Cations and anions I: Definitions

Chemists teach students to first think of atoms as uncharged entities, where the number of electrons equals the number of protons. Earth scientists more commonly encounter atoms in their charged forms, and thus as ions. This page begins the discussion of ions with some definitions and related comments.

**Cations**

- Positively charged
- (fewer electrons than protons)
- (number of protons is a defining characteristic of the element in question, and thus not subject to change)

**Anions**

- Negatively charged
- (more electrons than protons)
- (number of protons is a defining characteristic of the element in question, and thus not subject to change)

**Charge** (defining characteristic)

**Size relationships among simple ions**

- Generally smaller than anions
- (because they have proportionately few electrons)

- Generally larger than cations
- (because they have proportionately extra electrons)

**Examples of simple ions**

- K⁺, Na⁺, Mg²⁺, Ca²⁺, Fe²⁺, Fe³⁺, Al³⁺, Ti⁴⁺
- F⁻, Cl⁻, O²⁻, S²⁻, NO₃⁻, CO₃²⁻, HCO₃⁻, SO₄²⁻, PO₄³⁻, SiO₄⁴⁻, OH⁻, Al(OH)₄⁻

**Examples of complex ions**

- K⁺, Na⁺, Mg²⁺, Ca²⁺, Fe²⁺, Fe³⁺, Al³⁺, Ti⁴⁺
- NH₄⁺, UO₂²⁺

Complex ions, or "radical groups", consist of a strongly charged central atom consistently surrounded by less strongly charged atoms (in most cases, a central atom of large positive charge surrounded by O²⁻ s)

It's unwise to define cations as "oxidized" and anions as "reduced", because some elements have multiple cationic or anionic forms. Most notably, iron has the two common cations, Fe³⁺ (the more oxidized form) and Fe²⁺ (the relatively reduced form).

For conceptual purposes, we commonly refer to these entities as N⁵⁺, C⁴⁺, S⁶⁺, P⁵⁺, Si⁴⁺, U⁶⁺, etc., but they never exist in nature as simple cations but instead combine with the ubiquitous O²⁻ or OH⁻ anions to make these complex anions. (For more, see Part IV of this series).