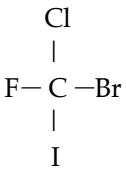
MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

70 1) A valid Lewis structure of _____ cannot be drawn without violating the octet rule.

A) NF_3 B) PF_3 C) IF_3 D) SbF_3 E) SO_4^{2-}

78 2) In the molecule below, which atom has the largest partial negative charge _____?



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

72 3) In order to produce sp^3 hybrid orbitals, _____ s atomic orbital(s) and _____ p atomic orbital(s) must be mixed.

A) two, two B) two, three C) one, one D) one, two E) one, three

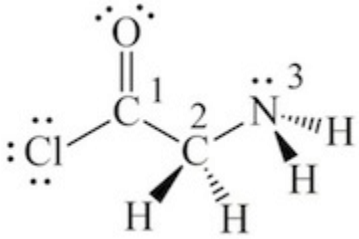
72 4) In counting the electron domains around the central atom in VSEPR theory, a _____ is not included.

A) nonbonding pair of electrons
B) double covalent bond
C) core level electron pair
D) single covalent bond
E) triple covalent bond

76 5) The molecular geometry of the $PHCl_2$ molecule is _____.

A) tetrahedral
B) bent
C) trigonal pyramidal
D) trigonal planar
E) T-shaped

73 6) Consider the molecule below. Determine the hybridization at each of the 3 labeled atoms.

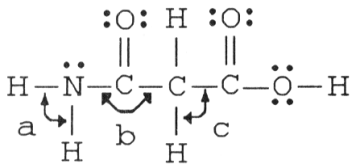


A) 1=sp , 2=sp^2, 3=sp^2
B) 1=sp^2, 2=sp^3, 3=sp^2
C) 1=sp^3, 2=sp^3, 3=sp^3
D) 1=sp^2, 2=sp^3, 3=sp^3
E) 1=sp^3, 2=sp^3, 3=sp^2

91 7) The Lewis structure of PF_3 shows that the central phosphorus atom has _____ nonbonding and _____ bonding electron pairs.

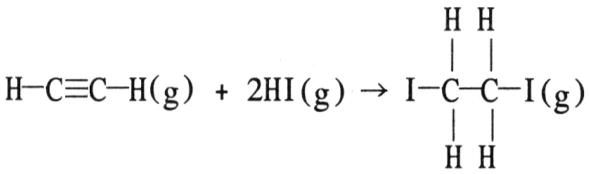
A) 3, 1 B) 3, 3 C) 1, 2 D) 2, 2 E) 1, 3

83 8) The bond angles marked a, b, and c in the molecule below are about _____, _____, and _____, respectively.



A) 120°, 120°, 109.5°
B) 109.5°, 90°, 120°
C) 120°, 120°, 90°
D) 90°, 90°, 90°
E) 109.5°, 120°, 109.5°

75 9) 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) –217 B) –160 C) +160 D) –63 E) +63

74 10) The F–N–F bond angle in the NF_3 molecule is slightly less than _____.

A) 90° B) 109.5° C) 180° D) 60° E) 120°

90 11) Of the bonds C–N, C═N, and C≡N, the C–N bond is _____.

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

53 12) Which of the following statements is true regarding Ne_2^{2+}? Refer to the MO diagrams attached to this exam if necessary.

A) Its bonding order is 0 and it is not expected to exist.
B) Its bonding order is 1 and it is not expected to exist.
C) Its bond order is 0 and it is expected to exist.
D) Its bond order is 1 and it is expected to exist.
E) Its bond order is 3/2 and it is expected to exist.

Consider the following species when answering the following questions:

(i) PCl_3 (ii) CCl_4 (iii) $TeCl_4$ (iv) XeF_4 (v) SF_6

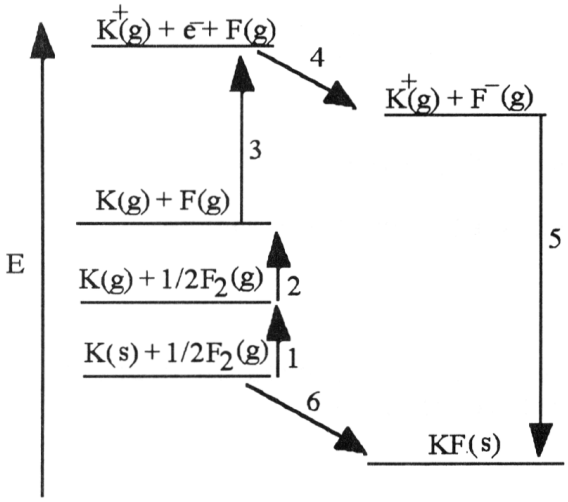
76 13) In which of the molecules does the central atom utilize d orbitals to form hybrid orbitals?

A) (i) and (ii)
B) (iii) only
C) (i) and (v)
D) (iii), (iv), and (v)
E) (v) only

70 14) Of the bonds below, _____ is the least polar.

A) Na, S B) Si, Cl C) C, F D) P, S E) Na, Cl

The diagram below is the Born–Haber cycle for the formation of crystalline potassium fluoride.



77 15) Which energy change corresponds to the electron affinity of fluorine?

A) 2 B) 5 C) 6 D) 1 E) 4

59 16) There are _____ σ and _____ π bonds in the $H_2C{=}C{=}CH_2$ molecule.

A) 6, 4 B) 2, 2 C) 4, 2 D) 2, 6 E) 6, 2

83 17) The halogens, alkali metals, and alkaline earth metals have _____ valence electrons, respectively.

A) 7, 4, and 6 B) 1, 5, and 7 C) 8, 2, and 3 D) 2, 7, and 4 E) 7, 1, and 2

38 18) Choose the compound below that contains at least one polar covalent bond, but is nonpolar.

A) ICl_3

B) SeF_4

C) HCN

D) CCl_4

E) Both B and C are nonpolar and contain a polar covalent bond.

88 19) Elements from opposite sides of the periodic table tend to form _____.

A) covalent compounds that are gaseous at room temperature

B) ionic compounds

C) compounds that are gaseous at room temperature

D) covalent compounds

E) homonuclear diatomic compounds

68 20) There are _____ unpaired electrons in the Lewis symbol for an oxygen atom.

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

94 21) 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) linear

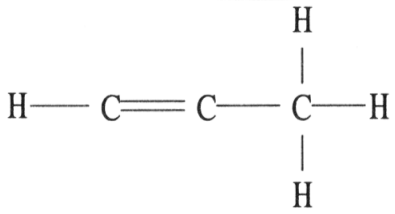
B) octahedral

C) trigonal planar

D) tetrahedral

E) trigonal bipyramidal

84 22) There is/are _____ π bond(s) in the molecule below.



A) 6 B) 2 C) 0 D) 1 E) 7

57 23) Use the molecular orbital diagram included with this exam to determine which of the following are paramagnetic.

A) Ne_2^{2+}

B) F_2^{2+}

C) O_2^{2+}

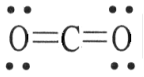
D) O_2^{2-}

E) None of the above are paramagnetic.

95 24) The hybridization of orbitals on the central atom in a molecule is sp. The electron-domain geometry around this central atom is _____.

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

79 25) The Lewis structure of carbon dioxide is given below. The hybridization of the carbon atom in carbon dioxide is _____.



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

65 26) Why don't we draw double bonds between the Be atom and the Cl atoms in $BeCl_2$?

A) That would result in more than eight electrons around each chlorine atom.
B) That would result in the formal charges not adding up to zero.
C) There aren't enough electrons.
D) That would give positive formal charges to the chlorine atoms and a negative formal charge to the beryllium atom.
E) That would result in more than eight electrons around beryllium.

7 27) In the nitrite ion (NO_2^-), _____.

A) both bonds are the same
B) both bonds are single bonds
C) both bonds are double bonds
D) there are 20 valence electrons
E) one bond is a double bond and the other is a single bond

The bonds are equivalent because of resonance.

69 28) Which of the following is a correct description of SeF_5^- ?

A) Trigonal bipyrimidal shape and non-polar
B) see-saw shape and polar
C) square pyramidal shape and ono-polar
D) square pyramidal shape and polar
E) square planar shape and non-polar

71 29) What is the hybridization of the central atom in XeF_4?

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

21 30) An antibonding π orbital contains a maximum of _____ electrons.

A) 1 B) 2 C) 4 D) 6 E) 8

No orbital can have more than two electrons. You forgot that there are two anti-bonding pi orbitals.

1) C
2) C
3) E
4) C
5) C
6) D
7) E
8) E
9) A
10) B
11) D
12) D
13) D
14) D
15) E
16) E
17) E
18) D
19) B
20) C
21) E
22) D
23) B
24) B
25) A
26) D
27) A
28) D
29) E
30) B