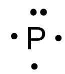
1) There are __________ paired and __________ unpaired electrons in the Lewis symbol for a phosphorus atom.

A) 2, 4
B) 4, 3
C) 0, 3
D) 2, 3
E) 4, 2

phosphorus has 5 valence electrons, which are written singly before pairing



2) Based on the octet rule, phosphorus most likely forms a __________ ion.

A) P^{5+}
B) P^{+}
C) P^{3-}
D) P^{3+}
E) P^{5-}

Three additional electrons produces a filled octet.

3) The only noble gas without eight valence electrons is __________.

A) Ar
B) Kr
C) Ne
D) He
E) All noble gases have eight valence electrons.

4) Elements from opposite sides of the periodic table tend to form __________.

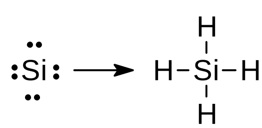
A) covalent compounds that are gaseous at room temperature
B) ionic compounds
C) homonuclear diatomic compounds
D) covalent compounds
E) compounds that are gaseous at room temperature

Think NaCl

5) How many single covalent bonds must a silicon atom form to have a complete octet in its valence shell?

A) 0
B) 3
C) 2
D) 4
E) 1

Si has 4 valence electrons, needing 4 more to fill the octet. This would give 4 bonds.



6) A double bond consists of __________ pairs of electrons shared between two atoms.

A) 1
B) 2
C) 3
D) 4
E) 6

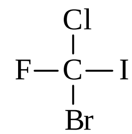
Each bond is composed of a pair of electrons, and a double bond is composed of two bonds, one sigma and one pi.

7) What is the maximum number double bonds that a carbon atom can form?

A) 2
B) 1
C) 3
D) 4
E) 0

More than 2 double bonds would result in more than 4 bonds, which would mean more than 8 electrons

8) In the molecule to the right, which atom has the largest partial negative charge?



A) Br
B) C
C) F
D) Cl
E) I

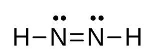
The most electronegative atom, F, will draw the electrons closest to itself, thus yielding the largest partial negative charge.

9) The ability of an atom in a molecule to attract electrons is best quantified by the __________.

A) paramagnetism
B) diamagnetism
C) electron change-to-mass ratio
D) first ionization potential
E) electronegativity

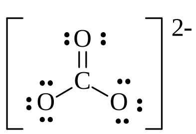
10) The Lewis structure of N_2H_2 shows __________.

A) a nitrogen-nitrogen single bond
B) a nitrogen-nitrogen triple bond
C) each hydrogen has one nonbonding electron pair
D) each nitrogen has two nonbinding electron pairs
E) each nitrogen has one nonbinding electron pair



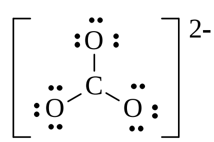
11) The Lewis structure of the CO_3^{2-} ion is __________.

A)



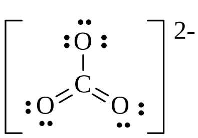
All atoms have an octet, electron count is correct, and formal charges are minimized.

B)



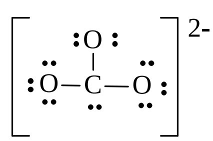
C only has six electrons, yielding a formal (+) on C and formal (-1) on all three oxygens

C)



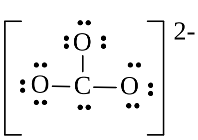
C has too many electrons (octet exceeded).

D)



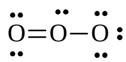
Upper O has only six electrons, giving it a formal (+1) and the C a formal (-1)

E)



Too many electrons.

12) In the resonance form of ozone shown below, the formal charge on the central oxygen atom is __________.



A) -1
B) +2
C) -2
D) 0
E) +1

formal charge = # valence electrons – # surrounding electrons.
formal charge = 6 – 5 = +1
(recall that only half the bonding electrons are considered to be around the atom)

13) For resonance forms of a molecule or ion, __________.

A) all the resonance structures are observed in various proportions
B) one always corresponds to the observed structure
C) the observed structure is an average of the resonance forms
D) the same atoms need not be bonded to each other in all resonance forms
E) there cannot be more than two resonance structures for a given species

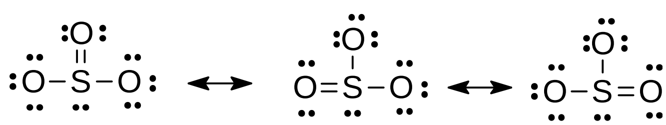
14) Resonance structures differ by __________.

A) placement of electrons only
B) number and placement of electrons
C) number of atoms only
D) placement of atoms only
E) number of electrons only

Changing the number of electrons will change the charge on the molecule/ion, making it a different molecule/ion. Likewise, changing the number or placement of the atoms makes it a different molecule/ion.

15) How many different types of resonance structures can be drawn for the ion SO_3^{2-}?

A) 3
B) 2
C) 1
D) 5
E) 4



16) Of the bonds C-N, C=N, and C=N, the C-N bond is __________.

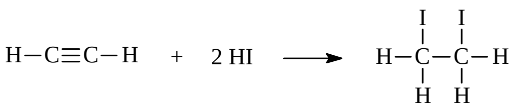
A) weakest/longest
B) strongest/longest
C) strongest/shortest
D) weakest/shortest
E) intermediate in both strength and length

17) According to VSEPR theory, if there are three electron domains in the valence shell of an atom, they will be arranged in a(n) __________ geometry.

A) trigonal bipyramidal
B) octahedral
C) tetrahedral
D) linear
E) trigonal planar

This is the orientation that results in the greatest spacing between the electron pairs.

18) Using the table of average bond energies below, the ΔH for the reaction is ___________ kJ.



Bond:	C=C	C-C	H-I	C-I	C-H
D (kJ/mol):	839	348	299	240	413

A) +63
B) +160
C) -63
D) -160
E) -217

ΔH = sum of bonds broken – sum of bonds made.
ΔH = [2(C-H) + (C=C) + 2(H-I)] – [4(CH) + (C-C) + 2(C-I)]
ΔH = [2(413) + (839) + 2(299)] – [4(413) + (348) + 2(240)]
ΔH = -217

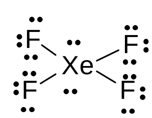
19) According to VSEPR theory, if there are five electron domains in the valence shell of an atom, they will be arranged in a(n) ___________ geometry.

A) tetrahedral
B) octahedral
C) trigonal planar
D) trigonal bipyramidal
E) linear

20) The molecular geometry of ___________ is square planar.

A) ICl_3
B) XeF_2
C) XeF_4
D) PH_3
E) CCl_4

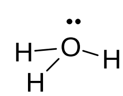
To be square planar, there must be 4 atoms around the central atom, thus only C and D are possibilities. Furthermore, square planar requires 6 electron domains, two of which would be non-bonding.



21) The molecular geometry of the H_3O^+ ion is ___________.

A) trigonal pyramidal
B) linear
C) tetrahedral
D) bent
E) octahedral

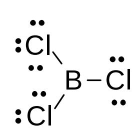
With 4 electron domains, the domain geometry is tetrahedral, but with only 3 peripheral atoms, the molecular geometry is trigonal pyramidal



22) Of the following species, ___________ will have bond angles of 120°.

A) ClF_3
B) NCl_3
C) BCl_3
D) PH_3
E) All of these will have bond angles of 120degree.

To have a bond angle of 120, the central atom must have only 3 electron domains. This is true only for C (B & D have 4 domains, A has 5)



23) According to VSEPR theory, if there are four electron domains on a central atom, they will be arranged such that the angles between the domains are __________.

A) 180degree
B) 120degree
C) 90degree
D) 360degree
E) 109.5degree

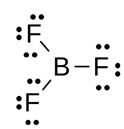
24) The electron-domain geometry and the molecular geometry of a molecule of the general formula AB_n will always be the same if __________.

A) there are no lone pairs on the central atom
B) the octet rule is obeyed
C) n is greater than four
D) n is less than four
E) there is more than one central atom

25) Of the molecules below, only __________ is nonpolar.

A) IF_3
B) $BrCl_3$
C) PF_3
D) NF_3
E) BF_3

To be nonpolar, all the individual dipoles must cancel. This is only true for BF_3. A & B are bent, while C & D are trigonal pyramidal and thus have a net dipole.



26) The combination of two atomic orbitals results in the formation of __________ molecular orbitals.

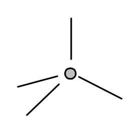
A) 1
B) 2
C) 3
D) 4
E) 0

The number of orbitals that result is always equal to the number that are mixed. This is not only true for hybridization, but also for formation of molecular orbitals from atomic orbitals.

27) The electron-domain geometry of a sulfur-centered compound is trigonal pyramidal. The hybridization of the central sulfur atom is __________.

A) sp^2
B) sp^3d
C) sp^3
D) sp
E) sp^3d^2

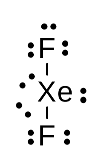
To be trigonal pyramidal, the atom must have 4 electron domains (1 nonbonding, 3 bonding), indicating that 4 orbitals have been hybridized (1s + 3p), which yields an sp^3 hybrid.



28) The hybrid orbitals used for bonding by Xe in the unstable XeF_2 molecule are __________ orbitals.

A) sp^3d^2
B) sp^2
C) sp^3d
D) sp
E) sp^3

Xe has 5 electron domains, 2 bonding, 3 non-bonding. Thus it must have hybridized five orbitals (1s + 3p + 1d), which yields an sp^3d hybrid.



29) The blending of one s atomic orbital and two p atomic orbitals produces __________.

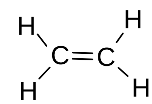
A) three sp^2 hybrid orbitals
B) three sp hybrid orbitals
C) two sp^2 hybrid orbitals
D) two sp^3 hybrid orbitals
E) three sp^3 hybrid orbitals

Combining 3 orbitals gives three orbitals, and the superscripts denote the number of each type of orbital combined. Thus:
1s + 2p ? $3sp^2$

30) The carbon-carbon sigma bond in ethylene, CH_2CH_2, results from the overlap of __________.

A) sp^3 hybrid orbitals
B) p atomic orbitals
C) sp^2 hybrid orbitals
D) s atomic orbitals
E) sp hybrid orbitals

Each carbon has 3 electron domains, so the hybridization must be sp^2. Thus the CC bond is from the overlap of two sp^2 hybrid orbitals.

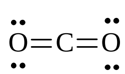


31) The pi bond in ethylene, CH_2CH_2, results from the overlap of __________.

A) s atomic orbitals
B) sp hybrid orbitals
C) sp^3 hybrid orbitals
D) p atomic orbitals
E) sp^2 hybrid orbitals

The carbons are sp2 hybridized, leaving a p-orbital that is not hybridized. It is the overlap of these (parallel) p-orbitals that results in the pi bond. Recall that a pi bond results from the overlap of two lobes of each orbital.

32) The Lewis structure of carbon dioxide is given below. The hybridization of the carbon atom in carbon dioxide is __________.



A) sp^2
B) sp^2d^2
C) sp
D) sp^3
E) sp^2d

wo electron domains means the hybridization of two orbitals (1s + 1p), resulting in an sp hybridization. The remaining two p-orbitals are involved in the two pi bonds.

33) Based on molecular orbital theory, the bond order of the N-N bond in the N_2^{2+} ion is __________.

A) 0
B) 3
C) 1/2
D) 2
E) 1

Each N has 5 valence electrons. The 2+ indicates that the ion lost two electrons. Thus N_2^{2+} has 8 electrons, giving the M.O diagram shown to the right.

Three bonding orbitals and one antibonding orbital result in a bond order of 2.