Chapter 3

Ions

Cations

What are cations?
How are they formed?
Give some examples.
Naming of cations, same as element name for monatomic cations.

Anions

What are anions?
How are they formed?
Give some examples.
Naming of anions, element stem with –ide ending for monatomic anions.

Ions of various atoms

Anions are formed from non-metal atoms.
Cations are formed from metal atoms.
Ions have totally different properties than the elements from which they are derived. Know some examples and explain the difference in element and ion properties.

What ions are most likely? (octet rule)

Noble gas electron configurations are quite stable. (ns^2p^6)
Atoms will generally lose or gain electrons to achieve this electron configuration. Looking at the periodic table, give examples.

Cations – charge is main group number or for new numbering, group number –10 in the p-block.
Anions – charge is main group number –8 or for new numbering, group number-18 in the p-block.

Ionic Compounds

Ionic compounds are held together by attractions between positive and negative ions.

The attractions are not 1-to-1, especially in the crystalline state, but positive ions are attracted to many negative ions simultaneously and negative ions are likewise attracted to many positive ions. (6 is a common number of nearest neighbors in ionic crystals)

There are no discrete uncharged molecules in ionic compounds.

The sum of the positive charges must be equal to the sum of the negative charges in an ionic material.

When positive and negative ions are combined to form a compound, the number of positive charges must equal the number of negative charges.

For two atoms that are combining the one that becomes negative is the farther to the right and to the top of the periodic table. If the elements are adjacent, the one above in the previous group is more negative.

You must now be able to write chemical formulas for the combination of any two main group elements.

Covalent Bonds – Atoms share a pair of electrons.

Atoms share to achieve ns^2p^6 electron configuration.

Pure covalent – equal sharing, same atoms on either side of bond
Polar covalent – unequal sharing, different atoms on either side of bond

Strongest between various atoms in the upper right hand portion of the periodic table.

Covalently bound atoms form molecules; shared electrons are in molecular orbitals.

A line drawn between atoms represents an electron pair.

One line for one electron pair is called a single bond.
Two lines representing two shared electron pairs in the same bond is a double bond.
Three lines represents three shared electron pairs and is a triple bond.
Structural formulas indicate the explicit connections between the constituent atoms of a molecule.
Molecular formulas give less information, only the number of each of the constituent atoms and no indication of how the atoms are structurally arranged.

Lewis electron dot structures

Draw Lewis electron dot structures for simple molecules.

Add the electrons contributed by each neutral atom in the structure.
Add or subtract electrons to account for the charge, if any.
Distribute the electrons in pairs so that each atom in the structure has eight around it. (octet rule)
The more positive atom is more likely the central atom in a many atom structure.

The shapes of molecules

Use valence shell electron pair repulsion theory, VSEPR, to derive shapes of simple molecules.

Count the total number of valence shell electrons.
The number of valence electrons on the central atom plus the number contributed by attached atoms or atom groups. .
Add one electron for each attached atom or group, except for atoms in the oxygen group, add zero.
Add or subtract electrons to account for the charge on an ion.

Electron pairs are arranged around the central atom so that each has the maximum amount of space.

2 pair – linear – 180 deg.
3 pair – trigonal planar – 120 deg.
4 pair – tetrahedral – 109 deg.
5 pair – trigonal bipyramid – 90 and 120 deg.
6 pair – octahedral – 90 deg.

The electron pairs are now used to create bonds to the surrounding atoms or groups as required. All electron pairs need not be used to form bonds. Some may be lone or unshared electron pairs.

Electronegativity and Dipoles

When a covalent bond forms between two different atoms the electrons in the bond will experience a different attraction to each of the atoms. The relative strength of attraction that an atom has for electrons in a bond is called the electronegativity of the atom.

Electronegativity generally increases across a period of the periodic table and decreases down a group.

Metals have low electronegativities and nonmetals have high electronegativities.

Scales of electronegativity have been developed. On one common scale developed by Linus Pauling, Cs has a value of 0.7 and F has the highest value of 4. H is about 2.1 on the scale.

Atoms with large electronegativity differences (>2) give ions.
A pure covalent bond forms between two atoms that are the same.
Atoms with small electronegativity difference (<2) form polar covalent bonds. One atom becomes more negative and the other becomes more positive forming a dipole because of the uneven distribution of the bonding electrons.
A polyatomic molecule may have a dipole or not depending on its structure.

Polyatomic Ions

Compounds can be ionic and also have covalent bonds.

Know some of the important polyatomic ions and compounds that include them.

Naming Simple Inorganic Compounds

Binary ionic compounds

The cation is written first in the chemical formula and is first in the name. It has the same name as the element.
The anion is named as the stem of the element with -ide as suffix;
bromide, oxide, nitride, sulfide, etc.,
If the cation can have more than one charge, the charge is indicated by a Roman Numeral after the name; iron (II), iron (III)…

Ionic compounds that contain polyatomic ions

Name the cation as above.
The anion is just the name of the polyatomic ion.

Binary molecular compounds

The more positive is first in the name and formula.
The more negative is the element stem with the suffix –ide.
The prefixes *di, tri, tetra, penta, hexa,* etc., are use to show the number of atoms of each element.