Chemical Bonding and Molecular Structure

Question 1.
Based on VSEPR theory, the number of 90° F-Br-F angles in BrF_5 is
(a) 0
(b) 2
(c) 4
(d) 8

▼ Answer

Answer: (a) 0
Explanation:
BrF_5 has octahedral geometry and square pyramidal shape.
It has one lone pair and five bond pairs. So, geometry will be octahedral. But since lone pair repels too much, all the four bond pairs that had to be on a square planar surface, will tilt. This will result in a destructed geometry.

Question 2.
The hybrid state of sulphur in SO_2 molecule is :
(a) sp^2
(b) sp^3
(c) sp
(d) sp^3d

▼ Answer

Answer: (a) sp^2
Explanation:
The hybridisation of sulphur in SO_2 is sp^2. Sulphur atom has one lone pair of electrons and two bonding domains. Bond angle is <120° and molecular geometry is V-shape, bent or angular

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Question 3.
In allene (C_3H_4), the type(s) of hybridisation of the carbon atoms is (are)
(a) sp and sp^3
(b) sp and sp^2
(c) Only sp^2
(d) sp^2 and sp^3

▼ Answer

Answer: (b) sp and sp^2
Explanation:
Allene: $H_2C = C = CH_2$. The central carbon is attached to other carbons by two sigma and two pi bonds so its hybridisation will be sp. The terminal carbon is attached to other carbon and hydrogen by 3 sigma and 2 pi bonds and hence, its hybridisation will be sp^2

Question 4.
The state of hybridization of the central atom and the number of lone pairs over the central atom in $POCl_3$ are
(a) sp, 0
(b) sp^2, 0
(c) sp^3, 0
(d) dsp^2, 1

▼ Answer

Answer: (c) sp^3, 0
Explanation:
The central atom of $POCl_3$ that is P has sp3 hybridization and the number of lone pairs over the central atom in $POCl_3$ is zero.

The central atom is P, which has 5 valence electrons. Out of them, two valence electrons are used to form a P = O double bond, while the other 3 valence electrons are used to form 3 P-Cl bonds. The molecular geometry of $POCl_3$ is tetrahedral with asymmetric charge distribution around the central atom. Therefore this molecule is polar. The structure of this compound is tetrahedral and hybridisation of P is sp^3.

On the central atom P, there are 4 bonding electron clouds (1 P = O double bond and 3 P-Cl bonds) but no lone pair of electrons.

Question 5.
The charge/size ratio of a cation determines its polarizing power. Which one of the following sequences represents the increasing order of the polarizing order of the polarizing power of the cationic species, K^+, Ca^{2+}, Mg^{2+}, Be^{2+}?
(a) $Ca^{2+} < Mg^{2+} < Be^{+} < K^{+}$
(b) $Mg^{2+} < Be^{2+} < K^{+} < Ca^{2+}$
(c) $Be^{2+} < K^{+} < Ca^{2+} < Mg^{2+}$
(d) $K^{+} < Ca^{2+} < Mg^{2+} < Be^{2+}$

▼ Answer

Answer: (d) $K^{+} < Ca^{2+} < Mg^{2+} < Be^{2+}$
Explanation:
High charge and small size of the cations increases polarisation.
As the size of the given cations decreases as
$K^{+} > Ca^{2+} > Mg^{2+} > Be^{2+}$
Hence, polarising power decreases as $K^{+} < Ca^{2+} < Mg^{2+} < Be^{2+}$

Question 6.
Which one of the following does not have sp^2 hybridised carbon?
(a) Acetone
(b) Acetic acid
(c) Acetonitrile
(d) Acetamide

▼ Answer

Answer: (c) Acetonitrile
Explanation:
Acetonitrile does not contain sp^2 hybridized carbon.

Question 7.
Which one of the following is paramagnetic?
(a) NO^{+}
(b) CO
(c) O_2^{-}
(d) CN

▼ Answer

Answer: (c) O_2^-
Explanation:
O_2^-(17)Super oxide has one unpaired electron. Since Paramagnetism is shown by those molecules which have at least one unpaired electron, hence, O_2^- is paramagnetic.
Option 1)
NO^+
This solution is incorrect
Option 2)
CO
This solution is incorrect
Option 3)
O_2^-
This solution is correct
Option 4)
CN^-
This solution is incorrect

Question 8.
Which of the following structures will have a bond angle of 120° around the central atom?
(a) Linear
(b) Tetrahedral
(c) Triangular
(d) Square planar

▼ Answer

Answer: (c) Triangular
Explanation:
When three electrons pairs get as far apart from each other, a trigonal planar structure is formed. The bond angle in this structure will be 120°.

Question 9.
An atom of an element A has three electrons in its outermost orbit and that of B has six electrons in its outermost orbit. The formula of the compound between these two will be
(a) $A_3\ B_6$
(b) $A_2\ B_3$
(c) $A_3\ B_2$
(d) A_2 B

▼ Answer

Answer: (b) $A_2\ B_3$
Explanation:
A has 3 electrons in outermost orbit and B has 6 electrons in its outermost orbits. So A can give three electrons to complete its octet and B needs 2 electrons to complete its octet. So 2 atoms of A will release 6 electrons and 3 atoms of B will need six electrons to complete their octet
So, the formula will be A_2B_3

Question 10.
In which of the following , the angle around the central atom is largest?
(a) CS_2
(b) SF_4
(c) SO_2
(d) BBR_3

▼ Answer

Answer: (b) SF_4
Explanation:
Bond angle is determined by the hybridization.
SO_2 undergo sp3 hybridization and exhibits 109° bond angle
BBr_3 undergo sp2 hybridization and exhibits 120° bond angle
CS_2 undergo sp hybridization and exhibits 180° bond angle.
SF_4 undergo sp3 d hybridization and exhibits different bond angles.
So, the least bond angle is exhibited by CS_2

Question 11.
Based on lattice enthalpy and other considerations which one the following alkali metals chlorides is expected to have the higher melting point?
(a) RbCl
(b) KCl
(c) NaCl
(d) LiCl

▼ Answer

Answer: (c) NaCl
Explanation:
The highest melting point will be NaCl, it is because, the lattice energy decreases as the size of alkali metal increases so going down the group the melting point decreases, but due to the covalent bonding in LiCl, its melting point is lower than NaCl and so NaCl is expected to have maximum melting point in the alkali chlorides.

Question 12.
In which of the following substances, the intermolecular forces are hydrogen bonds?
(a) Hydrogen Chloride
(b) Hydrogen Sulphide
(c) Dry Ice
(d) Ice

▼ Answer

Answer: (d) Ice
Explanation:
Ice is held together by hydrogen bonds.

Question 13.
Which one of the following pairs of species have the same bond order?
(a) CN^- and NO^+
(b) CN^- and CN^+
(c) O_2^- and CN^-
(d) NO^+ and CN^+

▼ Answer

Answer: (d) NO^+ and CN^+
Explanation:
CN^- and NO^+ are isoelectronic 14 and have same bond order.

Question 14.
Dipole-induced dipole interactions are present in which of the following pairs?
(a) H_2O and alcohol
(b) Cl_2 and CCl_4
(c) HCl and He atoms
(d) SiF_4 and He atoms

▼ Answer

Answer: (c) HCl and He atoms
Explanation:
HCl is polar ($\mu \neq 0$) and He is non-polar ($\mu = 0$) gives dipole-induced dipole interaction.

Question 15.
In allene (C_3H_4), the type(s) of hybridisation of the carbon atoms is (are)
(a) sp and sp^3
(b) sp and sp^2
(c) Only sp^2
(d) sp^2 and sp^3

▼ Answer

Answer: (b) sp and sp^2
Explanation:
Allene: $H_2C = C = CH_2$. The central carbon is attached to other carbons by two sigma and two pi bonds so its hybridisation will be sp. The terminal carbon is attached to other carbon and hydrogen by 3 sigma and 2 pi bonds and hence, its hybridisation will be sp^2

Question 16.
The weakest interparticle forces are found in which of the following?
(a) Ionic Solids
(b) Metallic Solids
(c) Molecular Solids
(d) All types of solids are equal in terms of interparticle forces.

▼ Answer

Answer: (c) Molecular Solids
Explanation:
Molecular solids are the weakest.
Because Ionic solids and metallic solids are a type of bond. Bonds are stronger than Van der Waals forces.

Question 17.
Which of the following types of hybridisation leads to three dimensional geometry of bonds around the carbon atom ?
(a) sp
(b) sp^2
(c) sp^3
(d) None of these

▼ Answer

Answer: (b) sp^2
Explanation:
sp^2 hybrid structures have trigonal planar geometry, which is two dimensional.

Question 18.
If the bond length and dipole moment of a diatomic molecule are 1.25 A and 1.0 D respectively, what is the percent ionic character of the bond?
(a) 10.66
(b) 12.33
(c) 16.66
(d) 19.33

▼ Answer

Answer: (c) 16.66
Explanation:
μ_{ionic} = (1.6 × 10^{-19} C)(1.25 × 10^{-10} m)/(3.335 × 10^{-30}) (Cm/D)
= 5.99 D
%ionic character = (100 × μ_{obs})/ (μ_{ionic})
=100 × 15.99 = 16.66%

Question 19.
The number of types of bonds between two carbon atoms in calcium carbide is
(a) Two sigma, two pi
(b) One sigma, two pi
(c) One sigma, one pi
(d) Two sigma, one pi

▼ Answer

Answer: (b) One sigma, two pi
Explanation:
A single bond between two atoms is always considered as sigma bond.
A double bond between two atoms is always considered as one sigma and one pi bond
A triple bond between two atoms is always considered as one sigma bond and two pi bonds.
So according to the given structure CaC_2 (Calcium carbide) has 1 sigma and 2 pi bonds

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Question 20.
Which of the following species contain non-directional bonds ?
(a) NCl_3
(b) $BeCl_2$
(c) BCl_3
(d) RbCl

▼ Answer

Answer: (b) $BeCl_2$
Explanation:
Ionic or electrovalent bonds are called non-directional bonds, the meaning of non-directional is that these type of bonds does not have any special type of geometry, that is only attraction of positive and negative charge as we know ionic bonds made between metal[positively charged] and non-metal[negatively charged]

RbCl is ionic compound and non-directional
