



Concept Review

Chapter 6

Summary of Terms

Alloy A mixture of two or more metallic elements.

Covalent bond A chemical bond in which atoms are held together by their mutual attraction for two or more electrons they share.

Covalent compound A substance, such as an element or chemical compound, in which atoms are held together by covalent bonds.

Dipole A separation of charge that occurs in a chemical bond because of differences in the electronegativities of the bonded atoms.

Electron-dot structure A shorthand notation of the shell model of the atom, in which valence electrons are shown around an atomic symbol. The electron-dot structure for an atom or ion is sometimes called a Lewis dot symbol while the electron-dot structure of a molecule or polyatomic ion is sometimes called a Lewis structure.

Electronegativity The ability of an atom to attract a bonding pair of electrons to itself when bonded to another atom.

Ion An atom having a net electrical charge because of either a loss or gain of electrons.

Ionic bond A chemical bond in which there is an electric force of attraction between two oppositely charged ions.

Ionic compound A chemical compound containing ions.

Metallic Bond A chemical bond in which positively charged metal ions are held together within a “fluid” of loosely held electrons.

Molecule The fundamental unit of a chemical compound, which is a group of atoms held tightly together by covalent bonds.

Nonbonding pairs Two paired valence electrons that are not participating in a chemical bond.

Nonpolar Said of a chemical bond or molecule that has no dipole. In a nonpolar bond or molecule, the electrons are distributed evenly.

Ore A geologic deposit containing relatively high concentrations of one or more metal-containing compounds.

Polar Said of a chemical bond or molecule that has a dipole. In a polar bond or molecule, electrons are congregated to one side. This makes that side slightly negative while the opposite side (lacking electrons) becomes slightly positive.

Polyatomic ion An ionically charged molecule.

Substituent A term used to describe an atom or nonbonding pair of electrons surrounding a centrally located atom.

Valence electron The electrons in the outermost occupied shell of an atom.

Valence shell The outermost occupied shell of an atom.

Valence-shell electron-pair repulsion A model, also known as VSEPR (pronounced ves-per), that explains molecular geometries in terms of electron pairs striving to be as far apart from one another as possible.

Review Questions

6.1 Electron-Dot Structures

1. How many electrons can occupy the first shell? How many can occupy the second shell?
2. Which electrons are represented by an electron-dot structure?
3. How do the electron-dot structures of elements in the same group in the periodic table compare with one another?

4. Which are more stable: paired electrons or unpaired electrons?

6.2 Ion Formation

5. How does an ion differ from an atom?
6. To become a negative ion, does an atom lose or gain electrons?
7. Why does the fluorine atom tend to gain only one electron?

- Why does the sodium atom to lose only one electron?
- What is a polyatomic ion?

6.3 Ionic Bonds

- Which elements tend to form ionic bonds?
- Suppose an oxygen atom gains two electrons to become an oxygen ion. What is its net electric charge?
- What is an ionic crystal?
- In the formation aluminum oxide, Al_2O_3 , who gains electrons and who loses them?

6.4 Metallic Bonds

- Do metal atoms more readily gain or lose electrons?
- What is an alloy?
- What is a native metal?
- What are two potential sources of metals that have yet to be exploited?

6.5 Covalent Bonds

- Which elements tend to form covalent bonds?
- How many electrons are shared in a double covalent bond?
- Within a neutral molecule, how many covalent bonds does an oxygen atom form?
- Within a polyatomic ion, how many covalent bonds does a negatively charged oxygen form?

6.6 Molecular Shape

- What does vsepr stand for?
- What is meant by the term substituent?
- How many substituents does the oxygen atom in a water molecule have?

6.7 Polar Covalent Bonds

- What is a dipole?
- Which element in the periodic table has the greatest electronegativity? Which has the least electronegativity?
- Which is more polar: a carbon–oxygen bond or a carbon–nitrogen bond?

6.8 Molecular Polarity

- How can a molecule be nonpolar when it consists of atoms that have different electronegativities?
- Why do nonpolar substances boil at relatively low temperatures?
- Which has a greater degree of symmetry: a polar molecule or a nonpolar molecule?
- Why don't oil and water mix?

Quantitative Questions

- Ores of manganese, Mn, sometimes contain the mineral rhodochrosite, MnCO_3 , which is an ionic compound of manganese ions and carbonate ions. How many electrons has each manganese atom lost to make this compound?
- What is the electric charge on the calcium ion in calcium chloride, CaCl_2 ?
- Magnesium ions carry a 2+ charge, and chloride ions carry a 1- charge. What is the chemical formula for the ionic compound magnesium chloride?
- Barium ions carry a 2+ charge, and nitrogen ions carry a 3- charge. What would be the chemical formula for the ionic compound barium nitride?
- Rank the following bonds in order of increasing polarity:
a) C—H b) O—H c) N—H
- Rank the following compounds in order of increasing boiling point:
a) Fluorine, F_2 b) Hydrogen fluoride, HF
c) Hydrogen chloride, HCl
- Rank the following in order of increasing symmetry:
a) CH_4 b) NH_3 c) H_2O



Solutions (Odd-Numbered)

1. Two electrons fit into the first shell. Eight electrons fit into the second shell.
3. Electron dot structures of elements in the same group have the same number of valence electrons.
5. An ion has a charge and an atom does not.
7. Fluorine only has room for one more electron in its outermost shell.
9. A polyatomic ion is a molecule that carries a charge. A polyatomic ion is formed when ever the molecule loses or gains a hydrogen ion, which is the same thing as a proton.
11. The charge on the O atoms is -2 .
13. Each aluminum loses three electrons while each oxygen gains two electrons.
15. An alloy is a mixture composed of two or more metallic elements.
17. High-grade ore on the ocean floor and asteroids.
19. Four electrons are shared within a double covalent bond.
21. The negatively charged oxygen within a polyatomic ion forms only one bond and has three lone pairs as a consequence.
23. A substituent is any atom or lone pair of electrons emanating from a central atom.
25. A dipole is an uneven distribution of electrons in a bond caused by a difference in electronegativity between two atoms.
27. A carbon-oxygen bond is more polar.
29. The molecules of a nonpolar substance tends to have weak attractions to themselves, which causes a low boiling point.
31. Oil and water do not mix because water molecules are more attracted to themselves than to oil molecules.

Quantitative Questions

33. The electronic charge on Ca is $+2$ in CaCl_2 .
35. Ba_3N_2 A shortcut way of solving these sorts of problems is to take the charge of one ion and make it the subscript of the opposite ion. For example, take the $2+$ charge of the barium and make it the subscript on the nitrogen. Then take the $3-$ charge on the nitrogen and make that the subscript of the barium: Ba_3N_2 .
37. Fluorine, F_2 (-188°C) < Hydrogen chloride, HCl (-85°C) < Hydrogen fluoride, HF ($+19^\circ\text{C}$)

Explanation: The fluorine is a nonpolar compound and so should have the lowest boiling point—the attraction between fluorine molecules is so weak. The fluorine has a greater electronegativity than the chlorine, which means that the H—F bond should be more polar than the H—Cl bond. That HF is the most polar suggests that it should also have the highest boiling point.