condition, for a molecule do not exist?
a) $N_A = N_B$
b) $N_A > N_B$
c) $N_A < N_B$
d) $N_A >/< N_B$

Answer: a
Explanation: When a molecule's bond order is equal to zero, the molecule cannot exist. The formula for finding out bond order is $12(N_B – N_A)$. So $N_A – N_B = 0$, that is $N_A = N_B$. Where N_A as the number of anti-bonding molecular orbitals and N_B as the number of bonding molecular orbitals.

3. Which of the following molecule doesn't exist?
a) O_2
b) H_2
c) He_2
d) N_2

Answer: b
Explanation: The electronic configuration of He_2 is $\sigma 1s^2 \sigma^* 1s^2$. Here $N_A = N_B$ (where N_A as the number of anti-bonding molecular orbitals and N_B as the number of bonding molecular orbitals). So the molecule He_2 doesn't exist.

4. The number of electrons in bonding orbital and anti-bonding orbital of Lithium molecule are _____ and _____ respectively.
a) 4, 4
b) 2, 2
c) 2, 4
d) 4, 2

Answer: d
Explanation: The lithium molecule is denoted by Li_2. When the lithium molecule is formed, each of the lithium shares an electron in the 2s orbital. Its electronic configuration is $\sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2$. So the number of electrons in bonding orbital and anti-bonding orbital of Lithium molecule are 4 and 2 respectively.

5. What is the electronic configuration of the carbon atom?
a) $1s^2 2s^2 2p^2$
b) $\sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \pi 2p_x^2 \pi 2p_y^2$
c) $1s^2 2s^2 2p^1$
d) $\sigma 1s^2 \sigma^* 1s\ \sigma 2s^2 \pi 2p_x^2 \pi 2p_y^2$

Answer: a
Explanation: The given question electronic configuration of carbon "atom", but not carbon "molecule". So by following Aufbau's principle

and noting that carbon contains 6 electrons, the answer is given as $1s^2 2s^2 2p^2$.

6. O_2 is paramagnetic in nature.
a) True
b) False

Answer: a
Explanation: $\sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 2p_z^2 \pi 2p_x^2 \pi 2_y^2 \pi^* 2p_x^1 \pi^* 2p_y^1$ is the electronic configuration of O_2 molecule. According to this, it has two unpaired electrons, making it paramagnetic and is attracted by the magnetic field.

7. The electronic configurations of molecules change when the number of electrons is _____
a) 10
b) 20
c) 17
d) 14

Answer: d
Explanation: The electronic configuration below number of electrons = 14, i.e. number of electrons = 12 is $\sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2$ $\sigma^* 2s^2 \pi 2p_x^2 \pi 2_y^2$but after 14, take number of electrons = 16 is $\sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 2p_z^2 \pi 2p_x^2 \pi 2_y^2 \pi^* 2p_x^1 \pi^* 2p_y^1$ So the change comes near $2p_z$ orbital's place.

8. Which of the following is true regarding nitrogen molecule.
a) Diamagnetic
b) Paramagnetic
c) Bond order is 2
d) Total number of electrons in the molecule is 13

Answer: a
Explanation: The Nitrogen molecule N_2 is diamagnetic in nature as it contains zero single electrons, all the electrons are paired. Its bond order

is calculated as 3 and the total number of electrons the nitrogen molecule are 14.

9. H_2, N_2, O_2 and Li_2 are _____
a) heteronuclear diatomic molecules
b) heteronuclear triatomic molecules
c) homonuclear diatomic molecules
d) homonuclear triatomic molecules

Answer: c
Explanation: The molecules that have the same atoms in them are called as homonuclear molecules. The molecules that have only two atoms are called diatomic molecules. So H_2, N_2, O_2, and Li_2 are called homonuclear diatomic molecules.

10. What is the total number of electrons in the Chlorine molecule?
a) 17
b) 34
c) 18
d) 16

Answer: b
Explanation: A Chlorine atom is made up of 17 electrons. When two Chlorine atoms share an electron covalently, the Chlorine molecule is formed. So the Chlorine molecule Cl_2 has a total of 17 + 17 atoms = 34 atoms.

Hydrogen Bonding

1. Nitrogen, fluorine and oxygen are _____ in nature.
a) electronegative
b) electropositive
c) metallic
d) semi-metallic

Answer: a
Explanation: Electronegativity is the tendency of a neutrally isolated gaseous atom to attract an electron. This is high in the case of nitrogen, oxygen, and fluorine. So the negative charge in the hydrogen bond is towards them.

2. Which bond acts like a bridge two molecules formed by a covalent bond?
a) Covalent bond
b) Ionic bond
c) Hydrogen bond
d) Metallic bond

Answer: c
Explanation: For example, consider a molecule that's formed due to a covalent between hydrogen and fluorine. Here hydrogen acquires a positive charge. Hydrogen bond formation occurs between hydrogen in a molecule and fluorine of the other molecule.

3. A molecule named o-nitrophenol consists of _____hydrogen bond/s.
a) intermolecular
b) intramolecular
c) both intermolecular and intramolecular
d) neither intermolecular nor intramolecular

Answer: b
Explanation: The presence of hydrogen between molecules is intermolecular hydrogen bond and presence of hydrogen bond in the molecule itself is intramolecular hydrogen bond. In o-nitrophenol, there is a hydrogen bond between the hydrogen of the hydroxide group and oxygen.

4. In a hydrogen bond, hydrogen has a positive charge.
a) True

b) False

Answer: a
Explanation: IN the hydrogen bond, the other element is highly electronegative, So the hydrogen becomes electropositive comparatively in this case and there is a displacement of electrons towards the electronegative side. Hence hydrogen has a positive charge.

5. Water molecules contain _____ hydrogen bond/s.
a) intermolecular
b) intramolecular
c) both intermolecular and intramolecular
d) neither intermolecular nor intramolecular

Answer: a
Explanation: In a water molecule, the hydrogen bonds are formed between other molecules but not within the same molecule. The presence of hydrogen between molecules is intermolecular hydrogen bond and presence of hydrogen bond in the molecule itself is intramolecular hydrogen bond.

6. The magnitude of the H-bonding depends on the _____ of the compound.
a) surroundings
b) system
c) atmosphere
d) physical state

Answer: d
Explanation: The magnitude of the H-bonding depends on the physical state of the compound. In the gaseous state, it is minimum and in the solid state, it is maximum. There is a great influence on a compound’s structure and properties.

7. Which of the following molecule can form a hydrogen bond with hydrogen?

a) Sodium
b) Oxygen
c) Aluminum
d) Rubidium

Answer: b
Explanation: Most Electronegative elements can only form hydrogen bonds with hydrogen, Among Sodium, Oxygen, Aluminium, and Rubidium, Oxygen is the electronegative element. So only oxygen can form a hydrogen bond.

8. Which of the following molecules doesn't involve hydrogen bond formation?
a) H_2O
b) O-nitrophenol
c) NaCl
d) HF

Answer: c
Explanation: Water, Hydrogen fluoride include intermolecular hydrogen while o-nitrophenol has intramolecular hydrogen bonding. Sodium Chloride NaCl has an ionic bond that is much stronger than hydrogen bond.

9. In a hydrogen bond, the electron pair that is shared moves away from hydrogen.
a) True
b) False

Answer: a
Explanation: Yes, in the formation of a hydrogen bond, the electron pair moves away from hydrogen. This occurs due to the high electronegativity of other atoms participating in a hydrogen bond. So naturally, hydrogen has positive charges and electrons move away.

10. Alcohol and HF molecule contains _____ & _____ hydrogen bonds.
a) intramolecular, intermolecular
b) intermolecular, intermolecular
c) intermolecular, intramolecular
d) intramolecular, intramolecular

Answer: b
Explanation: The presence of hydrogen between molecules is intermolecular hydrogen bond and the presence of hydrogen bond in the molecule itself is intramolecular hydrogen bond. So it's intermolecular in case of alcohol and water.