# 9TQ: Molecular Geometry and Bonding Theories Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

# *Text Questions from Brown, et. al.*

1. What four factors determine the properties of a substance?

9.1

2. What do Lewis structures NOT indicate?

3. How are bond angles defined?

4. What is the value of the bond angle that is characteristic of a tetrahedron?

5. VSEPR is an acronym for…

9.2

6. A region in which electrons are likely to be found is an \_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_. We call such a domain that

exists between two atoms a \_\_\_\_\_\_\_\_\_ domain. When two electrons are located principally on one

atom, they constitute a \_\_\_\_\_\_\_\_\_\_\_\_\_\_ (or \_\_\_\_\_\_\_) \_\_\_\_\_\_.

7. The three things that produce an electron domain around a central atom are…

8. The best arrangement of electron domains is the one that…

9. With reference to Table 9.1, list the names of the various electron-domain geometries, along with how

many domains each has AND the predicted bond angles.

10. What is the difference between the electron-domain geometry and the molecular geometry?

11. To predict the shapes of species… A. Draw the \_*\_\_\_\_\_\_\_*\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_.

B. Determine the \_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_.

C. Determine the \_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_.

12. What do nonbonding pairs tend to do to adjacent bond angles?

13. Compared to domains for single bonds, domains for multiple bonds…

14. Central atoms of which elements may have more than four electron pairs around them?

15. For the trigonal bipyramidal electron domain geometry, two of the domains point toward the \_\_\_\_\_\_\_\_

positions and three point toward the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ positions.

16. Why do domains from nonbonding pairs always occupy equatorial positions?

9.3

17. Bond polarity is a measure of…

18. Bond polarity increases as…

19. On what two factors does the dipole moment depend?

20. What is a bond dipole?

21. The overall dipole moment of a polyatomic molecule is the \_\_\_\_\_\_\_\_\_\_\_ sum of its bond dipoles.

22. In CO2, the individual bonds are \_\_\_\_\_\_, but the linear geometry dictates that the overall dipole

moment is \_\_\_\_\_, which means that CO2 is a \_\_\_\_\_\_\_\_ molecule. H2O, on the other hand, has a

\_\_\_\_\_\_ geometry; the bond dipoles do NOT \_\_\_\_\_\_\_\_\_ each other. H2O is a \_\_\_\_\_\_\_\_ molecule.

9.4

23. Valence-bond theory is a mixture of what two ideas?

24. Valence-bond theory deals with how atomic orbitals can \_\_\_\_\_*\_* with each other.

25. In the valence-bond theory, electron density builds up between two nuclei when…

26. Between two atoms, the internuclear distance (or bond length) corresponds to what?

27. An observed bond length is the distance at which…

9.5

28. What are hybrid orbitals?

29. How does the shape of a hybrid orbital compare to the shapes of the original atomic orbitals?

30. The number of hybrid orbitals equal to…

31. For what reason are *sp* hybrid orbitals named the way they are?

32. According to the valence-bond theory, *sp* hybridization implies what electron-domain geometry?

33. Within a subshell, what atomic orbitals – and how many of each – mix to produce *sp2* hybrid orbitals?

34. Within a subshell, what atomic orbitals – and how many of each – mix to produce *sp3* hybrid orbitals?

35. In H2O, two of the \_\_\_\_ hybrid orbitals around the O contain \_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_, while the other

two contain pairs that \_\_\_\_\_\_\_ the H atoms to the O.

36. What results from the mixing of one *s*, three *p*, and one *d* orbital?

37. What results from the mixing of one *s*, three *p*, and two *d* orbitals?

38. List the steps used to predict the hybrid orbitals that are formed by a central atom in a species.

A. Draw the…

B. Determine the…

C. Specify the…

9.6

# 39. Sigma () bonds concentrate electron density along the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_.

# 40. What results in the production of a pi () bond?

41. Single bonds are \_\_\_ bonds; a double bond consists of one \_\_\_ and one \_\_\_ bond; a triple bond consists of one \_\_\_ bond and two \_\_\_ bonds.

42. Why do  bonds introduce rigidity into molecules?

43. Why can only atoms with *sp* or *sp2* hybridizations be involved in  bonding?

44. What is meant in saying that bonding electrons are localized?

45. In benzene, the  bonds are delocalized among how many carbon atoms?

46. When atoms share more than one pair of electrons, one pair forms a \_\_*\_* bond; the other pairs form

\_\_\_ bonds.

47. Delocalized electrons are ones in p bonds that extend over…

9.7

48. Electrons in atoms can be described by wave functions called \_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_, while – according to

\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_, electrons in molecules are described by wave functions called

\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_.

49. Like atomic orbitals, each molecular orbital (MO) can hold how many electrons?

50. According to MO theory, whenever two atomic orbitals overlap…

51. The lower-energy MO of H2 is called the \_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_. This MO concentrates the

\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_ between the nuclei. The higher-energy MO has very little \_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_

between the nuclei and is called the \_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_.

52. What does the asterisk denote in the label of an MO?

53. According to MO theory, why is the H2 molecule more stable than the two separate H atoms?

54. What is the electron configuration for H2?

55. Write the equation for calculating bond order.

56. A bond order of \_\_\_ represents a single bond; a bond order of \_\_\_ represents a double bond; and a

bond order of \_\_\_ represents a triple bond.

57. What does a bond order of zero mean?

9.8

58. According to MO theory, do core electrons contribute significantly to bonding in molecules?

59. When two 2p orbitals overlap in head-to-head fashion, the two MOs formed are designated as \_\_\_\_

and \_\_\_\_. When the other 2p orbitals overlap in sideways fashion, we get two \_\_\_\_ orbitals and two

\_\_\_\_ orbitals.