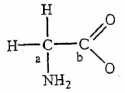
Unit 2 – Chapters 8,9: Bonding & Hybridization **Name _____**

Exercises **Period _____**

1) What geometry do the following hybrid bonds possess?
   a. sp
   b. sp^2
   c. sp^3
   d. sp^3d
   e. sp^3d^2

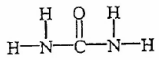
2) Predict the geometries of the following compounds:
   a. SF_2
   b. SF_4
   c. XeF_2
   d. XeF_4
   e. IF_5
   f. ClF_3

3) Predict the geometry about the indicated atom and identify the hybridization of each atom
   a. the two carbon atoms and the nitrogen atom of glycine



   b. the carbon atom in CF_2Cl_2
   c. the phosphorous atom in PCl_5
   d. the nitrogen atom in NH_2^-

4) The structure of urea is



   a. How many σ bonds are there?
   b. How many π bonds are there?
   c. What is the hybridization at the carbon?
   d. How are the nitrogen atoms hybridized?
   e. What is the N-C-N bond angle expected to be?
   f. How many lone pairs of electrons are there?

_____ 5. What hybridization describes square planar geometry?
   a. sp^3
   b. spd
   c. sp^2d
   d. sp^2

_____ 6. Formaldehyde is used as a preservative. In the presence of air, formaldehyde is oxidized to formic acid, HCOOH. What hybridization does the carbon atom have in formic acid?
   a. sp^2
   b. sp^3
   c. sp
   d. spd

_____ 7. Phosphorous pentachloride is produced upon reaction of phosphorous trichloride with chlorine. What hybridization is present in the phosphorus atom of PCl_3 and PCl_5 molecules, respectively?

a. spd, sp^3d^2
b. sp^3, sp^3d
c. sp^3, sp^3d^2
d. sp^3d^2, sp^3d

_____ 8. How many σ, and how many π bonds, respectively, are there in the following molecule:

CH_3-CH_2-CH_2-CH_2-CH=C=C=CH_2

(Remember that carbon needs to have four bonds to be satisfied.)

a. 19, 3
b. 16, 7
c. 16, 3
d. 20, 4

_____ 9. The following molecule CH_3CH_2CHO, is reduced to $CH_3CH_2CH_2OH$. What orbital is most probably used in the reduction process?

a. π orbital of one of the sp^3 carbons
b. σ orbital of one of the sp^2 carbons
c. σ orbital of one of the sp^3 carbons
d. π orbital of the sp^2 carbons

_____ 10. What is the hybridization of phosphorus in PCl_6^-?

a. d^2sp^3
b. dsp^3
c. sp^3
d. sp^2

_____ 11. How many π bonds are in the following molecule?

CH_3-CH=CH-CH=C=CH-CH_3

a. 4
b. 3
c. 0
d. 1

_____ 12. The bond in RbF is:

a. Covalent
b. Polar covalent
c. Molecular
d. Ionic

_____ 13. Which of the following bonds do you expect to be polar covalent?

a. H-N
b. H-H
c. Cs-F
d. H-O

_____ 14. In a polar bond, electrons:

a. spend equal time around both nuclei
b. are localized between both nuclei
c. spend more time around the bigger nucleus
d. spend more time around one of the nuclei than the other one

_____ 15. What is the electronegativity difference between At and H?

a. 0.1
b. -0.1
c. 4.3
d. 0.0

_____ 16. Which of the following bonds is the most polar one?

a. H-O
b. Cs-Cl
c. N-O
d. C-H

_____ 17. Order the following bonds in order of increasing bond polarity:

H-F, Se-Cl, C-O, C-At

a. C-At<Se-Cl<C-O<H-F
b. C-O<Se-Cl<H-F<C-At
c. H-F<C-O<Se-Cl<C-At
d. C-At<C-O<Se-Cl<H-F

_____ 18. Order the following bonds in order of decreasing bond polarity:

Ca-O, Ca-Cl, P-Cl, Fe-O, B-O, N-O

a. N-O>P-Cl>B-O>Fe-O>Ca-Cl>Ca-O
b. Ca-Cl>P-Cl>Ca-O>Fe-O>B-O>N-O
c. Ca-O>Ca-Cl>Fe-O>B-O>P-Cl>N-O
d. Fe-O>Ca-O>B-O>N-O>Ca-Cl>P-Cl

_____ 19. Which of the following molecules would exhibit the greatest polarity? All molecules are tetrahedral in shape.

a. $CHCl_3$
b. CH_4
c. CCl_4
d. CH_3Cl

_____ 20. Which of the following molecules has a dipole moment equal to 0?

a. SiO_4 (tetrahedral)
b. H_2O (bent)
c. $C_2H_2F_2$ (tetrahedral)
d. $CBrCl_2F$

_____ 21. Which ion could the following electron configuration describe? $1s^2 2s^2 2p^6 3s^2 3p^4$

a. K^+
b. Cl^+
c. S^{2-}
d. Ca^{2+}

_____ 22. Which of the following ions does not have the following configuration? $1s^2 2s^2 2p^6 3s^2 3p^4$

a. V^+
b. Nb^{3+}
c. Mn^{2+}
d. all of them

_____ 23. Place the following species in order of increasing size: Ne, B^{3+}, O^{2-}, and Be^{2+}

a. $B^{3+}<Be^{2+}<Ne<O^{2-}$
b. $Ne<B^{3+}<Be^{2+}<O^{2-}$
c. $O^{2-}<Ne<Be^{2+}<B^{3+}$
d. $Ne<O^{2-}<B^{3+}<Be^{2+}$

_____ 24. Determine the formula for the following sets of atoms when they combine to form binary compounds: Cs and F, Al and O, B and F, Ag and Cl

a. Cs_2F, Al_2O_3, BF, AgCl
b. CsF, Al_2O_3, BF_3, AgCl
c. CsF_2, AlO, B_3F, $AgCl_2$
d. Cs_2F_2, Al_3O_5, B_2F_2, Ag_2Cl_2

_____ 25. Select the crystal that would have the largest lattice energy. Assume that the internuclear distance is the same in all these crystals.

a. NaCl
b. KCl
c. K_2S
d. CaO

_____ 26. Chemical bonds between two atoms result because:

a. The atoms can thus achieve a state of higher energy
b. The atoms can thus achieve a state of lower energy
c. The atoms fit together nicely
d. The atoms can react better when bonded

_____ 27. Two bonded atoms:

a. React more readily with other substances.
b. Are less reactive compared to when free.
c. Share all their electrons.
d. Behave in unpredictable ways.

_____ 28. The reaction of hydrogen with fluorine gas is highly exothermic (releases a high degree of energy). Calculate the F-F bond energy knowing that: H-H = 432 kJ/mol, H-F = 565 kJ/mol, and ΔH = -543 kJ.

a. 155 kJ/mol
b. 543 kJ/mol
c. 698 kJ/mol
d. 1019 kJ/mol

_____ 29. A truck uses propane (C_3H_8) to power its engine. Calculate how much heat will be released when 5 moles of propane are burned, knowing that the reaction of propane with oxygen gas produces carbon dioxide and water.

a. 7330 kJ
b. 75 kJ
c. 10,000 kJ
d. 4784 kJ

_____ 30. Chlorine trifluoride is prepared by reacting chlorine gas with fluorine gas. The heat of the reaction is -803 kJ/mol of chlorine reacted. Calculate the Cl-Cl bond energy.

a. 1091 kJ/mol
b. 155 kJ/mol
c. 238 kJ/mol
d. 50 kJ/mol

_____ 31. How many valence electrons does selenium have?

a. 6
b. 4
c. 3
d. 5

_____ 32. How many of the 6 valence electrons in sulfur are used in covalent bonding in sulfur tetrachloride and disulfur difluoride?

a. 4 and 2
b. 3 and 2
c. 6 and 1
d. 2 and 2

_____ 33. How many of the 6 valence electrons in oxygen are usually used in covalent bonding?

a. 4 c. 6

b. 3 d. 2

_____ 34. In the $POCl_3$ molecule, how many double bonds are there? How about single bonds?

a. 1 and 3 c. 2 and 1

b. 4 and 1 d. 1 and 2

_____ 35. Which one of the following molecules possesses a triple bond?

a. SF_4 c. C_2H_2

b. PCl_5 d. C_2H_6

_____ 36. Which one of the following molecules does not possess a double bond?

a. C_2F_4 c. OCH_2

b. $C_2H_4F_2$ d. HOCOCl

_____ 37. Which one of the following molecules contains a central atom that violates the octet rule?

a. SF_4 c. $Si(OH)_4$

b. COF_2 d. PBr_3

_____ 38. Calculate the formal charge on chlorine in ClO_4^-

a. 1- c. 6+

b. 3+ d. 4+