

Chemistry 20 Final Review

Bonding Checklist

Have you mastered the concepts, applications, and skills associated with the following items? Check them off when you are confident in your understanding.

Knowledge

- explain why formulas for ionic compounds refer to the simplest whole-number ratio of ions that result in a net charge of zero
- define valence electron, electronegativity, and ionic bond
- use the periodic table and Lewis structures to support and explain ionic bonding theory
- explain how an ionic bond results from the simultaneous attraction of oppositely charged ions
- draw or build models of common ionic lattices and relate structures and properties
- explain why the formulas for molecular substances refer to the number of atoms of each constituent element
- relate electron pairing to covalent bonds
- build models depicting the structure of simple covalent molecules, including selected organic compounds
- draw electron-dot diagrams (Lewis symbols and formulas) of atoms and molecules, writing structural formulas for molecular substances and using Lewis structures (formulas) to predict bonding in simple molecules
- apply VSEPR theory to predict molecular shapes
- illustrate, by drawing or building models, the structure of simple molecular substances
- explain intermolecular forces, London (dispersion) forces, dipole–dipole attractions, and hydrogen bonding
- relate properties of substances to the predicted intermolecular bonding in the substance
- determine the polarity of a molecule based on simple structural shapes and unequal charge distribution
- describe bonding as a continuum ranging from complete electron transfer to equal sharing of electrons.

Key Terms

structural formula

valence electron

orbital

valence orbital

bonding electron

lone pair

octet rule

electronegativity

intermolecular force

covalent network

isoelectronic molecules

bonding capacity

empirical formula

molecular formula

Lewis formula

structural formula

bond dipole

covalent bond

crystal lattice

dipole–dipole force

hydrogen bond

VSEPR theory

polar molecule

nonpolar molecule

nonpolar covalent bond

polar covalent bond

Lewis symbol

ionic bond

van der Waals force

London force

Empirical Rules for Polar and Nonpolar Molecules

	Type	Description of molecule	Examples
Polar	AB	diatomic with different atoms	HCl(g), CO(g)
	N _x A _y	containing nitrogen and other atoms	NH ₃ (g), NF ₃ (g)
	O _x A _y	containing oxygen and other atoms	H ₂ O(l), OCl ₂ (g)
	C _x A _y B _z	containing carbon and two other kinds of atoms	CHCl ₃ (l), C ₂ H ₅ OH(l)
Nonpolar	A _x	all elements	Cl ₂ (g), N ₂ (g)
	C _x A _y	containing carbon and only one other kind of atom (except CO(g))	CO ₂ (g), CH ₄ (g)

Summary of Bonding

Intramolecular force	Bonding model
ionic bond	<ul style="list-style-type: none"> involves an electron transfer, resulting in the formation of cations and anions cations and anions attract each other
polar covalent bond	<ul style="list-style-type: none"> involves unequal sharing of pairs of electrons by atoms of two different elements bonds can involve one, two, or three pairs of electrons, that is, single (weakest), double, or triple (strongest) bonds
covalent bond	<ul style="list-style-type: none"> involves equal sharing of pairs of electrons bonds can involve one, two, or three pairs of electrons, that is, single (weakest), double, or triple (strongest) bonds

Classifying Solids

Class of substance	Elements combined	Examples
ionic	metal + nonmetal	NaCl(s), CaCO ₃ (s)
metallic	metal(s)	Cu(s), CuZn ₃ (s)
molecular	nonmetal(s)	I ₂ (s), H ₂ O(s), CO ₂ (s)
covalent network	semi-metals/nonmetals (carbon)	C(s), SiC(s), SiO ₂ (s)

Explaining the Properties of Metals

Property	Explanation
shiny, silvery	valence electrons absorb and re-emit the energy from all wavelengths of visible and near-visible light
flexible	nondirectional bonds mean that the planes of ions can slide over each other while remaining bonded
electrical conductivity	valence electrons can freely move throughout the metal
crystalline	electrons provide the “electrostatic glue” holding the metal ions together producing structures that are continuous and closely packed

Summary: Structures and Properties of Crystals

Crystal	Entities	Force/Bond	Properties	Examples
ionic	cations anions	ionic	hard; brittle; high melting point; liquid and solution conducts	NaCl(s), Na ₃ PO ₄ (s), CuSO ₄ ·5H ₂ O(s)
metallic	cations electrons	metallic	soft to very hard; solid and liquid conducts; ductile; malleable; lustrous	Pb(s), Fe(s), Cu(s), Al(s)
molecular	molecules	London dipole–dipole hydrogen	soft; low melting point; nonconducting solid, liquid, and solution	H ₂ O(s) (ice), CO ₂ (s) (dry ice), I ₂ (s)
covalent network	atoms	covalent	very hard; very high melting point; nonconducting	C(s), SiC(s), SiO ₂ (s)

Bonding Questions For Review

1. The forces that keep molecules together are called what?
2. The forces that keep atoms within a molecule together are called what?
3. Ionic bonds
 - a. Describe Ionic Bonds:

 - b. List properties of ionic compounds:
4. Covalent bonds
 - a. Describe covalent bonds:

 - b. List the types of covalent bonds:
5. London Dispersion Forces
 - a. Describe London Dispersion Forces (LDF).

 - b. What substances exhibit London Dispersion force?

 - c. Explain why larger molecules have greater LDFs than smaller molecules?
6. Dipole-Dipole Forces
 - a. Describe Intermolecular dipole-dipole forces.

 - b. What substances exhibit Dipole Forces?

7. Hydrogen Bonding

a. Describe Hydrogen Bonding.

b. What elements must hydrogen be bonded to in order for hydrogen bonds to occur?

8. If substance A has a higher melting and boiling point than substance B, what can you say about the substances' intermolecular forces?

9. Nitrogen has 7 protons and 7 electrons, sulfur has 16 protons and 16 electrons. Which of the two have a greater London dispersion forces?

10. Describe metallic bonding.

11. What causes an electrical current in alloys (metallic bonds)?

12. Describe the binding structure of network covalent (giant) structures.

13. What happens to the movement of electrons in a network covalent molecule?

14. Rank the IMFs from strongest to weakest?

15. Complete the following table on atom characteristics.

Atomic Number	Atom Symbol	Group Number	Number of Valence Electrons	Number of Occupied Energy Levels	Lewis Diagram of atom	Number of Lone Electrons Pairs	Number of Bonding Electron
	S						
	Si						
	P						
	Cl						
	Br						
	Ge						
	H						
	C						
	N						
	O						

16. Complete the following table on atom characteristics.

Molecule or Ion Formula	Total # of e ⁻ / Central Atom	Lewis Structure	Areas of e-density / Lone e- pairs around the central atom	VSEPR Diagram	Name of VSEPR Shape/ Bond Angle
CF₄					
PH₃					
H₂S					
CO₂					
HF					
SO₂					
SO₃²⁻					
SO₄²⁻					