11th Science Lesson 9 Questions in English

9] Chemical Bonding

1. In which year the Linus Carl Pauling was awarded Nobel Prize for his research?

a) 1982

b) 1954

c) 1948

d) 1970

Explanation

Linus Carl Pauling was an American chemist, biochemist, peace activist, author and educator. In addition to his contribution to chemistry and he also worked with many biologists. He received the Nobel Prize in Chemistry in 1954 for his research into the nature of the chemical bond and its application to the elucidation of the structure of complex substances.

2. Choose the Incorrect statements.

i) Hydrogen and Oxygen are monoatomic and the inert gases are diatomic.

ii) Sodium combines with chlorine and forms sodium chloride that readily dissolves in water.

iii) Carbon combines with chlorine to form carbon tetrachloride that is insoluble in water.

a) i only

b) ii only

c) iii only

d) None of the above

Explanation

Diamond is very hard while its allotrope graphite is very soft. Gases like hydrogen and oxygen are diatomic while the inert gases are monoatomic. Carbon combines with chlorine to form carbon tetrachloride, which is a liquid and insoluble (immiscible) in water. Sodium combines with chlorine atom to form sodium chloride, a hard and brittle compound that readily dissolves in water.

3. Which of these attractive forces hold the atoms together in a chemical bond?

a) Electron forces

b) Static forces

c) Interatomic forces

d) Wander Walsh forces

Explanation

The interatomic attractive forces which hold the constituent atoms/ions together in a molecule are called chemical bonds.

4. Who provided the logical explanation for the chemical bonding?

a) Kossel and Lewis

b) Heitler and London

c) F. Hund and Robert. S. Mulliken

d) Linus Pauling

Explanation

A logical explanation for chemical bonding was provided by Kossel and Lewis in 1916.

5. Which of these facts is not true based on the Kossel and Lewis approach on chemical bonding?

a) The inertness of the noble gases is the basis for the chemical bonding.

b) Noble gas has little or no tendency to combine with other atoms.

c) Noble gases are not stable due to their completely filled outer shell electronic configuration.

d) Elements attain the completely filled configurations by losing, gaining or sharing on or more electrons.

Explanation

The Kossel and Lewis approach to chemical bonding is based on the inertness of the noble gases which have little or no tendency to combine with other atoms. They proposed that the noble gases are stable due to their completely filled outer shell electronic configuration. Elements other than noble gases, try to attain the completely filled electronic configurations by losing, gaining or sharing one or more electrons from their outer shell.

6. Which of these was introduced by G.N. Lewis?

a) Chemical bonding

b) Lewis dot structure

c) Diatomic nitrogen

d) Valence electrons

Explanation

G. N. Lewis proposed that the attainment of stable electronic configuration in molecules such as diatomic nitrogen, oxygen is achieved by mutual sharing of the electrons. He introduced a simple scheme to represent the chemical bond and the electrons present in the outer shell of an atom, called Lewis dot structure.

7. Which of the following is represented by the small dots in the Lewis dot scheme?

a) Valence electrons

b) Number of protons

c) Atomic number

d) Number of electrons

Explanation

In the Lewis dot scheme, the valence electrons (outer shell electrons) of an element are represented as small dots around the symbol of the element. The first four valence electrons are denoted as single dots around the four sides of the atomic symbol and then the fifth onwards, the electrons are denoted as pairs.

8. Which of these has two electrons in the valence shell?

a) Nitrogen

b) Oxygen

c) Hydrogen

d) Helium

Explanation

Only exception to this is helium which has only two electrons in its valence shell which is represented as a pair of dots (duet).

9. Which of the following is based on the Kossel-Lewis idea of chemical bonding?

a) Gravitational concept

b) Octet rule

c) Relativity theory

d) Electro static theory

Explanation

The idea of Kossel – Lewis approach to chemical bond lead to the octet rule which states that the atoms transfer or share electrons so that all atoms involved in chemical bonding obtain 8 electrons in their outer shell (valence shell)".

10. Based on which of these the chemical bonds are classified?

a) Materials involved in the bonding.

b) Number of atoms present in the bonds.

c) Nature of interaction between the bonded atoms.

d) All the above

Explanation

The chemical bonds can be classified based on the nature of the interaction between the bonded atoms. Two major types of chemical bonds are covalent bonds and ionic bonds. Generally metals

react with non-metals to form ionic compounds and the covalent bonds are present in the compounds formed by non-metals.

11. Define Covalent bond.

a) Mutual sharing of one or more pairs of electrons between two combining atoms.

b) Two atoms share just one pair of electron.

c) Metals reacting with non-metals to form covalent bonds.

d) External sharing of one electron between two atoms.

Explanation

In the case of oxygen molecule, both the oxygen atoms share two electron pairs between them and in nitrogen molecule three electron pairs are shared between two nitrogen atoms. This type of mutual sharing of one or more pairs of electrons between two combining atoms results in the formation of a chemical bond called a covalent bond.

12. Which of these molecules has a single covalent bond?

a) Helium molecule

b) Hydrogen molecule

c) Oxygen molecule

d) Nitrogen molecule

Explanation

If two atoms share just one pair of electron a single covalent bond is formed as in the case of hydrogen molecule. If two or three electron pairs are shared between the two combining atoms, then the covalent bond is called a double bond or a triple bond, respectively.

13. Which of these are denoted by pair of dots on the individual atoms in the Lewis structure?

a) Shared pair of valence electrons

b) Total number of shared electrons

c) Unshared electrons

d) Atomic value of individual atom

Explanation

Lewis structure (Lewis dot structure) is a pictorial representation of covalent bonding between the combining atoms. In this structure the shared valence electrons are represented as a pair of dots between the combining atoms and the unshared electrons of the atoms are represented as a pair of dots (lone pair) on the respective individual atoms.

14. What is the skeletal structure of the water?

a) O 2 H

b) H H O

c) H O H

d) 2 H O

Explanation

Draw the skeletal structure of the molecule. In general, the less electronegative atom is placed at the center. Hydrogen and fluorine atoms should be placed at the terminal positions. For water, the skeletal structure is

15. In which of these cases the number of negative charges is added to the number of valence electrons?

a) Anion

b) Polyatomic gas

c) Cation

d) Positive ions

Explanation

Calculate the total number of valence electrons of all the atoms in the molecule. In case of polyatomic ions the charge on ion should also be considered during the calculation of the total number of valence electrons. In case of anions the number of negative charges should be added to the number of valence electrons. For positive ions the total number of positive charges should be subtracted from the total number of valence electrons.

16. How many valence electrons will account for a single bond in the Lewis structure?

a) 1

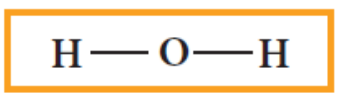
b) 4

c) 2

d) 6

Explanation

Draw a single bond between the atoms in the skeletal structure of the molecule. Each bond will account for two valence electrons (a bond pair). For water, we can draw two bonds accounting for four valence electrons as follows.



17. Assertion (A): The Valence electrons are distributed after the bond formation as pairs by the octet rule.

Reasoning(R): Most electronegative atoms are distributed the lone pairs first then followed by other atoms.

a) Both A and R is True and R is the correct explanation of A.

b) Both A and R is True but R is not the correct explanation of A.

c) A is True but R is False.

d) Both A and R is False.

Explanation

Distribute the remaining valence electrons as pairs (lone pair), giving octet (only duet for hydrogen) to the atoms in the molecule. The distribution of lone pairs starts with the most electronegative atoms followed by other atoms.

18. What is used for satisfying the octet rule in the atoms?

a) Lone pairs

b) Valence electrons

c) Shared electrons

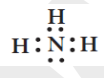
d) All the above

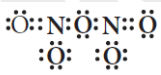
Explanation

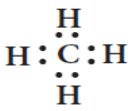
Verify whether all the atoms satisfy the octet rule (for hydrogen duet). If not, use the lone pairs of electrons to form additional bond to satisfy the octet rule. In case of water, oxygen has octet and the hydrogen have duets, hence there is no need for shifting the lone pairs.

19. State the correct Lewis structure for Sulphur trioxide.

a) 

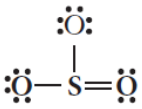
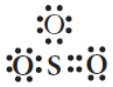
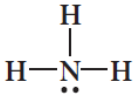
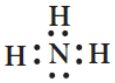
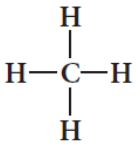
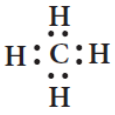
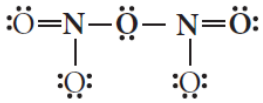
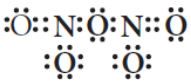
b) 

c) 

d) 

Explanation

The Lewis dot structures for some molecules

S. No	Molecule	Lewis Structure	
1.	Sulphur trioxide (SO_3)		
2.	Ammonia (NH_3)		
3.	Methane (CH_4)		
4.	Dinitrogen Pentoxide (N_2O_5)		

20. Which of the following is not a guideline for representing the Lewis structure?

a) A structure with all formal charges are zero is preferred over the one with charges.

b) A structure with small formal charges is preferred over the higher formal charges.

c) A structure with lone pairs are preferred than the duet pairs of atoms.

d) A structure in which negative formal charges are placed on the most electronegative atom is preferred.

Explanation

After calculating the formal charges, the best representation of Lewis structure can be selected by using following guidelines. A structure in which all formal charges are zero preferred over the one with charges. A structure with small formal charges is preferred over the one with higher formal charges. A structure in which negative formal charges are placed on the most electronegative atom is preferred.

21. Which of the following is not an exception for the octet rule categorization?

a) Molecules containing even electrons.

b) Molecules with electron deficient central atoms.

c) Molecules containing odd electrons.

d) Molecules with expanded valence shells.

Explanation

The octet rule is useful for writing Lewis structures for molecules with second period element as central atoms. In some molecules, the central atoms have less than eight electrons around them while some others have more than eight electrons. Exception to the octet rule can be categorized into following three types. Molecules with electron deficient central atoms, Molecules containing odd electrons and Molecules with expanded valence shells.

22. Which of the following have more than eight electrons around the central atom?

a) SF_3

b) PCl_2

c) PCl_5

d) SF_2

Explanation

In molecules such as sulphur hexafluoride (SF_6), phosphorous penta chloride (PCl_5) the central atom has more than eight valence electrons around them. Here the central atom can accommodate additional electron pairs by using outer vacant d orbitals. In SF6 the central atom sulphur is surrounded by six bonding pair of electrons or twelve electrons.

23. Choose the correct statements.

i) The combining atoms attain the nearest inert gas configuration when the electronegativity difference is small.

ii) The complete transfer of electrons between the atoms leads to the formation of a cation and an anion.

iii) The Anion and cation are held together by the electrostatic attractive force known as covalent bond.

a) i only

b) ii only

c) iii only

d) All the above

Explanation

When the electronegativity difference between the two combining atoms is large, the least electronegative atom completely transfers one or more of its valence electrons to the other combining atom so that both atoms can attain the nearest inert gas electronic configuration. The complete transfer of electron leads to the formation of a cation and an anion. Both these ions are held together by the electrostatic attractive force which is known as ionic bond.

24. In which of these bonds combining atoms donates a pair of electrons and share them commonly?

a) Special ionic bond

b) Shared ionic bond

c) Co-ordinate covalent bond

d) Combined covalent bond

Explanation

In certain bond formation, one of the combining atoms donates a pair of electrons i.e. two electrons which are necessary for the covalent bond formation and these electrons are shared by both the combining atoms. These types of bonds are called coordinate covalent bond or coordinate bond. The combining atom which donates the pair of electron is called a donor atom and the other atom an acceptor atom. This bond is denoted by an arrow starting from the donor atom pointing towards the acceptor atom.

25. What is defined as the bond length?

a) Distance between the valence bonds of combining atoms.

b) Distance between the nuclei of two covalent bond atoms.

c) Maximum distance between the nuclei and the valence bond.

d) Minimum distance shared between the covalent bond atoms.

Explanation

Bond length: The distance between the nuclei of the two covalently bonded atoms is called bond length. Consider a covalent molecule A-B. The bond length is given by the sum of the radii of the bonded atoms (rA + rB).

26. Which of the following are used to determine the bond length?

a) Spectroscopic Technique

b) X-ray diffraction Technique

c) Electron-diffraction Technique

d) All the above

Explanation

The length of a bond can be determined by spectroscopic, x-ray diffraction and electron-diffraction techniques.

27. Which of the following statement is not true regarding the bond length?

a) The size of the atom decides the length of the bond.

b) The number of valence electrons will decrease the bond length.

c) The number of bonds between the combining atoms also decides the bond length.

d) Greater the size of the atom the bond length will also be greater.

Explanation

The bond length depends on the size of the atom and the number of bonds (multiplicity) between the combining atoms. Greater the size of the atom greater will be the bond length. For example, carbon-carbon single bond length (1.54 Å) is longer than the carbon-nitrogen single bond length (1.43 Å).

28. Choose the correct statements.

i) Bond order is defined as the number of bonds formed between the two bonded atoms.

ii) The Bond order is equal to the number of shared pair of electrons between the two bonded atoms.

a) i only

b) ii only

c) Both i and ii

d) Neither i nor ii

Explanation

The number of bonds formed between the two bonded atoms in a molecule is called the bond order. In Lewis theory, the bond order is equal to the number of shared pair of electrons between the two bonded atoms. For example in hydrogen molecules, there is only one shared pair of electrons and hence, the bond order is one. Similarly in H2O, HCl, Methane, etc the central atom forms single bonds with bond order of one.

29. Assertion (A): The fixed angle between two covalent bonds in a molecule is defined as Bond angle.

Reasoning(R): The Covalent bonds are directional in nature and oriented in specific directions in space.

a) Both A and R is True and R is the correct explanation of A.

b) Both A and R is True but R is not the correct explanation of A.

c) A is True but R is False.

d) Both A and R is False.

Explanation

Covalent bonds are directional in nature and are oriented in specific directions in space. This directional nature creates a fixed angle between two covalent bonds in a molecule and this angle is termed as bond angle.

30. Which of the following statement is not correct regarding the bond angle?

a) The Spectroscopic methods are used to determine the bond angle.

b) Bond angle is expressed in degrees.

c) Bond angle is used to determine the size of the atom.

d) The bond angle can give idea about the shape of the molecule.

Explanation

Bond angle is usually expressed in degrees. The bond angle can be determined by spectroscopic methods and it can give some idea about the shape of the molecule.

31. Which of these atoms define the bond angle for CH4?

a) C only

b) C, H only

c) H, O only

d) H only

Explanation

Bond angles for some common molecules

S. No.	Molecule	Bonded atoms	Bond order (No. of shared pair of electrons between bonded atoms)
1	H_2	H-H	1
2	O_2	O=O	2
3	N_2	N≡N	3
4	HCN	C≡N	3
5	HCHO	C=O	2
6	CH_4	C–H	1
7	C_2H_4	C=C	2

32. In which state the bond enthalpy is defined for the molecules?

a) Solid state

b) Liquid state

c) Gaseous state

d) All the above

Explanation

The bond enthalpy is defined as the minimum amount of energy required to break one mole of a particular bond in molecules in their gaseous state.

33. What is the unit of bond enthalpy?

a) k mol

b) kJ mol^{-1}

c) kJ

d) J mol^{-2}

Explanation

The unit of bond enthalpy is kJ mol^{-1}.

34. Which of the below statements are not true about the bond enthalpy?

a) Larger the value of bond enthalpy stronger the bond.

b) The bond energy value depends on the size of the atoms.

c) The number of bonds between the bonded atoms decides the bond angles.

d) Larger the size of atoms involved lesser the bond enthalpy.

Explanation

Larger the bond enthalpy, stronger will be the bond. The bond energy value depends on the size of the atoms and the number of bonds between the bonded atoms. Larger the size of the atom involved in the bond, lesser is the bond enthalpy.

35. Identify the Incorrect Match.

BOND TYPE	BOND LENGTH
A. C-C	i) 1.54
B. H-Cl	ii) 1.27
C. H-H	iii) 1.33
D. C-I	iv) 2.13

a) i only

b) ii only

c) iii only

d) iv only

Explanation

Bond lengths and bond enthalpies of some common bonds.

S. No.	Bond type	Bond Enthalpy (kJ mol^{-1})	Bond Length (Å)
1	H-H	432	0.74
2	H-F	565	0.92
3	H-Cl	427	1.27
4	H-Br	363	1.41
5	H-I	295	1.61
6	C-H	413	1.09
7	C-C	347	1.54
8	C-Si	301	1.86
9	C-N	305	1.47
10	C-O	358	1.43
11	C-P	264	1.87
12	C-S	259	1.81
13	C-F	453	1.33
14	C-Cl	339	1.77
15	C-Br	276	1.94
16	C-I	216	2.13

36. Assertion (A): Resonance structures differ in the position of bonding and lone pair of electrons.
Reasoning(R): Resonance phenomenon occurs at some molecules which has more than one valid Lewis structures.

a) Both A and R is True and R is the correct explanation of A.

b) Both A and R is True but R is not the correct explanation of A.

c) A is True but R is False.

d) Both A and R is False.

Explanation

Resonance: When we write Lewis structures for a molecule, more than one valid Lewis structures are possible in certain cases. For example let us consider the Lewis structure of carbonate ion [CO3]2-.The skeletal structure of carbonate ion (The oxygen atoms are denoted as OA, OB & OC relative position of the atoms are same. They only differ in the position of bonding and lone pair of electrons. Such structures are called resonance structures (canonical structures) and this phenomenon is called resonance.

37. Choose the incorrect statements.

i) All the carbon-oxygen bonds in carbonate ion are equivalent.

ii) The actual structure of the molecules is said to be the resonance hybrid an average of ten resonance forms.

iii) A single Lewis structure is not enough to picture the resonance hybrid.

a) i only

b) ii only

c) iii only

d) None of the above

Explanation

It is evident from the experimental results that all carbon-oxygen bonds in carbonate ion are equivalent. The actual structure of the molecules is said to be the resonance hybrid, an average of these three resonance forms. It is important to note that carbonate ion does not change from one structure to another and vice versa. It is not possible to picture the resonance hybrid by drawing a single Lewis structure.

38. Choose the correct statements.

i) The energy of the resonance hybrid structures is higher than that of all possible canonical structures.

ii) The Resonance energy is the energy difference between the most stable canonical structures and the resonance hybrid structures.

a) i only

b) ii only

c) Both i and ii

d) Neither i nor ii

Explanation

It is found that the energy of the resonance hybrid (structure 4) is lower than that of all possible canonical structures (Structure 1, 2 & 3). The difference in energy between most stable canonical structure and resonance hybrid is called resonance energy.

39. Assertion (A): In a covalent bond of two identical atoms both have equal tendency to attract the shared pair of electrons.

Reasoning(R): In a covalent bond of atoms having different electro negativities, the atom with higher electronegativity will have greater tendency to attract the shared pair of electrons.

a) Both A and R is True and R is the correct explanation of A.

b) Both A and R is True but R is not the correct explanation of A.

c) A is True but R is False.

d) Both A and R is False.

Explanation

When a covalent bond is formed between two identical atoms (as in the case of H2, O2, Cl2 etc...) both atoms have equal tendency to attract the shared pair of electrons and hence the shared pair of electrons lies exactly in the middle of the nuclei of two atoms. However, in the case of covalent bond formed between atoms having different electro negativities, the atom with higher electronegativity will have greater tendency to attract the shared pair of electrons more towards itself than the other atom. As a result the cloud of shared electron pair gets distorted.

40. Define Dipole.

a) Difference between the electro negativities of all the connected atoms.

b) Maximum value between the shared pair of electrons.

c) A small, equal and opposite charges are separated by a small distance.

d) All the above

Explanation

The electro negativities of hydrogen and fluorine on Pauling's scale are 2.1 and 4 respectively. It means that fluorine attracts the shared pair of electrons approximately twice as much as the hydrogen which leads to partial negative charge on fluorine and partial positive charge on hydrogen. Hence, the H-F bond is said to be polar covalent bond. Here, a very small, equal and opposite charges are separated by a small distance (91pm) and is referred to as a dipole.

41. What is the value of the dipole moment?

a) $\mu = q \times 2d$

b) $\mu = q\ d$

c) $\mu = q / 2d$

d) $\mu = q + d$

Explanation

The polarity of a covalent bond can be measured in terms of dipole moment which is defined as $\mu = q \times 2d$ Where μ is the dipole moment, q is the charge and 2d is the distance between the two charges.

42. Choose the correct statements.

i) The Value of dipole moment of a covalent bond is a vector.

ii) The dipole moment vector points from the positive charge to negative charge.

a) i only

b) ii only

c) Both i and ii

d) Neither i nor ii

Explanation

The dipole moment is a vector and the direction of the dipole moment vector points from the negative charge to positive charge.

43. In which of these values the dipole moment is expressed?

a) Joule

b) Newton

c) Kilowatt

d) Debye

Explanation

The unit for dipole moment is columb meter (C m). It is usually expressed in Debye unit (D). The conversion factor is 1 Debye = 3.336 x 10^{-30}C m

44. Which of the following is not a polar molecule or a non-zero dipole moment?

a) HF

b) O_2

c) HCl

d) NO

Explanation

Diatomic molecules such as H_2, O_2, F_2 have zero dipole moment and are called non polar molecules and molecules such as HF, HCl, CO, NO have non zero dipole moments and are called polar molecules.

45. Assertion (A): Diatomic molecules have zero dipole moment and called as non-polar molecules.

Reasoning(R): All the polar bond molecules have a dipole moment value.

a) Both A and R is True and R is the correct explanation of A.

b) Both A and R is True but R is not the correct explanation of A.

c) A is True but R is False.

d) Both A and R is False.

Explanation

Molecules having polar bonds will not necessarily have a dipole moment. For example, the linear form of carbon dioxide has zero dipole moment, even though it has two polar bonds. In CO_2, the dipole moments of two polar bonds (CO) are equal in magnitude but have opposite direction. Hence, the net dipole moment of the CO_2 is, μ = μ1 + μ2 = μ1 + (-μ1) = 0

46. What is the dipole moment of the water?

a) 2.5D

b) 1 D

c) 1.85D

d) 11.5D

Explanation

Dipole moment in water is found to be 1.85D

47. Match the common molecules with its Dipole moment.

A. NH_3 i) 1.91

B. $CHCl_3$ ii) 1.85

C. HF iii) 1.04

D. H_2O iv) 1.47

a) ii, iii, iv, i

b) iv, iii, i, ii

c) ii, iv, i, iii

d) i, iv, iii, ii

Explanation

Dipole moments of common molecules

S. No.	Molecule	Dipole moment (in D)
1	HF	1.91
2	HCl	1.03
3	H_2O	1.85
4	NH_3	1.47
5	$CHCl_3$	1.04

48. What is used to predict the percentage of the ionic character of the atoms?

a) Electronegativity difference

b) Number of bonded pairs

c) Total number of shared electrons

d) Number of protons

Explanation

The extent of ionic character in a covalent bond can be related to the electro negativity difference to the bonded atoms.

49. What is the electronegativity difference value that decides the ionic character of the atoms?

a) 0.7

b) 11.7

c) 1.7

d) 111.7

Explanation

In a typical polar molecule the electronegativity difference can be used to predict the percentage of ionic character as follows. If the electronegativity difference is equal to 1.7, then the bond A-B has 50% ionic character if it is greater than 1.7, then the bond A-B has more than 50% ionic character, and if it is lesser than 1.7, then the bond A-B has less than 50% ionic character.

50. Which of these characters of the ionic compounds can be explained by the Polarization?

a) Partial covalent character

b) Bond enthalpy

c) Bond energy

d) Number of bonds

Explanation

Like the partial ionic character in covalent compounds, ionic compounds show partial covalent character. For example, the ionic compound, lithium chloride shows covalent character and is soluble in organic solvents such as ethanol. The partial covalent character in ionic compounds can be explained on the basis of a phenomenon called polarization.

51. Choose the incorrect statements about the mechanism the polarization.

i) In an ionic compound the negative charged cation attracts the valence electrons of cation while attracting the nucleus.

ii) The distortion in the electron cloud of the anion drifts the density towards cation and shares the valence electrons.

a) i only

b) ii only

c) Both i and ii

d) Neither i nor ii

Explanation

We know that in an ionic compound, there is an electrostatic attractive force between the cation and anion. The positively charged cation attracts the valence electrons of anion while repelling the

nucleus. This causes a distortion in the electron cloud of the anion and its electron density drifts towards the cation, which results in some sharing of the valence electrons between these ions. Thus, a partial covalent character is developed between them. This phenomenon is called polarization.

52. Which is known as the polarisibility?

a) Total number of non-polarized atoms

b) Tendency of an anion to get polarized

c) Extent of polarization

d) Number of atoms polarized

Explanation

The ability of a cation to polarize an anion is called its polarizing ability and the tendency of an anion to get polarized is called its polarisibility. The extent of polarization in an ionic compound is given by the Fajans rules

53. Assertion (A): The Increase in charge on cation or in anion will increase the covalent character.

Reasoning(R): The Polarisibility is increased if the magnitude of negative charge on the anion is higher.

a) Both A and R is True and R is the correct explanation of A.

b) Both A and R is True but R is not the correct explanation of A.

c) A is True but R is False.

d) Both A and R is False.

Explanation

Fajans Rules: To show greater covalent character, both the cation and anion should have high charge on them. Higher the positive charge on the cation, greater will be the attraction on the electron cloud of the anion. Similarly higher the magnitude of negative charge on the anion, greater is its polarisibility. Hence, the increase in charge on cation or in anion increases the covalent character.

54. Which of these shows greater covalent character due to greater extent of polarization?

a) Smaller cation and larger anion

b) Equal cation and anion

c) Larger cation and smaller anion

d) Varying anion and cation

Explanation

The smaller cation and larger anion show greater covalent character due to the greater extent of polarization.

55. Which of these will be useful in predicting the shape of molecules?

a) Lewis theory alone

b) Number of combining atoms

c) Lewis theory with VSEPR theory

d) Number of cations and anion

Explanation

Lewis concept of structure of molecules deals with the relative position of atoms in the molecules and sharing of electron pairs between them. However, we cannot predict the shape of the molecule using Lewis concept. Lewis theory in combination with VSEPR theory will be useful in predicting the shape of molecules.

56. Which of these will depend on the number of valence shell electron pair of the molecules according to VSEPR theory?

a) Number of Lone pairs

b) Shape of molecules

c) Total number of bonded pairs

d) Number of valence electron

Explanation

Important principles of VSEPR Theory are as follows: The shape of the molecules depends on the number of valence shell electron pair around the central atom.

57. Choose the correct statements.

i) Various numbers of electron pairs are available in that bond pairs and lone pairs are one of them.

ii) Lone pairs are the valence electron pairs which are not involved in bonding.

a) i only

b) ii only

c) Both i and ii

d) Neither i nor ii

Explanation

There are two types of electron pairs namely bond pairs and lone pairs. The bond pair of electrons are those shared between two atoms, while the lone pairs are the valence electron pairs that are not involved in bonding.

58. Which of this order denotes the repulsive interaction between the types of electron pairs as per VSEPR theory?

a) lp - lp > lp – bp > bp- bp

b) lp - lp < lp – bp < bp-bp

c) lp - lp > bp – bp > lp-bp

d) lp - lp < lp – bp > bp-bp

Explanation

Each pair of valence electrons around the central atom repels each other and hence, they are located as far away as possible in three dimensional spaces to minimize the repulsion between them. The repulsive interaction between the different types of electron pairs is in the following order. lp - lp > lp – bp > bp-bp where lp- lone pair; bp- bond pair.

59. Why the lone pairs have greater repulsive power in a molecule?

a) Lone pairs are localized on the central atom.

b) Lone pairs interact with only one nucleus.

c) Lone pairs occupy more space than bond pairs.

d) All the above

Explanation

The lone pair of electrons are localized only on the central atom and interacts with only one nucleus whereas the bond pairs are shared between two atoms and they interact with two nuclei. Because of this the lone pairs occupy more space and have greater repulsive power than the bond pairs in a molecule.

60. Which of the following has a v- shape or bent shape geometry?

a) CO_2

b) HCN

c) O_3

d) BF_3

61. Identify the incorrect Match

A. Trigonal planar	i) HCHO
B. Tetrahedral	ii) CS_2
C. Linear	iii) $BeCl_2$
D. Bent shape	iv) $PbCl_2$

a) i only

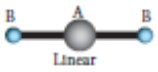
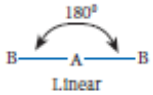
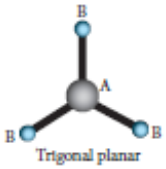
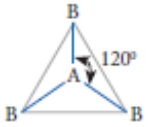
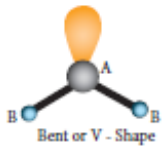
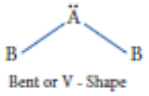
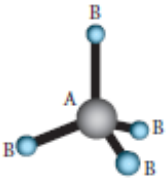
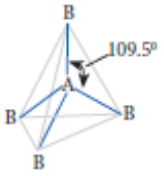
b) ii only

c) iii only

d) iv only

Explanation

Shapes of molecules predicted by VSEPR theory.

Number of electron Pairs	Molecule	No.of bond pairs	No.of. lone pairs	Shape	Molecular geometry	Examples
2	AB_2	2	-	 Linear	 Linear	$BeCl_2$, $HgCl_2$, CO_2, CS_2, HCN, BeF_2
3	AB_3	3	-	 Trigonal planar	 Trigonal planar	BF_3, BCl_3, NO_3^-, BF_3, CO_3^{2-}, HCHO
	AB_2L	2	1	 Bent or V - Shape	 Bent or V - Shape	SO_2, O_3, $PbCl_2$, $SnBr_2$
4	AB_4	4	-	 Tetrahedral	 Tetrahedral	CH_4, CCl_4, CCl_2F_2, SO_4^{2-}, ClO_4^-, NH_4^+

62. Which of these molecules has single lone pair?

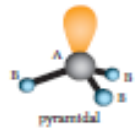
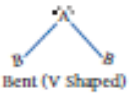
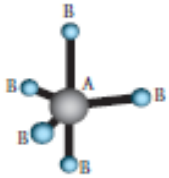
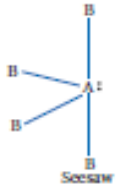
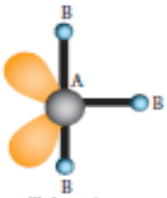
a) AB_2L_2

b) AB_3L

c) AB_5

d) AB_3L_2

Explanation

Number of electron Pairs	Molecule	No.of bond pairs	No.of lone pairs	Shape	Molecular geometry	Examples
	AB_3L	3	1	 pyramidal	 pyramidal	NH_3, PF_3, ClO_3^-, H_3O^+,
	AB_2L_2	2	2	 Bent (V Shaped)	 Bent (V Shaped)	H_2O, OF_2, SCl_2
5	AB_5	5	-	 Trigonal bipyramidal	 Trigonal bipyramidal	PCl_5, ASF_5, SOF_4
	AB_4L	4	1	 Seesaw	 Seesaw	SF_4, XeO_2F_2, IF_4^+, $IO_2F_2^-$
	AB_3L_2	3	2	 T shaped	 T Shaped	BrF_3, ClF_3,

63. Which of this molecule does not have a square pyramidal geometry?

a) BrF_5

b) $XeOF_4$

c) XeF_4

d) TeF^-_5

64. What is the molecular geometry shape of the molecule AB_7?

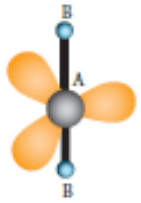
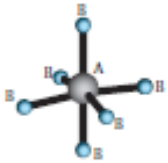
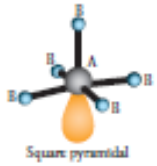
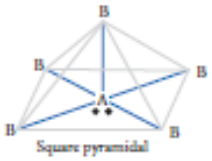
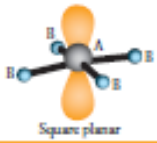
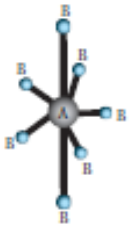
a) Pentagonal bi-pyramidal

b) Linear

c) Square planar

d) Octahedral

Explanation

Number of electron Pairs	Molecule	No.of bond pairs	No.of. lone pairs	Shape	Molecular geometry	Examples
	AB_2L_3	2	3	 Linear	 Linear	XeF_2, I_3^-, IF_2^-
	AB_6	6	-	 Octahedral	 Octahedral	SF_6, IOF_5,
6	AB_5L	5	1	 Square pyramidal	 Square pyramidal	BrF_5, IF_5, TeF_5^-, $XeOF_4$,
	AB_4L_2	4	2	 Square planar	 Square Planar	XeF_4, ICl_4^-
7	AB_7	7	-		 pentagonal bi-pyramidal	IF_7

65. Who gave the theoretical explanation for the covalent bond in hydrogen?

a) Linus Carl Pauling

b) Kossel and Lewis

c) Heitler and London

d) Pauling and Slater

Explanation

Heitler and London gave a theoretical treatment to explain the formation of covalent bond in hydrogen molecule on the basis of wave mechanics of electrons. It was further developed by Pauling and Slater.

66. Which of this statement is not a salient feature of VB theory?

a) Greater the overlap slows down the energy and the weakest bond is formed.

b) A covalent bond will be formed when half-filled orbitals of two atoms overlap.

c) Orbital overlap takes place in the direction that maximizes the overlap.

d) The strength of a covalent bond depends upon the extent of overlap of atomic orbitals.

Explanation

Salient features of VB Theory: When half-filled orbitals of two atoms overlap, a covalent bond will be formed between them. The resultant overlapping orbital is occupied by the two electrons with opposite spins. For example, when H2 is formed, the two 1s electrons of two hydrogen atoms get paired up and occupy the overlapped orbital. The strength of a covalent bond depends upon the extent of overlap of atomic orbitals. Greater the overlap, larger is the energy released and stronger will be the bond formed. Each atomic orbital has a specific direction (except s-orbital which is spherical) and hence orbital overlap takes place in the direction that maximizes overlap

67. By which of these the covalent bond is classified as sigma and pi bonds?

a) Extent of polarization

b) Nature of overlap

c) Direction of overlap

d) Strength of overlap

Explanation

When atoms combine to form a covalent molecule, the atomic orbitals of the combining atoms overlap to form a covalent bond. The bond pair of electrons will occupy the overlapped region of the orbitals. Depending upon the nature of overlap we can classify the covalent bonding between the two atoms as sigma (σ) and pi (π) bonds.

68. Which of these bonds are created by two atomic orbitals overlapping linearly along the axis?

a) Sigma bond

b) Head-on overlap

c) Axial overlap

d) All the above

Explanation

Sigma and Pi bonds: When two atomic orbitals overlap linearly along the axis, the resultant bond is called a sigma (σ) bond. This overlap is also called 'head-on overlap' or 'axial overlap'.

69. Assertion (A): Overlap of s orbital and two p orbitals along the molecular axis results in sigma bond formation.

Reasoning(R): If the x-axis is considered as molecular axis the overlap will result in sigma bond.

a) Both A and R is True and R is the correct explanation of A.

b) Both A and R is True but R is not the correct explanation of A.

c) A is True but R is False.

d) Both A and R is False.

Explanation

Overlap involves an s orbital (s-s and s-p overlaps) will always result in a sigma bond as the s orbital is spherical. Overlap between two p orbitals along the molecular axis will also result in sigma bond formation. When we consider x-axis as molecular axis, the p_x–p_x overlap will result in σ-bond.

70. In which ways the two atomic orbitals overlap to form a pi bond?

a) Sideways

b) Perpendicular

c) Linearly

d) Parallel

Explanation

When two atomic orbitals overlap sideways, the resultant covalent bond is called a pi (π) bond. When we consider x-axis as molecular axis, the p_y - p_y and p_z - p_z overlaps will result in the formation of a π-bond.

71. Which of this molecule has a s-s overlap and a sigma covalent bond?

a) Helium

b) Hydrogen

c) Ozone

d) Hydrogen Sulphide

Explanation

Formation of hydrogen (H_2) Molecule: Electronic configuration of hydrogen atom is 1s1 during the formation of H_2 molecule, the 1s orbitals of two hydrogen atoms containing one unpaired electron with opposite spin overlap with each other along the inter-nuclear axis. This overlap is called s-s overlap. Such axial overlap results in the formation of a σ-covalent bond.

72. In which axis the sigma covalent bond is formed in a fluorine molecule?

a) x- axis

b) z- axis

c) y- axis

d) All the above

Explanation

Formation of fluorine molecule (F2): Valence shell electronic configuration of fluorine atom: 2s2 2px 2, 2py 2, 2pz 1. When the half-filled pz orbitals of two fluorine overlap along the z-axis, a σ-covalent bond is formed between them.

73. Assertion (A): Bonding in simple and complex molecules can be explained on the basis of overlap of the combining atoms.

Reasoning(R): The Polyatomic molecules cannot be explained on the basis of simple overlap of atomic orbitals.

a) Both A and R is True and R is the correct explanation of A.

b) Both A and R is True but R is not the correct explanation of A.

c) A is False but R is True.

d) Both A and R is False.

Explanation

Bonding in simple molecules such as hydrogen and fluorine can easily be explained on the basis of overlap of the respective atomic orbitals of the combining atoms. But the observed properties of polyatomic molecules such as methane, ammonia, beryllium chloride etc. cannot be explained on the basis of simple overlap of atomic orbitals. For example, it was experimentally proved that methane has a tetrahedral structure and the four C-H bonds are equivalent. This fact cannot be explained on the basis of overlap of atomic orbitals of hydrogen (1s) and the atomic orbitals of carbon with different energies (2s2 2px 2 2py 2pz).

74. Who introduced the concept of hybridization of atomic orbitals?

a) Linus Pauling

b) Lewis

c) Kossel

d) Robert Mulliken

Explanation

Linus Pauling proposed that the valence atomic orbitals in the molecules are different from those in isolated atom and he introduced the concept of hybridization.

75. Which of these denotes the hybridization or the hybridized orbitals?

a) Process of mixing atomic orbitals of same atom to form equal number of new orbitals with same energy.

b) Process of mixing various orbital atoms to form new orbitals with higher energy.

c) Process of mixing same orbital atoms to form unequal number of atoms.

d) Process of mixing various orbital atoms to create lower energy atoms of equal number.

Explanation

Hybridization is the process of mixing of atomic orbitals of the same atom with comparable energy to form equal number of new equivalent orbitals with same energy. The resultant orbitals are called hybridized orbitals and they possess maximum symmetry and definite orientation in space so as to minimize the force of repulsion between their electrons.

76. Which of these concepts of bonding is not explained by the Lewis concept and Valence bond theory?

a) Chemical bonding

b) Nature of paramagnetic molecules

c) Molecular structure

d) Electron pair bond formation

Explanation

Lewis concept and valence bond theory qualitatively explains the chemical bonding and molecular structure. Both approaches are inadequate to describe some of the observed properties of molecules. For example, these theories predict that oxygen is diamagnetic. However, it was observed that oxygen in liquid form was attracted towards the poles of strong magnet, indicating that oxygen is paramagnetic. As both these theories treated the bond formation in terms of electron pairs and hence they fail to explain the bonding nature of paramagnetic molecules.

77. Who explained the magnetic behavior of the molecules?

a) Heitler and London

b) Linus Carl Pauling

c) F. Hund and Robert Mulliken

d) G.N. Lewis

Explanation

F. Hund and Robert. S. Mulliken developed a bonding theory called molecular orbital theory which explains the magnetic behavior of molecules.

78. Assertion (A): The shape of the molecular orbitals does not depend upon the shapes of combining atomic orbitals.

Reasoning(R): The identity of the individual atomic orbitals is not changed while combining to form new orbitals.

a) Both A and R is True and R is the correct explanation of A.

b) Both A and R is True but R is not the correct explanation of A.

c) A is True but R is False.

d) Both A and R is False.

Explanation

The salient features of Molecular orbital Theory (MOT): When atoms combine to form molecules, their individual atomic orbitals lose their identity and forms new orbitals called molecular orbitals. The shapes of molecular orbitals depend upon the shapes of combining atomic orbitals.

79. Choose the correct statements.

i) The number of molecular orbitals formed and the number of combining atomic orbitals are not same.

ii) Half the number of formed molecular orbitals has lower energy and half of them will have high energy.

iii) The anti-bonding molecular orbitals have low energy and the bonding material is of high energy.

a) i only

b) ii only

c) iii only

d) None of the above

Explanation

The number of molecular orbitals formed is the same as the number of combining atomic orbitals. Half the number of molecular orbitals formed will have lower energy than the corresponding atomic orbital, while the remaining molecular orbitals will have higher energy. The molecular orbital with lower energy is called bonding molecular orbital and the one with higher energy is called anti-bonding molecular orbital. The bonding molecular orbitals are represented as σ (Sigma), π (pi), δ (delta) and the corresponding anti-bonding orbitals are denoted as σ*, π* and δ*.

80. Which of these principles are followed for filling of electrons in the molecular orbitals?

a) Pauli's exception principle

b) Hund's rule

c) Aufbau's principle

d) All the above

Explanation

The electrons in a molecule are accommodated in the newly formed molecular orbitals. The filling of electrons in these orbitals follows Aufbau's principle, Pauli's exclusion principle and Hund's rule as in the case of filling of electrons in atomic orbitals.

81. Which of these is inferred by the bond order value of a molecule?

a) Number of covalent bonds between the combining atoms.

b) Total number of electrons present in anti-bonding molecular orbitals.

c) Total number of covalent and ionic bonds of a molecule.

d) Number of linear combinations in a molecule.

Explanation

Bond order gives the number of covalent bonds between the two combining atoms. The bond order of a molecule can be calculated using the following equation,

$$\text{Bond order} = \frac{N_b - N_a}{2}$$

Where, N_b = Total number of electrons present in the bonding molecular orbitals and N_a = Total number of electrons present in the anti-bonding molecular orbitals

82. What is the value of bond order for a molecule that doesn't exist?

a) Unity

b) Zero

c) Infinity

d) Fractional value

Explanation

A bond order of zero value indicates that the molecule doesn't exist.

83. Which is the most common method for calculating the wave functions of the molecular orbits?

a) Schrodinger equation

b) Electroscopic methods

c) X-ray diffraction

d) Linear combination of atomic orbitals

Explanation

The wave functions for the molecular orbitals can be obtained by solving Schrödinger wave equation for the molecule. Since solving the Schrödinger equation is too complex, approximation methods are used to obtain the wave function for molecular orbitals. The most common method is the linear combination of atomic orbitals (LCAO).

84. What is the anti-bonding molecular orbit value for the wave functions ψA and ψB?

a) ψA + ψB

b) ψA - ψB

c) ψA * ψB

d) ψA / ψB

Explanation

The atomic orbitals are represented by the wave function Ψ. Let us consider two atomic orbitals represented by the wave function ψA and ψB with comparable energy, combines to form two molecular orbitals. One is bonding molecular orbital (ψ bonding) and the other is anti-bonding molecular orbital (ψ anti-bonding). The wave functions for these two molecular orbitals can be obtained by the linear combination of the atomic orbitals ψA and ψB as below.

Ψ bonding = ψA + ψB ψ anti-bonding = ψA - ψB

The formation of bonding molecular orbital can be considered as the result of constructive interference of the atomic orbitals and the formation of anti-bonding molecular orbital can be the result of the destructive interference of the atomic orbitals.

85. Choose the Incorrect statements about the properties of metals.

i) The Metallic bond keeps the atoms of the metal so closely in a metallic crystal.

ii) The ionic bonds are formed between the atoms of different electro negativities.

iii) The Metallic bond is a covalent bond as the metals have sufficient number of valence electrons for mutual sharing.

a) i only

b) ii only

c) iii only

d) None of the above

Explanation

Metals have some special properties of lustre, high density, high electrical and thermal conductivity, malleability and ductility, and high melting and boiling points. The forces that keep the atoms of the metal so closely in a metallic crystal constitute what is generally known as the metallic bond. The metallic bond is not just an electrovalent bond (ionic bond), as the latter is formed between atoms of different electro negativities. Similarly, the metallic bond is not a covalent bond as the metal atoms do not have sufficient number of valence electrons for mutual sharing with 8 or 12 neighboring metal atoms in a crystal.

86. Which of these forces between in the metal ions makes closely packed crystals?

a) Ion repulsion

b) Electrostatic attraction

c) Magnetic deflection

d) Thermal equilibrium

Explanation

The electrostatic attraction between the metal ions and the free electrons yields a three-dimensional close packed crystal with a large number of nearest metal ions. So, metals have high

density. As the close packed structure contains many slip planes along which movement can occur during mechanical loading, the metal acquires ductility.

87. Why the metallic bonding has no directional properties?

a) Each metal ion is surrounded by electron cloud in all directions.

b) The electron clouds reflect the light.

c) Metals are closely packed crystals with large number of ions.

d) Electrons are free to move around the positive ions.

Explanation

As each metal ion is surrounded by electron cloud in all directions, the metallic bonding has no directional properties.

88. Which of the following is not a quality of metals?

a) High electrical conductivity

b) Metallic luster

c) Low boiling point and low thermal conductivity

d) High melting points

Explanation

As the electrons are free to move around the positive ions, the metals exhibit high electrical and thermal conductivity. The metallic luster is due to reflection of light by the electron cloud. As the metallic bond is strong enough, the metal atoms are reluctant to break apart into a liquid or gas, so the metals have high melting and boiling points.

89. Assertion (A): The atoms in a crystal overlap to form numerous bonding and anti-bonding molecular orbitals without any gap.

Reasoning(R): The bonding orbitals are completely filled with an electron pair and the anti-bonding molecules are empty.

a) Both A and R is True and R is the correct explanation of A.

b) Both A and R is True but R is not the correct explanation of A.

c) A is True but R is False.

d) Both A and R is False.

Explanation

The bonding in metal is better treated by Molecular orbital theory. As per this theory, the atomic orbitals of large number of atoms in a crystal overlap to form numerous bonding and anti-bonding molecular orbitals without any band gap. The bonding molecular orbitals are completely filled with an electron pair in each, and the anti-bonding molecular orbitals are empty.

90. Choose the correct statements.

i) Absence of band gap accounts for the low electrical conductivity of metals.

ii) High thermal conductivity in metals is due to thermal excitation of many electrons from valence to conductance band.

iii) The temperature increase in metals increases the electrical conductivity due to vigorous thermal motion of lattice ions.

a) i only

b) ii only

c) iii only

d) All the above

Explanation

Absence of band gap accounts for high electrical conductivity of metals. High thermal conductivity is due to thermal excitation of many electrons from the valence band to the conductance band. With an increase in temperature, the electrical conductivity decreases due to vigorous thermal motion of lattice ions that disrupts the uniform lattice structure, that is required for free motion of electrons within the crystal.

91. Assertion (A): Most of the metals absorb light of all wavelengths and black in color.

Reasoning(R): Absorption of light of all wavelengths is due to absence of band gap in metals.

a) Both A and R is True and R is the correct explanation of A.

b) Both A and R is True but R is not the correct explanation of A.

c) A is True but R is False.

d) Both A and R is False.

Explanation

Most metals are black except copper, silver and gold. It is due to absorption of light of all wavelengths. Absorption of light of all wavelengths is due to absence of band gap in metals.

92. If a molecule has no unpaired electrons hence it is _____.

a) Paramagnetic

b) Diamagnetic

c) Both a and b

d) None of the above

Explanation

Molecule has two unpaired electrons. Hence it is paramagnetic. Molecule has no unpaired electrons. Hence it is diamagnetic.