

KEY

## Periodic trends and VSEPR practice problems

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

- 1) Which of the following occurs for the representative elements going left to right across the period? 1) \_\_\_\_\_  
A) electronegativity decreases  
B) atomic size increases  
C) atomic size remains constant  
D) attraction between outer electrons and the nucleus increases because effective nuclear charge increases  
E) the outer electrons are held more weakly
- 2) Which of the following has the largest atomic radius? 2) \_\_\_\_\_  
A) I                      B) Br                      C) Mo                      D) Ca                      E) Rb
- 3) Which of the following isoelectronic species has the largest radius? 3) \_\_\_\_\_  
A)  $P^{3-}$                       B)  $S^{2-}$                       C)  $Cl^-$                       D)  $K^+$                       E)  $Ca^{2+}$   
SAME  $e^-$  CONFIGURATION
- 4) Which of the following has the largest radius? 4) \_\_\_\_\_  
A)  $Br^-$                       B) Kr                      C)  $Se^{2-}$                       D)  $Cu^{2+}$                       E)  $Al^{3+}$
- 5) Which of the following pairs would you expect to have very similar radii? 5) \_\_\_\_\_  
A) Mo and W                      B) H and He                      C) Ne and Ar                      D) O and F                      E) Fe and Ru  
LANTHANIDE "CONTRACTION"
- 6) Which of the following statements is NOT true? 6) \_\_\_\_\_  
A) Ionization energy increases from left to right through a period of elements.  
B) Atomic radius decreases from left to right through a period of elements.  
C) Atomic radius increases down a group.  
D) Anions are always larger than the atoms from which they are formed.  
E) Cations are always larger than the atoms from which they are formed.
- 7) Choose the species from which one electron could most easily be removed. 7) \_\_\_\_\_  
A) Ar                      B)  $K^+$                       C) K                      D) Ca                      E) Cl
- 8) How many electrons will nitrogen gain or lose when it forms an ion? 8) \_\_\_\_\_  
A) lose 3                      B) lose 2                      C) gain 3                      D) lose 1                      E) lose 2 or 3
- 9) How many electrons will aluminum gain or lose when it forms an ion? 9) \_\_\_\_\_  
A) lose 2                      B) lose 1                      C) lose 3                      D) gain 3                      E) lose 2 or 3
- 10) What is the relationship between ionization energy and atomic radii? 10) \_\_\_\_\_  
A) Ionization energy increases as radii increases.  
B) Ionization energy decreases as radii decreases.  
C) Ionization energy decreases as radii increases.  
D) There is no relationship.

- 11) Why is the electron affinity so small for group 18 elements? 11) \_\_\_\_\_  
 A) Electrons can't be added to a gas.  
 B) The added electron would have to be added into the d subshell.  
 C) An added electron would have to be added into a stable half-filled p subshell.  
 D) An added electron would have to go into a new subshell in a higher energy level.  
 E) Adding an electron to a noble gas would cause an explosion.
- 12) Why is the electron affinity so small for the group 2 elements? 12) \_\_\_\_\_  
 A) Electrons can't be added to gases.  
 B) An added electron would have to be added into the half-filled p subshell.  
 C) The group 2 elements are diatomic elements.  
 D) An added electron would have to be added into a new subshell.
- 13) Why is the electron affinity so small for for nitrogen? 13) \_\_\_\_\_  
 A) Electrons can't be added to gases.  
 B) The added electron would have to be added into the p subshell.  
 C) The added electron would have to be added into a higher energy level.  
 D) The added electron would have to go into a new subshell.  
 E) The added electron would have to be added into a relatively stable half-filled p subshell.
- 14) Which of the following is least likely to form multiple bonds? 14) \_\_\_\_\_  
 A) fluorine  
 B) oxygen  
 C) nitrogen  
 D) phosphorus  
 E) chlorine
- 15) Among the alkali metals, cesium reacts more rapidly than sodium because: 15) \_\_\_\_\_  
 A) cesium can make more bonds  
 B) cesium has more electrons  
 C) the valence electrons of cesium are at a greater average distance from the nucleus causing them to be harder to remove  
 D) the valence electrons of cesium are at a greater average distance from the nucleus enabling them to be pulled off easier → MORE REACTIVE
- 16) The similar chemical behavior of the elements in a given group in the periodic table is best accounted for by the fact that atoms of these elements have: 16) \_\_\_\_\_  
 A) the same number of electrons  
 B) the same father  
 C) the same number of valence electrons  
 D) the same number of protons  
 E) the same charge
- 17) Valence electrons are: 17) \_\_\_\_\_  
 A) any unpaired electrons  
 B) all electrons after the last noble gas configuration  
 C) electrons needed to obtain a noble gas configuration  
 D) electrons in the highest energy level of an atom
- 18) The number of valence electrons in potassium is: 18) \_\_\_\_\_  
 A) 6                      B) 15                      C) 5                      D) 1                      E) 19

19) How many unpaired valence electrons does oxygen have? 19) \_\_\_\_\_  
A) 1      B) 2      C) 3      D) 4      E) 6

20) How many covalent bonds is oxygen likely to make? 20) \_\_\_\_\_  
A) 1      B) 2      C) 3      D) 4      E) 6

21) Which of the following is the correct electron dot structure (Lewis structure) for CS<sub>2</sub>? 21) \_\_\_\_\_  
A)  $\text{:}\ddot{\text{S}}\text{--}\ddot{\text{C}}\text{--}\ddot{\text{S}}\text{:}$       B)  $\text{:}\ddot{\text{S}}\text{=C=}\ddot{\text{S}}\text{:}$       C)  $\text{S--C--S}$       D)  $\text{:}\ddot{\text{S}}\text{=}\ddot{\text{C}}\text{=}\ddot{\text{S}}\text{:}$

22) Which of the following is the correct electron dot structure for C<sub>2</sub>F<sub>4</sub>? 22) \_\_\_\_\_  
A)  $\text{:}\ddot{\text{F}}\text{--}\ddot{\text{C}}\text{=}\ddot{\text{C}}\text{--}\ddot{\text{F}}\text{:}$       B)  $\text{F--C--C--F}$       C)  $\text{:}\ddot{\text{F}}\text{--}\ddot{\text{C}}\text{--}\ddot{\text{C}}\text{--}\ddot{\text{F}}\text{:}$       D)  $\text{:}\ddot{\text{F}}\text{--}\ddot{\text{C}}\text{--}\ddot{\text{C}}\text{--}\ddot{\text{F}}\text{:}$

23) When more than one Lewis structures can be written for a given molecule it is said to have \_\_\_\_\_ structures. 23) \_\_\_\_\_  
A) equal      B) polar      C) split      D) resonance      E) unstable

24) VSEPR theory allows us to determine the \_\_\_\_\_ based on its Lewis structure. 24) \_\_\_\_\_  
A) molar mass of a molecule  
B) charge on an ion  
C) formula for a compound  
D) three-dimensional shape of a molecule  
E) color of a compound

25) Regarding the Lewis structure of hydrogen cyanide, HCN, which of the following is incorrect? 25) \_\_\_\_\_  
A) There are no lone pairs on H.  
B) There are no lone pairs on C.  
C) There is a lone pair of electrons on N.  
D) The C-H bond is a single bond.  
E) The C-N bond is a double bond.       $\text{H--C}\equiv\text{N};$

26) What is the bond angle in water? 26) \_\_\_\_\_  
A) 120°      B) 90°      C) 104.5°      D) 180°      E) 109.5°

27) What are the bond angles in ammonia? 27) \_\_\_\_\_  
A) 109.5°      B) 180°      C) 107°      D) 90°      E) 120°

28) Which of the following bonds would you predict to be the most polar? 28) \_\_\_\_\_  
A) Se-H      B) C-H      C) P-H      D) O-H      E) N-H

29) Which of the following statements is INCORRECT concerning the carbonate ion? 29) \_\_\_\_\_

- A) the molecule has a trigonal planar geometry
- B) one of the C-O bonds is stronger than others**
- C) the molecule has three stable resonance structures
- D) the central carbon is  $sp^2$  hybridized
- E) all of the C-O bonds are equivalent

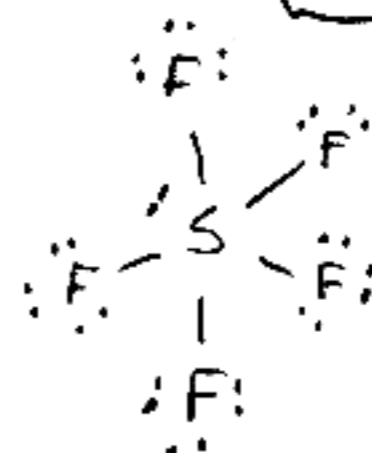
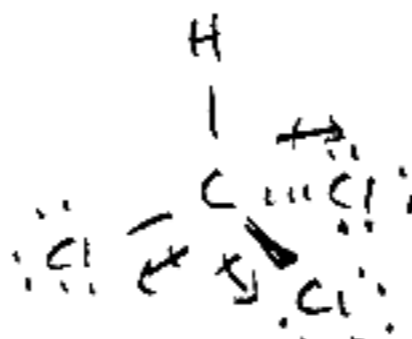
→ RESONANCE - ALL EQUAL

30) The hybridization of the central atom in the molecule  $SF_5^-$  is \_\_\_\_\_ 30) \_\_\_\_\_

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

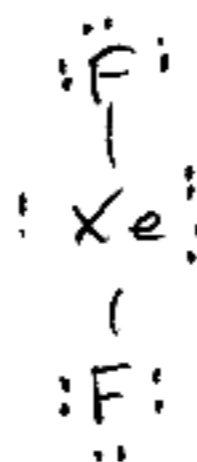
31) The molecule chloroform,  $CHCl_3$ , is \_\_\_\_\_ 31) \_\_\_\_\_

- A) bent and polar
- B) tetrahedral and nonpolar
- C) tetrahedral and polar**
- D) square planar and polar
- E) square pyramidal and nonpolar



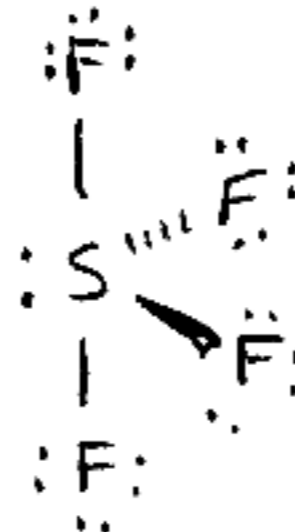
32) The shape of the molecule  $XeF_2$  is \_\_\_\_\_ 32) \_\_\_\_\_

- A) linear**
- B) octahedral
- C) trigonal planar
- D) trigonal something
- E) bent



33) The shape of the molecule  $SF_4$  is \_\_\_\_\_ 33) \_\_\_\_\_

- A) tetrahedral
- B) see-saw**
- C) bent
- D) octahedral
- E) square planar



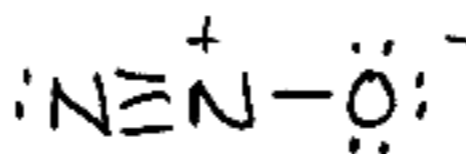
34) The bond in  $Cl_2$  is a(n) \_\_\_\_\_ bond. 34) \_\_\_\_\_

- A) polar ionic
- B) ionic
- C) nonpolar ionic
- D) nonpolar covalent**
- E) polar covalent

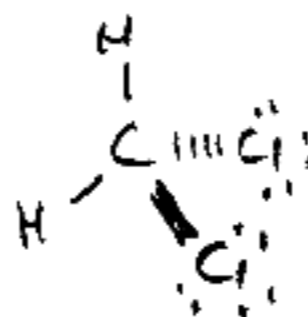
35) Choose the compound below that contains polar bonds, but is nonpolar. 35) \_\_\_\_\_

- A)  $ICl_3$
- B)  $HCN$
- C)  $SeBr_4$
- D)  $CF_4$**
- E) All molecules that contain polar bonds are polar

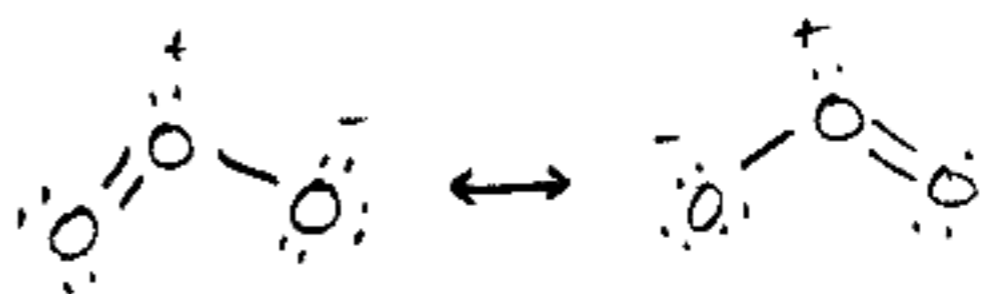
- 36) What is the molecular geometry and polarity of  $N_2O$ ? "NITROUS OXIDE" 36) \_\_\_\_\_
- A) linear, nonpolar  
 B) linear, nonpolar  
 C) bent, polar  
D) linear, polar  
 E) bent, polar



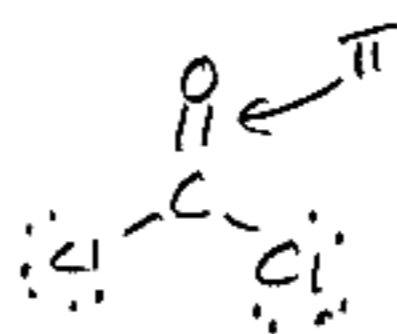
- 37) The molecule dichloromethane has what molecular shape? 37) \_\_\_\_\_
- A) trigonal pyramidal  
 B) square  
C) tetrahedral  
 D) trigonal planar  
 E) shapes can't be predicted simply from the name!



- 38) How many lone pairs are on the central atom of ozone ( $O_3$ )? 38) \_\_\_\_\_
- A) 0  
B) 1  
 C) 2  
 D) can't determine  
 E) unpaired radical

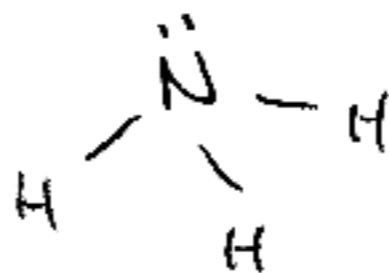


- 39) How many  $\pi$  bonds are found in the molecule  $COCl_2$ ? 39) \_\_\_\_\_
- A) 0  
B) 1  
 C) 2  
 D) 4  
 E) can't determine

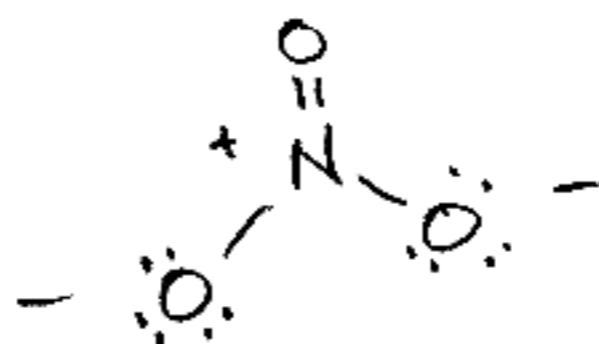


- 40) Which of the following statements is INCORRECT concerning carbon dioxide? 40) \_\_\_\_\_
- A) The molecule contains two  $\sigma$  bonds.  
 B) Each oxygen possesses two lone pairs.  
 C) The molecule contains two  $\pi$  bonds.  
D) The molecule is polar.  
E) The carbon is  $sp^2$  hybridized.
- $\Rightarrow$  BOTH INCORRECT - NON POLAR,  $SP$  HYB.

- 41) The hybridization of nitrogen in the ammonium ion is: 41) \_\_\_\_\_
- A)  $sp^3$   
 B)  $sp^2$   
 C)  $sp$   
 D)  $spd$   
 E) not hybridized

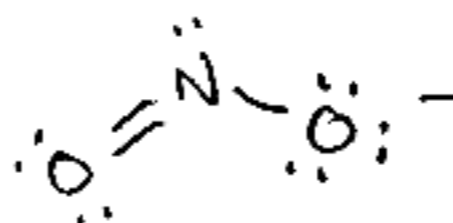


- 42) The hybridization of N in the nitrate ion is: 42) \_\_\_\_\_
- A)  $sp^2$   
 B)  $sp$   
 C)  $spd$   
 D)  $sp^3$   
 E) not hybridized



43) The hybridization of nitrogen in the nitrite ion is:

- A)  $sp^d$
- B)  $sp^2$
- C)  $sp$
- D)  $sp^3$
- E) not hybridized



43) \_\_\_\_\_

44) The hybridization of sulfur in  $SF_5^-$  is:

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

E)  $sp^3d^2$

REPEAT  
QUESTION

44) \_\_\_\_\_

TRUE/FALSE. Write 'T' if the statement is true and 'F' if the statement is false.

45) Nitrogen has a higher ionization energy than oxygen.

45) T

46) The ionization energy is the energy for an uncharged gaseous atom to lose an electron.

46) T

47) Electron affinities have the same magnitude as ionization energies, but opposite signs.

47) F

48) The electron affinity is the energy released as an uncharged gaseous atom gains an electron.

48) T

49) The core electrons in an atom are called valence electrons.

49) F

50) Gallium has 13 valence electrons.

50) F

51) Covalent bonds are formed by atoms sharing valence electrons.

51) T

52) A carbon-nitrogen covalent bond is polar.

52) T

53) Carbon dioxide is a linear, polar molecule.

53) F

54) The molecule  $CF_4$  is a tetrahedral polar molecule.

54) F

55) Polar bonds resulting in permanent dipoles are caused by the bonding pair of electrons being attracted to one atom more than the other.

55) T

56) Bonds between like atoms are nonpolar.

56) T

57) The central atom is typically the atom that is the most electronegative.

57) F

58) Hybrid orbitals participate in sigma bonds.

58) T

59) Hybrid orbitals participate in pi bonds.

59) F

60) Ammonia is a polar molecule.

60) T