HW 7

Atoms form chemical bonds through interactions involving their electrons. The electrons in the outermost occupied shell are especially important for understanding why atoms gain, lose, or share electrons.

Valence electrons

Valence electrons are the electrons in the outermost occupied electron shell of an atom. They play a major role in determining how that atom reacts and bonds with other atoms.
Electrons occupy energy levels (shells) around the nucleus. The first shell holds up to 2 electrons; the second holds up to 8, etc. For the following examples, electron arrangements are written from the innermost to the outermost shell:

Atom	Electrons by shell	Valence electrons
Sodium (Na)	2, 8, 1 ($1s^2 2s^2 2p^6 3s^1$)	1
Chlorine (Cl)	2, 8, 7 ($1s^2 2s^2 2p^6 3s^2 3p^5$)	7
Neon (Ne)	2, 8 ($1s^2 2s^2 2p^6$)	8

The octet rule

The octet rule is a guideline stating that many atoms tend to gain, lose, or share electrons when forming bonds in ways that give them 8 electrons in their outermost shell.
This arrangement is particularly stable for many main-group elements. Noble gases such as neon and argon already have full outer shells and are usually very unreactive.
Atoms can approach an octet in three common ways:

- **Lose electrons:** sodium can lose one electron.
- **Gain electrons:** chlorine can gain one electron.
- **Share electrons:** carbon often shares electrons in covalent bonds.

Important exception: The octet rule is not universal. Hydrogen and helium are associated with a filled first shell containing just 2 electrons; some other stable compounds also do not follow the octet rule.

Ions

An ion is an atom or group of atoms with a net electric charge because it has gained or lost electrons. A neutral atom has equal numbers of positively charged protons and negatively charged electrons.

Positive ion — cation	Negative ion — anion
Forms when an atom loses electrons. Sodium Na has 11 protons and electrons. It can lose 1 electron. The Na^+ ion has 11 protons and 10 electrons.	Forms when an atom gains electrons. Chlorine has 17 protons and 17 electrons. It can gain 1 electron. he Cl^- ion has 17 protons and 18 electrons.

Remember: Forming an ion changes the number of electrons, not the number of protons. The proton count determines which element it is.

Ionic bonds

An ionic bond is the electrostatic attraction between positively and negatively charged ions. Opposite electric charges attract, holding the ions together.

A familiar example is sodium chloride (NaCl), or table salt:

1. Sodium loses 1 electron	**2. Chlorine gains 1 electron**	**3. Ions attract** $\mathbf{Na^+ + Cl^- \rightarrow NaCl}$
Sodium becomes positive.	Chlorine becomes negative.	Opposite charges hold together.

As a result, both ions have 8 electrons in their outermost occupied shell: Na^+ has the arrangement $1s^2 2s^2 2p^6$; Cl^- has $1s^2 2s^2 2p^6 3s^2 3p^6$.

In solid salt, the ions are not separate NaCl molecules. They form a repeating three-dimensional crystal lattice made of many Na^+ and Cl^- ions.

Questions

1. Write electron configuration of Ca and Br elements, number of valence electrons, which element is most likely to lose electrons and how many, which element is most likely to gain electrons and how many?
2. Determine the total number of electrons in each of the following: Cu, H^+, He, Mg, Ca^{2+}, O^{2-}, S^{2-}
3. Determine the number of valence electrons in each of the following: Na, Mg, Al, Cl, K^+, Mg^{2+}, P^{3-}, Cl^-.