Ions Snapshot

Challenges

The Challenge Levels increase in rigor and complexity.
The first level is a tutorial.
• 15 core levels
• 3 connected levels to Atoms

Sandbox*

The Sandbox is an exploratory learning space for extended practice and review of ions.
• 11 Achievements

* Players must complete Levels 1-8 before unlocking the Sandbox.

Integrated Chemistry Concepts

• Cation and anion formation
• Octet rule
• Ionic radii
• Ionization energy

General Information

‘Atom Ionization’ mode

Skills
Ions: Overview

Ions Sandbox

To start, player must drag an atom onto an anchor in the workspace.

Achievements

Selected Bank of Atoms

The bank includes the following atoms:

Lithium  Phosphorous
Beryllium  Sulfur
Boron  Chlorine
Nitrogen  Potassium
Oxygen  Calcium
Fluorine  Arsenic
Sodium  Selenium
Magnesium  Bromine
Aluminum
Ions: Overview (cont.)

Ions Challenges

LEVELS 1 - 15 GOAL: Add or remove electrons from atoms to make ions that match the targets.

ATOMS to IONS CONNECTED LEVELS GOAL: Some atoms are missing from the bank. Use the button on the left to go to Atoms. Solve the Challenge and bring back the missing atoms!
**CHEMISTRY CONCEPT: Cation formation**
Player can form a positive ion (cation) by removing electrons from the valence shell.

**CHEMISTRY CONCEPT: Anion formation**
Player can form a negative ion (anion) by adding electrons to the valence shell.
CHEMISTRY CONCEPT: **Octet rule**
Players can add or remove electrons to create a complete set of valence electrons.

Electron removed to satisfy octet rule (8 valence electrons)

Electron added to satisfy octet rule (8 valence electrons)

CHEMISTRY CONCEPT: **Core electrons are held more strongly than valence electrons.**
Player will need more energy to remove an inner electron than a valence electron.

CHEMISTRY CONCEPT: **Ionic radii**
Player can observe difference in radii between ion and parent atom.

Anions are *larger* than their parent atoms.

Cations are *smaller* than their parent atoms.
CHEMISTRY CONCEPT: **Periodic trend: Ionization energy**

Player can observe that energy (ionization energy) is required to remove electrons from an atom.

Ionization energy increases across a period.

![Energy units used increase across Period II](image1)

Lithium

Beryllium

Boron

Ionization energy decrease down a group.

![Energy units used decrease across Group I](image2)

Lithium

Sodium

Potassium

Ionization energy increases upon removal of 2nd and 3rd electrons from an atom.

![Energy units used increase upon removal of each valence electron from Aluminum](image3)

First Ionization Energy

Second Ionization Energy

Third Ionization Energy
Ions: In-Game Feedback

Sandbox Check

• Add/Remove Mode
  Once an electron has been added or removed, the ion is locked into add or remove mode.

• Cannot Add/Remove more than 4 Electrons
  After adding/removing 4 electrons, the ion is locked.

• Valence Electron Check
  Octet rule must be satisfied.

Challenge Level Check

To check work in a challenge level, players can drag an ‘ionization mode’ atom to a chosen target. Ion will be checked against the target based on key chemistry content, as outlined below.

Incorrect

Correct