Chemistry 311/312

Name: Answer Key

Covalent Bonding

Unit Review Packet

Learning Targets
Identify the information a molecular formula provides.
Describe the representative units that define molecular compounds and ionic compounds.
Explain the result of electron sharing in covalent bonds.
Explain how the strength of a covalent bond is related to its bond dissociation energy.
Describe how the VESPR theory helps predict the shapes of molecules.
Describe how electronegativity values determine the charge distribution in a polar molecules.
Evaluate the strengths of intermolecular attractions compared with the strengths of ionic and covalent bonds.
Explain why the properties of covalent compounds are so diverse.

1. Why do atoms form bonds?

   To form a stable octet.

2. What subatomic particles are involved most in the bonding process?

   Electrons

3. What type of atoms (metals, metalloids, nonmetals) are bonded to each other in an ionic bond?

   metals and nonmetals

4. How do atoms achieve a stable octet in an ionic bond?

   By gaining or losing electrons

5. What types of atoms (metals, metalloids, nonmetals) are bonded to each other in a covalent bond?

   nonmetals

6. How do atoms achieve a stable octet in a covalent bond?

   Sharing electrons

7. In a dot structure, how many electrons should be surrounding each atom?

   8

8. What is one major exception to the rule in number 7?

   Hydrogen only needs 2.

9. What is an ionic bond?

   metals and nonmetals achieve stable octets by gaining or losing electrons.

Name:_____

10. What is a covalent bond?

Two or more nonmetals share electrons to obtain a stable octet.

11. What is the difference between a dot structure and line structure?

Both show a visual representation of valence electrons and covalent bonds in a molecule, but line structures use a (–) to represent two electrons and dot structures use (··).

12. What do molecular formulas tell you about a molecule or compound?

The types of elements, number of molecules, and number of atoms of each element.

13. What is a diatomic molecule? Give at least two examples of diatomic molecules.

A molecule that consists of two atoms.

H_2 O_2 F_2 Br_2 I_2 N_2 Cl_2

14. Ionic compounds are typically in what state at room temperature?

Crystalline solids

15. Covalent molecules are typically in what state at room temperature?

Solid, liquid, or gas

16. Compare the melting point, solubility in water, and electrical conductivity of ionic and covalent compounds.

	Ionic	Covalent
Melting Point	High	Low
Solubility	High	Low
Conductivity	Good	Poor to nonconducting.

17. What are the three different types of covalent bonds? Explain when two atoms are likely to form each type.

Single → share one pair of electrons

Double → share two pairs of electrons

Triple → share three pairs of electrons

18. Why do scientists use the VESPR theory?

To predict the three-dimensional shape of molecules.

19. What is a nonopolar covalent bond?

- When the atoms in the molecule pull equally.
- When the bonding electrons are shared equally.

20. What is a polar covalent bond?

A covalent bond between atoms in which the electrons are shared unequally.

Name:_____

21. What is electronegativity?
How strongly an atom attracts the electron that bonded it to another atom.

22. What does the electronegativity difference between two atoms tell you?
The type of bond between the atoms

23. What is a polar molecule?
A molecule where one end of the molecule is slightly negative, and one end is slightly positive.

24. What is a nonpolar molecule?
A molecule where there are not different poles.

25. What is a dipole?
A molecule that has two "poles".

26. Explain dipole forces.
- polar molecules are attracted to each other.
- positive and negative ends of molecules attract.

27. Explain dispersion (london) forces.
- caused by the motion of electrons, causes "temporary" dipoles.
- nonpolar molecules are attracted to each other.

28. Explain hydrogen bonding.
- special (strong) type of dipole force.
- Hydrogen MUST be bonded to O, N, or F.

29. Explain what ionic attractions are.
- positive and negative ions are attracted to each other.
- form crysta "lattices"

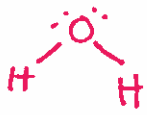
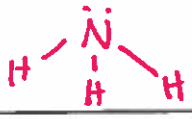
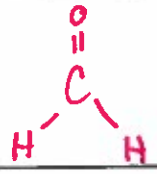
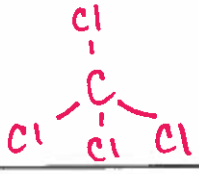
30. Rank the intermolecular forces from weakest to strongest.

London Dispersion Forces → Dipole Forces → Hydrogen Bonding → Ionic attractions

Chemistry 311/312

Name:_____

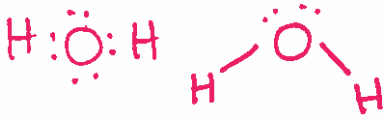
VESPR REVIEW

Shape	Number of unshared pairs	Molecular Model
Linear	None	 H–Cl or O=C=O
Bent	2	 
Trigonal Pyramidal	1	 
Trigonal Planar	0	 
Tetrahedral	0	 

DOT/LINE STRUCTURE REVIEW

Draw the dot and line structure for each of the following covalently bonded molecules.

H_2O



SiO_2

SCl_2

KrF_2

Kr is a noble gas!

NF_3

N_2

Chemistry 311/312

Name:_____

IDENTIFYING POLARITY IN BONDS AND MOLECULES

*For each of the molecular compounds below, draw the **line structure** and determine the **types of bonds** present, whether the **molecule is polar or nonpolar** and what **types of intermolecular forces are present**.*

1) SO_2

END
3.5-2.5
1

Polar Bonds

Polar molecule

Dipole Forces

2) SO_3

SKIP

3) HCN

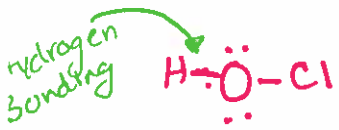
END
3.0-2.5
0.5 → Polar Bond

2.5-2.1
0.4 → non polar bond

Polar molecule

Dipole Forces

4) HClO



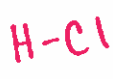
End
3.5-3.0
0.5 → Polar Bond

3.5-2.1
1.4 → Polar bond

Polar molecule

Dipole Forces and Hydrogen Bonding

5) HCl



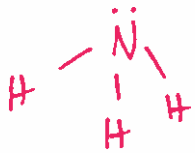
END
3.0-2.1
0.9

Polar Bond

Polar molecule

Dipole Forces

6) NH_3



END
3.0-2.1
0.9

Polar Bond

Polar molecule

Hydrogen Bonding

Chemistry 311/312

Name:_____

7) H_2S

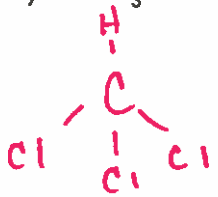
END
2.5 - 2.1
0.4

nonpolar bond

Polar molecule

Dipole forces

8) $CHCl_3$



END
2.5 - 2.1
0.4

nonpolar bond

3.0 - 2.5
0.5

polar bond

Polar molecule

Dipole Forces

9) CO_2

$O=C=O$

END
3.5 - 2.5
1.0

Polar Bonds

non polar molecule

London Forces

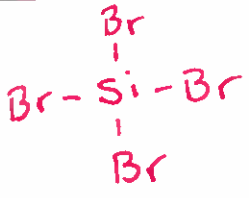
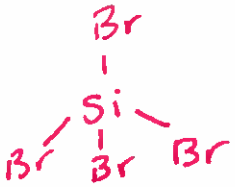
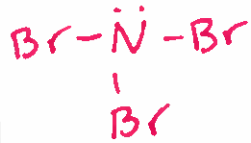
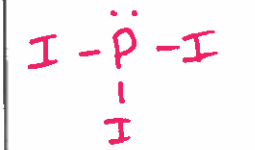
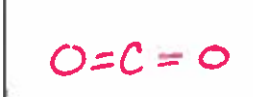
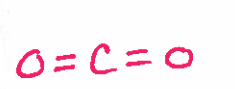
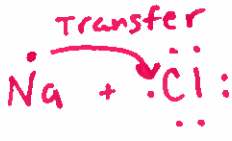
DETERMINING IONIC VS. COVALENT COMPOUNDS USING MOLECULAR FORMULAS

Determine if the elements in the following compounds are metals or nonmetals. Identify the type of bonding that will occur in the compound.

Compound	First Element (metal or nonmetal)	Second Element (metal or nonmetal)	Bond Type
NO_2	nonmetal	nonmetal	Covalent
NaCl	metal	non metal	Ionic
SO_2	nonmetal	non metal	Covalent
$MgBr_2$	metal	nonmetal	Ionic
CaO	metal	non metal	Ionic
H_2O	nonmetal	non metal	covalent
HF	non metal	nonmetal	covalent
Fe_2O_3	metal	nonmetal	Ionic

Chemistry 311/312

Name: _____

Molecule	E.N.D.	Bonds (NPC,PC,I)	Molecule Polarity	Line Structure	Name of Shape	Drawing of Shape
$SiBr_4$	2.8 - 1.8 1.0	PC	non-polar		Tetrahedral	
H_2S	2.5 - 2.1 0.4	NPC	Polar		Bent	
NBr_3	3.0 - 2.8 0.2	NPC	Polar		Trigonal Pyramid	
PI_3	2.5 - 2.1 0.4	NPC	polar		Trigonal Pyramid	
CO_2	3.5 - 2.5 1.0	PC	non-polar		Linear	
BF_3 SKIP	4.0 - 2.0 2.0					
O_2	3.5 - 3.5 0	NPC	non-polar		Linear	
NaCl	3.0 - 0.9 2.1	Ionic	—		—	—
MgF_2	4.0 - 1.2 2.8	Ionic	—	—	—	—

Chemistry 311/312

Name:_____

ADDITIONAL REVIEW QUESTIONS

1. Which are POLAR molecules?

H_2O SKIP CH_3F CF_4 NH_3 NF_3 CH_4

2. Based on the EN values, which elements will combine to have the most ionic character?

F = 4.0 O = 3.4 C = 2.6, Mg = 1.2

F and Mg have the greatest difference in electronegativity.

3. Which substance has 3 single covalent bonds?

CO_2 N_2 F_2 O_2 NH_3

4. All the bonds below are polar, but which molecules are polar?

CH_4 SKIP H_2O CO_2 HF

5. Which substance(s) have one double bond?

CO_2 N_2 F_2 O_2 NH_3

6. Which substance(s) have a triple bond?

CO_2 N_2 F_2 O_2 NH_3