AP Chemistry Unit 6 Bonding
Review Packet

I. Directions: Answer each of the following questions. No calculators are allowed unlessspecified.

Goal: I can differentiate between an ionic bond, covalent bond or metallic bond.

For # 1-8, identify which statements below is a characteristic of an ionic bond(I), covalent bond(C) or a metallic bond(M).

_____ 1. Potassium iodide.

_____ 2. Aluminum.

_____ 3. More transfer of electrons

_____ 4. Water

_____ 5. Conducts electricity in the solid state

_____ 6. More sharing of electrons.

_____ 7. Have mobile electrons.

_____ 8. Carbon disulfide

9. Which one of the following element combinations is likely to produce ionic bonds in a compound?

a) Li and F b) B and O c) N and O d) P and S e) Cl and Br

Goal: I can draw the Lewis symbols for any element on the periodic table.

10. Below each element, draw its Lewis dot structures

fluorine calcium vanadium lead sulfur xenon indium arsenic

11. Which one of the following has eight valence electrons?

a) Ti^{4+} b) Kr c) Cl^{-} d) Na^{+} e) All of these!

Goal: I can define Lattice Energy and its relationship to ionic compounds and their meltimg points. I will also be able to describe the factors which affect lattice energy.

12. Explain, using the factors that affect lattice energy why the following compounds increase in latttice energy: KBr < KF < MgSe < MgO < AlN

13. Which of the following compounds would you expect to have the lowest melting point?

a) NaF b) Na_2O c) NaBr d) NaI e) CaO

14. Calcium oxide has a lower melting point than magnesium oxide due to the
    a. greater charge on the Mg^{2+} than of Ca^{2+}.
    b. greater charge on the Ca^{2+} than of Mg^{2+}
    c. the greater distance between the charges in CaO.
    d. the greater distance between the charges in MgO.
    e. equal chages on the Mg^{2+} than of Ca^{2+}.

15. In ionic bond formation, the lattice energy of ions _____ as the magnitude of the ion charges _____ and the radii_____.
    a. increases, decrease, increase.
    b. increases, increase, increase.
    c. decreases, decrease, increase.
    d. increases, inecrease, decrease.
    e. decreases, increase, decrease.

Goal: I can differentiate between a single, double, and a triple covalent bond in terms of number of shared electrons, length and strength.

16. Which of the following elements is **most** likely to participate in the formation of multiple bonds?

a) H b) Na c) Cl d) S e) F

17. Which molecule has the weakest bond?

a) CO b) O_2 c) Cl_2 d) NO e) N_2

18. As the number of conalent bonds between two atoms increasers, the distance between the atoms _____ and the strength of the bond between them _____.
    a. increases, increases.
    b. decreases, increases.
    c. increases, decreases.
    d. decreases, decreases.
    e. is unpredictable

Goal: I am able to define to electronegativity and apply the electronegative trends to the periodic table.

19. In which of the following are the elements listed in order of increasing electronegativity?

a. Ba, Zn, C, Cl
b. O, N, S, Cl
c. N, P, As, Sb
d. K, Ba, Si, Ga
e. Li, K, Na, Ca

Goal: I am able to predict the relative polarities of bonds using either the periodic table or electronegativity values. I can also desrcibe the factors which affect bond polarity and dipole moment.

20. Which of the following bonds is expected to be the most polar?

a. C - Si b. C - N c. O - C d. S - C e. H - C

21. C, O C, F N, O K, Br S, O Rb, Cl

The bond above that is the most polar is _____ and the least polar is _____.

a. C,O K, Br
b. Rb, Cl N,O
c. C, F, S, O
d. Rb, Cl S,O
e. N,O C, F

Goal: Write the Lewis structures for molecules and ions containing covalent bonds using the periodic table.

22. Draw Lewis dot structures for the following molecules:

$CHCl_3$ C_2Cl_2 SO_3^{2-}

BH_3 F_2S NH_4^+

Goal 8: Explain the concept of resonance and draw resonance structures for molecules or polyatomic ions.

23. Which molecule below possesses resonance?

a) BCl_3 b) SO_2 c) CO_2 d) BeF_2 e) SO_4^{2-}

Questions 24-26: Consider the chemical bonds found in the white solid, potassium hydrogen phosphate, K_2HPO_4. For each bond specified, choose the best description from the list of bond types below.

a. ionic bond
b. hydrogen bond
c. single covalent bond
d. double covalent bond
e. covalent bond with resonance

24. phosphorus/oxygen bond

25. potassium/hydrogen phosphate bond

26. oxygen/hydrogen bond

Goal 9: Use the concept of formal charge to predict the most stable resonance structure.

27. The formal charge on the nitrogen in a nitrite ion (NO_2^-) is

a) -2 b) -1 c) 0 d) 1 e) 2

28. Identify all the following statements that are TRUE about formal charge.

a. The formal charge on an atom is determined by taking the valence electrons minus the electrons assigned to that atom.

b. A lewis structure is valid if a negative formal charge is on the least electronegative element.

c. The formal charge on the oxygen is a water molecue is -2.

d. For neutral compounds, the formal charges add up to variuous numbers and for ions the formal charges add up to equal the charge on the ion.

e. Lewis structures with large formal charges are most likely to exist.

Goal : Describe the 3 common exceptions to the octet rule and provide examples of each.

The three common exceptions are:
A. Molecules that have an odd number of electrons.
B. Molecules in which there is less than an octet of electrons.
C. Molecules in which there is more than an octet of electrons.
Knowing this, identify the exception that each molecule best fits.

29. XeF_4

30. NO

31. BH_2Cl

32. SeF_4

33. ClO_2^-

34. Which of the following is most likely to form compounds involving an expanded octet?

a) Li b) N c) F d) Ne e) S

Target 11: Relate bond enthalpies to bond strengths and and use bond enthalpies to estimate ΔH for reactions.

35. Bond enthalpy is _____ positive and is defined as the energy _____ to break a bond.

a. always , required
b. never, required
c. sometimes, produced
d. always, produced
e. never, requried

36. Given the bond dissociation energies below, calculate the standard molar enthalpy of formation of ClF_3.

$$Cl_2(g) + 3\ F_2(g) \text{ ---------> } 2\ ClF_3(g)$$

Bond	Dissociation Energy (kJ/mol)
Cl-Cl	243
F-F	159
Cl-F	255

a) 210 kJ/mol b) 147 kJ/mol c) -33 kJ/mol d) -405 kJ/mol e) -810 kJ/mol

Goal: I can determine the bond angle, geometric shape and the electron domain shape of a molecule or ion based upon the V.S.E.P.R. Theory.

37. Which of the following has a nonbonding pair of electrons on the central atom?
    a. BCl_3 b. NH_3 c. CCl_2Br_2 d. PF_5 e. SO_4^{2-}

38. Which one of the following may we draw both polar and nonpolar Lewis structures?
    a. $CHCl_3$
    b. NH_3
    c. BF_3
    d. SF_2Cl_4
    e. SO_2

39. Which one of the following is NOT a linear structure?
    a. I_2 b. I_2^- c. CO_2 d. H_2S e. $H-C\equiv C-H$

40. The Lewis structure of the cyanide ion most closely resembles which of the following?
    a. N_2 b. O_2 c. CO_2 d. NO e. C_2H_2

41. Which angle is NOT expected in any molecule?
    a. 60°
    b. 90°
    c. 109.5°
    d. 120°
    e. All of these are reasonable angles.

Goal: I can explain why nonbonding electron domains exert a greater repulsive interaction on other domains than do bonding electron domains.

42. Which molecule below would have the greatest repulsion of electrons resulting in the smallest bond angle.
    a. BH_3 b. H_2O c. PH_3 d. SO_2 e. CH_4

Goal : I can predict from the shape of a molecule whether it is polar or nonpolar.H

43. Which of the bonds below is the most polar? (Review from Chapter 8)

Element	Si	H	C	S	N	O
electronegativity	1.8	2.1	2.5	2.5	3.0	3.5

    a. C - Si b. C - N c. O - C d. S – C e. H - C

44. How many of the molecules below are polar. (Circle answers that are polar!)
    a. BH_3 b. H_2O c. PH_3 d. SO_2 e. CH_4

45. Which one molecule below will have a zero dipole moment?
    a. NH_3 b. NO_2 c. HCN d. SO_2 e. PF_5

Goal: I can explain the concept of hybridization and its relationship to geometrical structure.
I can predict the type of hybrid orbitals of an atom in a molecule.

46. The SF_5^- ion has a square pyramid structure. The hybridization of the orbitals in sulfur is:
    a. dsp^3
    b. sp
    c. d^2sp^3
    d. sp^3
    e. sp^2

47. Sulfur forms the following compounds: SO_2, SF_6, SCl_4, SCl_2. Which form of hybridization is NOT represented by these molecules?

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

Goal: I can explain the difference between a sigma bond and a pi bond. I can also determine the number of sigma bonds and pi bonds in a molecule or ion.

48. For # a - f, identify which statements below is a characteristic of a pi (p) or a sigma (s) bond.

_____ a. Formed by the head-to-head bond between atoms.

_____ b. Formed above and below the bond axis.

_____ c. A triple bond would contain two of these.

_____ d. This bonding occurs from the sideways overlap of an electron in p orbitals.

_____ e. A triple bond would contain one of these.

49. Which of the following has the fewest pi bonds and is nonpolar?

a. HCCH
b. CO2
c. CO_3^{2-}
d. N2
e. SO2

50. Which one of the following is true when the C = C and CΞC bonds are compared?

a. The triple bond is shorter than the double bond.
b. The double bond contains more pi bonds.
c. The double-bond energy is higher than the triple-bond energy.
d. The double bond contains less sigma bonds.

I. FREE RESPONSE: Complete each of the following free response questoins kin the spaces provided.

1. Draw the Lewis dot structure for a nonpolar molecule that has a molecular formula of $Si_2H_2Br_2$. (note Si is double bonded to Si)

a. There are _____ sigma bonds and _____ pi bond(s) in this molecule?

b. The hybridization around each carbon is _____, and the bond angle is _____.

This molecule is nonpolar because it is _____ and it has _____ dipoles.

c. Draw the two polar isomers of this compound and indicate where the dipole is located.

2. Draw the structure for acetic acid (H_3C-COOH) below. NOTE: The second carbon is double bonded to the first oxygen and single-bonded to the second O. The H is attached to the second oxygen.

a. What is the molecular geometry around each carbon atom?

b. What type of hybrid orbitals does each carbon have?

3. Name three elements which . . .

a) cannot have expanded octets when it is the central atom in a molecule.

b) do not need an octet to form stable compounds.

Molecule or Ion	Lewis Structure	e- domain geometry	Molecular geometry or shape	Bonded / Nonbonded e- domains	Polar or Nonpolar	Hybridizaion	Bond Angle
PH_3							
SO_2							
HCN							
PF_5							
SCl_4							
$XeFCl_3$							

c) Identify any molecules above that has pi bonding?

4. A compound consists of 61.70 %Cl 10.40 %C and 27.80 %S by mass. Knowing this determine the following.

a. What is the empirical formula(which is also the molecular formula) of this compound?

b. Draw the Lewis dot structure. (Note: Carbon is the central atom!)

c. This molecule has _____ sigma and _____ pi bonds.

d. What is the hybridization around the carbon? _____

5. Carbon dioxide is bubbled into water.

a. Write a net ionic equation for this reaction.

b. Draw the Lewis structures of the reactants and products. Include any valid resonance structures.

c. Given the following bond enthalpies, estimate the enthalpy of the reaction.

BOND	BOND ENTHALPY (kJ/mol)
H – H	436
H – O	463
O - O	146
C - O	358
C = O	799
C O	1072

d. Are the C – O bonds in the reactant stronger or weaker than those in the product? Explain. Is your explanation consistent with the sign of the enthalpy change you estimated? Explain.

e. Excess aqueous sodium hydroxide is added to the solution. Write a balanced net ionic equation for this reaction.

6. Complete the following table below.

Molecule or Ion	Lewis Dot Structure	Formal Charge on Central atom	Obeys Octet Rule Yes or No	Polar Yes or No	Resonance Yes or No
SiO_3^{2-}					
HCO_3^-					
SeO_2					
COS (carbon is the central atom)					