

Bonding - Review

Covalent Bonding in Molecular Compounds

1. How is the bonding in O_2 different than in MgO ? Give more of an explanation than just the name for the type of bonding in each.
2. Give the name or chemical formula for each of the following substances and in each case predict whether the bonding is better described as ionic or covalent:
 - a) iron(II) fluoride
 - b) chromium(III) oxide
 - c) selenium dibromide
 - d) SF_6
 - e) $CoCl_2$
 - f) $ScBr_3$
 - g) nitrogen dioxide
 - h) hydrogen sulfide
3. What happens when a covalent substance dissolves? When it melts?
4. Why do covalent compounds (in general) have lower melting and boiling points than ionic compounds?

Lewis Structures

5. What is a Lewis structure and how does it differ from a Lewis dot symbol?
6. Construct Lewis structures for F_2 , O_2 , and N_2 in which each atom achieves an octet of electrons. Explain how the covalent bonds differ for each molecule. How many pi and sigma bonds are present in each molecule?
7. Draw Lewis Structures for each of the following molecules and show the number of valence electrons in () below each chemical formula:

a) NCl_5	e) PF_3	i) OF_2
b) N_2O_4	f) CO_3^{2-}	j) O_3
c) CO	g) $C_2H_4(OH)_2$	k) BF_3
d) C_2FH_3	h) ClF_5	l) SO_2
m) HCN	q) HBr	u) NO_2^-
n) $CHCl_3$	r) NH_4^+	v) NO_3^-
o) H_2CO	s) PO_4^{3-}	
p) SeF_2	t) H_3O^+	
8. Draw Lewis structures for the following ions: NO_3^{-1} , PO_4^{-3} , and SO_4^{-2} . Explain why each of these ions is stable with the appropriate charge.
9. Urea, a substance produced in protein metabolism, has a central C atom bonded to an O and two N atoms, NH_2CONH_2 . Draw the Lewis structure for urea.
10. Three different Lewis structures are possible for N_2O . Draw all three. Which one is the best description of the bonding in this molecule? Why?

Molecular Shapes and VSEPR

11. Why is it important to understand and be able to predict the shape of molecules?
12. What factors do you consider in determining the molecular shape of a molecule?
13. What is the VSEPR model for determining molecular shape? What are the limitations of this model?
14. Define:
- a) bonding pair
 - b) nonbonding pair
 - c) electron geometry
 - d) molecular geometry
15. Describe the effect of nonbonding electrons on bond angles. Where do the nonbonding electrons have to be to affect molecular shape?
16. The Lewis Structure for which of the following molecules would have two non-bonded pairs of electrons on the central atom?
- a) H_2S
 - b) NH_3
 - c) CH_4
 - d) HCN
 - e) CO_2
17. For the following descriptions of molecular shape sketch the geometric object on which it is based and sketch a ball and stick drawing of the shape:
- a) trigonal planar
 - b) tetrahedral
 - c) trigonal pyramidal
 - d) bent
 - e) trigonal bipyramidal
 - f) octahedral
 - g) seesaw
 - h) t-shaped
 - i) square pyramidal
 - j) square planar
18. Rank the following VSEPR molecular shapes in order of decreasing bond angle: tetrahedral, linear, pyramidal, and triangular.
19. Use VSEPR theory to predict the shape of each molecule below and predict whether each molecule is polar or non-polar. Identify each molecule's shape by name, indicate the bond angles and the type of hybridization around the central atom(s)
- a) PCl_3
 - b) N_2O_4
 - c) NF_3
 - d) SO_2
 - e) $\text{C}_2\text{H}_4(\text{OH})_2$
 - f) OF_2
 - g) SO_3
 - h) BH_3
 - i) I_3^{-1}
 - j) NO
 - k) XeO_2F_2
 - l) IF_3
 - m) ClF_5
 - n) Hydrogen phosphide
 - o) Hydrobromic acid
 - p) Sulfuric acid
 - q) Phosphoric acid
 - r) Nitric acid
 - s) Xenon hexafluoride
 - t) H_2O_2
 - u) HClO_4
20. Describe the difference between a polar covalent bond and a non-polar covalent bond.

21. Which of the following bonds are polar and which is the more electronegative atom in each polar bond? (use the values listed on your periodic table to answer this question)

a) C - Cl

c) P - F

e) Si - Si

b) C - O

d) N - Br

22. Arrange the bonds in each of the following sets in order of increasing polarity:

a) C - F, O - F, Be - F

c) C - S, B - P, N - O

b) N - Br, P - Br, O - Br

23. How does a polar molecule differ from a non-polar one?

Metallic Bonding

24. What is a metallic bond?

25. Explain how the high electrical conductivity of metals is explained by the idea of metallic bonds.

26. If you were given a strange unknown solid what are some ways you could determine if it was an ionic compound or a metal?

Covalent bond characteristics

27. What is a covalent bond? How does it differ from an ionic bond?

28. What is a single covalent bond? Why does it form?

29. Why do multiple bonds (double and triple bonds) form? Explain the formation of multiple bonds in terms of orbital overlap.

30. What is the difference between single, double, and triple bonds in terms of bond strength? Bond length?

31. What are the similarities and differences between the bonding in diamond and graphite? How are these differences in bonding reflected in the properties of the materials?

Characteristics of Ionic compounds/bonds

32. What happens to an ionic compound when it dissolves? When it melts?

33. Why do ionic compounds conduct electricity when dissolved or melted?

34. What holds ionic crystals together?

35. Ionic compounds are generally hard, brittle, and have high melting and boiling points. How can these properties be explained by their bonding?

36. How could you predict that a bond between two elements would be ionic?

Intermolecular Forces

37. What are intermolecular forces?

38. What type of intermolecular forces are present in the following compounds?

a. Water

f. Hydrogen fluoride

b. Ammonia

g. Carbon dioxide

c. Iodine

h. Carbon monoxide

d. Ethanol ($\text{CH}_3\text{CH}_2\text{OH}$)

i. Hexane

e. Hydrogen chloride

($\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3$)

39. Why do ionic compounds dissolve in polar solvents but not in non-polar solvents?

40. Why does water have a much higher boiling point than H_2S ?