

Section K: Oxidation Numbers (also known as Oxidation States)

- These are charges assigned to every atom in a species--whether ionic or covalent.
- The underlying idea of oxidation numbers is the assignment of every electron in a species to only one of its constituent atoms. (In contrast, the Lewis structure paradigm (Chapter 2) asserts that electron pairs between a pair of atoms belong to both atoms.)
- Often, the oxidation number equals the charge an atom would have if it were isoelectronic with the noble gas atom closest to it on the periodic table. *This reflects the atom's quest for an octet (or duet).*
- Unless the species is a monatomic ion, an oxidation number does not correspond to the actual charge on an atom. What is physically meaningful is the **change** in oxidation number effected by an oxidation-reduction (redox) reaction.

Rules for Assigning Oxidation Numbers

- (1) The sum of the oxidation numbers in any species must equal the real overall charge of that species.
- (2) In substances consisting of one element (*e.g.* N₂), the oxidation number is **zero** for all atoms.

In compounds...

- (3) Group 1 (alkali metals): **Always +1**
Group 2 (alkaline earth metals): **Always +2**
Other metals (elements to the left of the periodic table diagonal): **Usually positive**
- (4) F is **always -1** (*e.g.* HF hydrogen fluoride or hydrofluoric acid)
- (5) H is **usually +1**...
...but **-1 with metals** (*e.g.* LiH lithium hydride)
- (6) O is **usually -2** (*e.g.* Li₂O lithium oxide)
but has a higher (*i.e.* less negative) oxidation state in species with O-O single bonds
e.g. Na₂O₂ sodium peroxide (Na is +1 ⇒ O is -1)
KO₂ potassium superoxide (K is +1 ⇒ O is -1/2 (fractions are possible!))
- (7) Other Group 17 elements besides F are **often -1**
 - (a) However, the above rules take precedence (*e.g.* HOCl: H is +1 and O is -2 ⇒ Cl is +1)
 - (b) In "interhalogen compounds" (*e.g.* ICl), give the atom higher in the group the -1 state.
- (8) The transition metals and elements in Groups 13, 14, 15 will often have a variety of oxidation states. The above rules will usually let us assign their oxidation numbers.
- (9) Remember (*i.e.* memorize) the overall charges of polyatomic cations and anions. (See the **Chemical Formulas and Names to Memorize** handout.) These provide essential clues when trying to assign oxidation numbers.