Ionization Energy

collisions

HIGHER EDUCATION

playmada™

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.
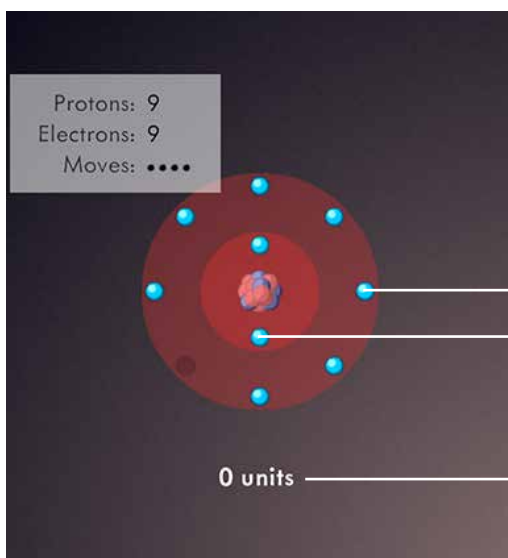- 11 Achievements

Integrated Chemistry Concepts

- Cation and Anion Formation
- Octet Rule
- Specific Ion Charges
- Ionic Radii
- Ionization Energy Trends
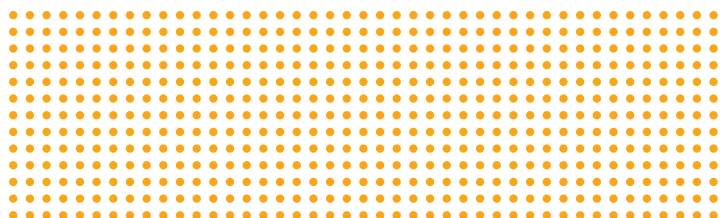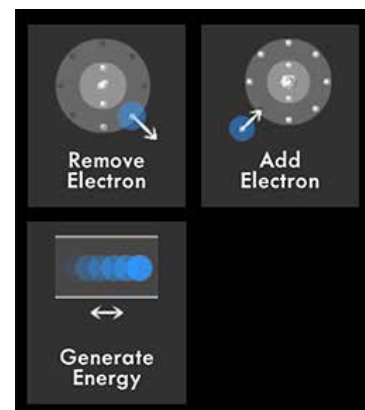- Electron Affinity Trends

GAMEPLAY BASICS

Atom Ionization Mode

VALENCE ELECTRON

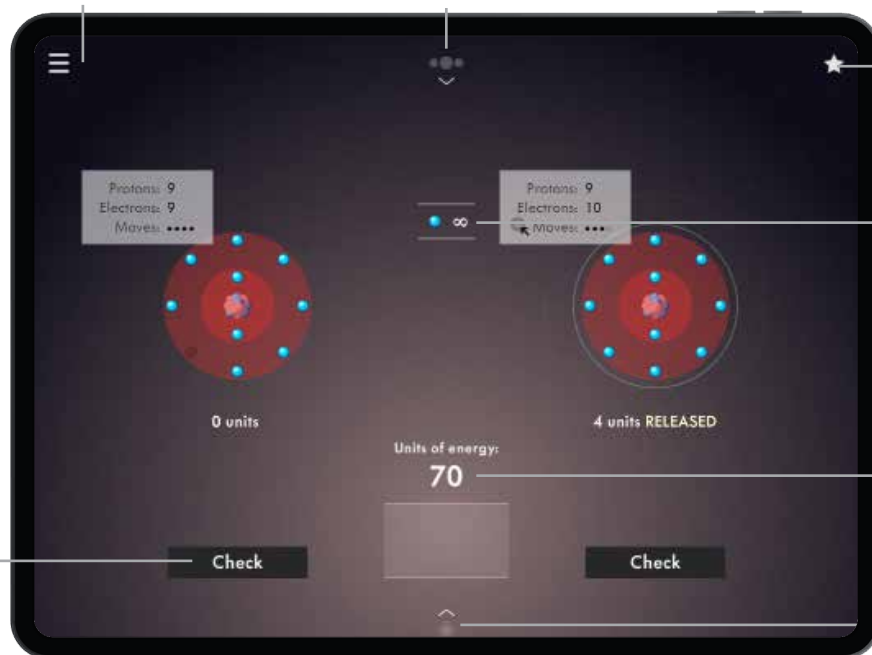INNER ELECTRON

ENERGY COUNTER

Skills

OVERVIEW

Ionization Energy Sandbox

MENU + HELP

OPENS BANK OF ATOMS

ACHIEVEMENTS

ELECTRON BANK

ENERGY COUNTER

OPENS COMPLETE AREA

TO START, PLAYER MUST DRAG AN ATOM ONTO AN ANCHOR IN THE WORKSPACE.

ION CHECK BUTTON

Protons: 9
Electrons: 9
Moves: ••••

Protons: 9
Electrons: 10
Moves: ••••

0 units

4 units RELEASED

Units of energy:
70

Check

Check

Achievements

-1 -1 ion ⓘ	Negative ion with 10 electrons ⓘ	
-3 -3 ion ⓘ	Positive ion with 10 electrons ⓘ	
+1 +1 ion ⓘ	-2 ion with 18 electrons ⓘ	
+3 +3 ion ⓘ	+2 ion with 18 electrons ⓘ	
Ion smaller than its parent atom ⓘ	+1 +1 ion easier to ionize than Na ⓘ	
Ion larger than its parent atom ⓘ		

Selected Bank of Atoms

The bank includes the following atoms:

Lithium

Beryllium

Boron

Nitrogen

Oxygen

Fluorine

Sodium

Magnesium

Aluminum

Phosphorous

Sulfur

Chlorine

Potassium

Calcium

Arsenic

Selenium

Bromine

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

RESTRICTED BANK OF ATOMS

ELECTRON BANK

FIXED AMOUNT OF ENERGY
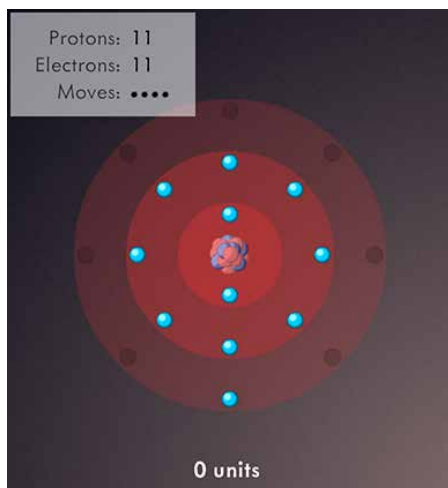
Units of energy:
6

LEVEL TARGETS

Ionization Energy Challenges

RADII TRENDS TO IONIZATION ENERGY CONNECTED LEVELS GOAL:
Some atoms are missing from the bank. Use the button on the left to go to Radii Trends. Solve the Challenge and bring back the missing atoms!
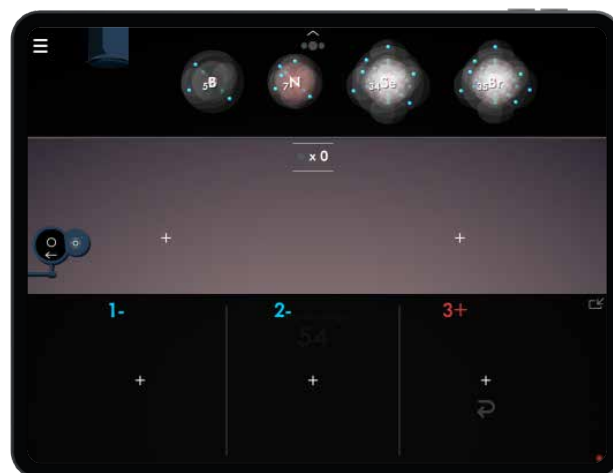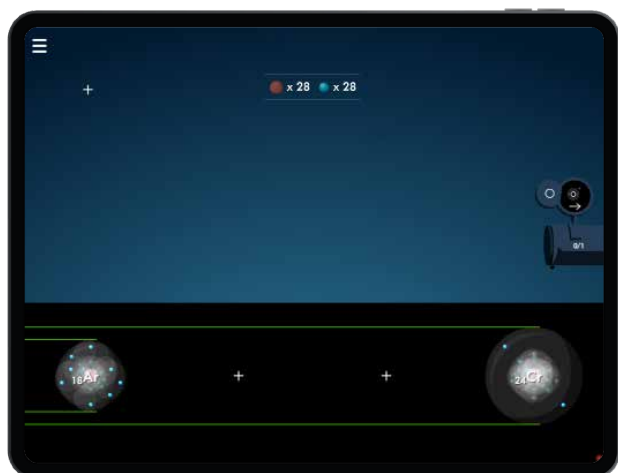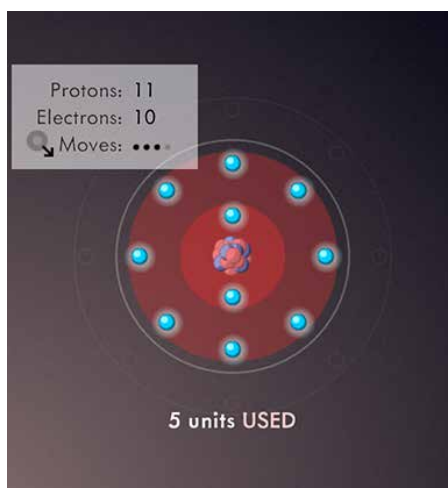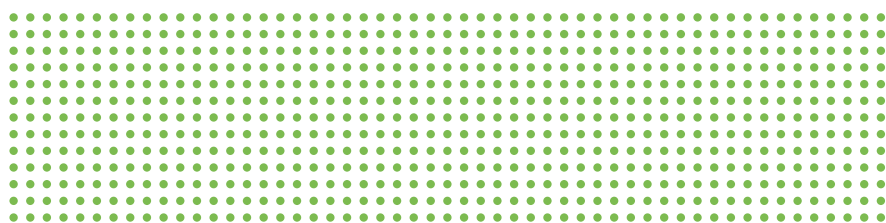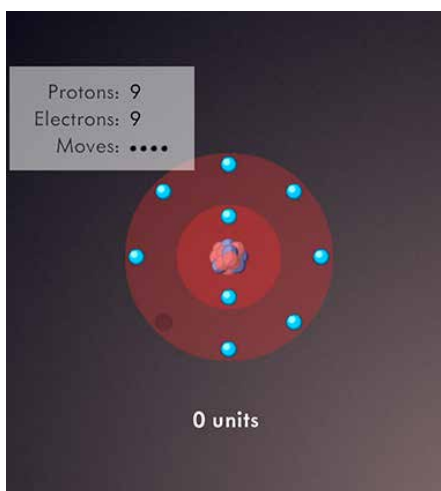
SODIUM (Na)

SODIUM ION (Na⁺)
VALENCE ELECTRON REMOVED

CHEMISTRY CONCEPT: Cation Formation
Player can form a positive ion (cation) by removing electrons from the valence shell.
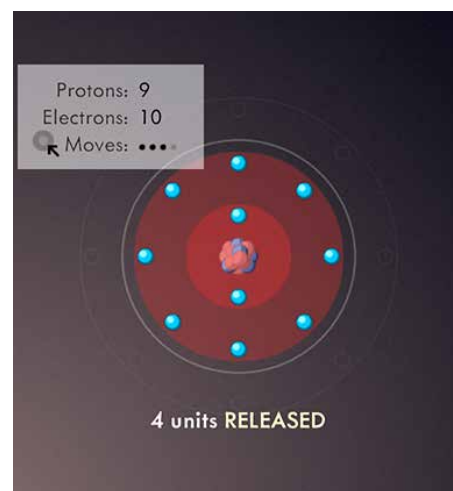
CHEMISTRY CONCEPT: Anion Formation
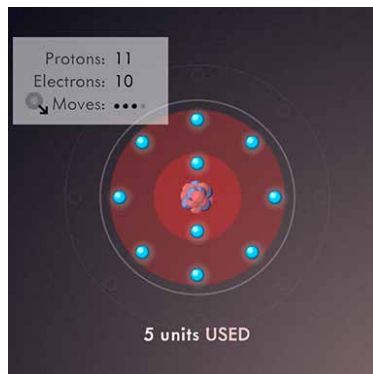Player can form a negative ion (anion) by adding electrons to the valence shell.

FLUORINE (F)

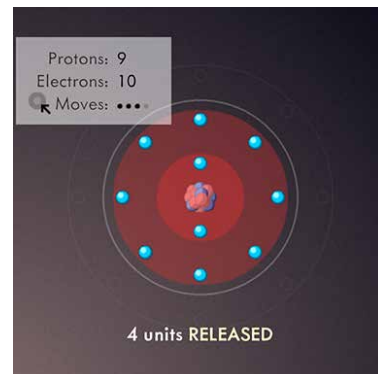
FLUORIDE (F⁻)
VALENCE ELECTRON ADDED

CHEMISTRY CONCEPT:
Octet Rule
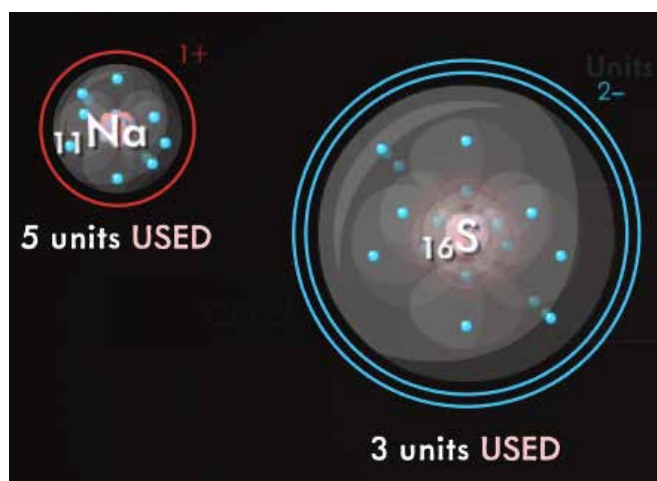Players can add or remove electrons to create a complete set of valence electrons.

Protons: 11
Electrons: 10
Moves: ●●●

5 units USED

ELECTRON REMOVED TO SATISFY OCTET RULE (8 VALENCE ELECTRONS)

Protons: 9
Electrons: 10
Moves: ●●●

4 units RELEASED

ELECTRON ADDED TO SATISFY OCTET RULE (8 VALENCE ELECTRONS)

1+
11 Na
5 units USED

Units
2−
16 S
3 units USED

CHARGES ARE INDICATED ABOVE ALL IONS CREATED

CHEMISTRY CONCEPT:
Specific Ion Charges
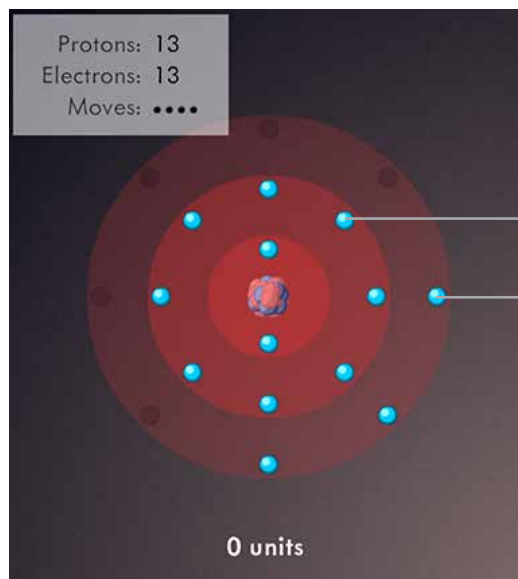Players can see the specific charge of any ions that they create.

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.
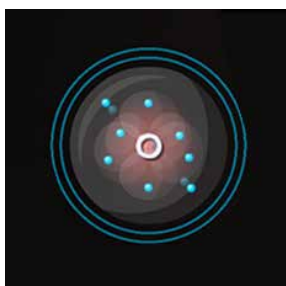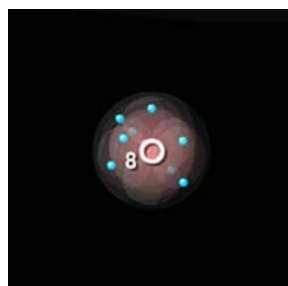

Protons: 13
Electrons: 13
Moves: ••••

106 UNITS USED

6 UNITS USED

0 units

ANIONS ARE **LARGER** THAN THEIR PARENT ATOMS.

CATIONS ARE **SMALLER** THAN THEIR PARENT ATOMS.

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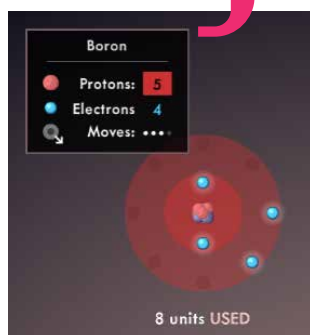Player can observe difference in radii between ion and parent atom.
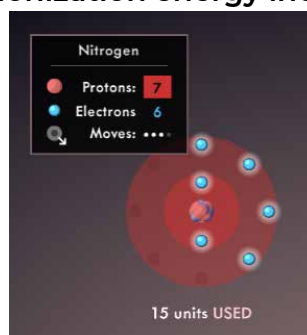
CHEMISTRY CONNECTIONS

Ionization energy increases across a period.

ENERGY UNITS USED INCREASE ACROSS PERIOD 2

Boron
Protons: 5
Electrons: 4
Moves: •••
8 units USED

BORON

Nitrogen
Protons: 7
Electrons: 6
Moves: •••
15 units USED

NITROGEN

Fluorine
Protons: 9
Electrons: 8
Moves: •••
17 units USED
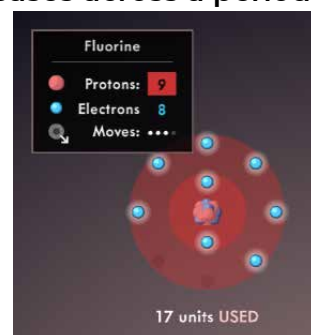
FLUORINE

Ionization energy decreases down a group.

Protons: 3
Electrons: 2
Moves: •••
6 units USED

LITHIUM

Protons: 11
Electrons: 10
Moves: •••
5 units USED

SODIUM

Protons: 19
Electrons: 18
Moves: •••
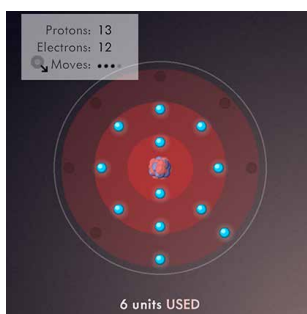4 units USED
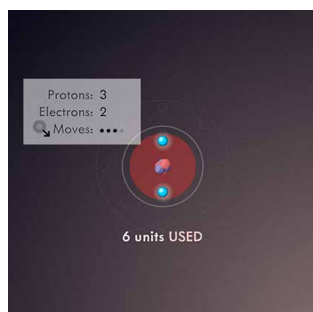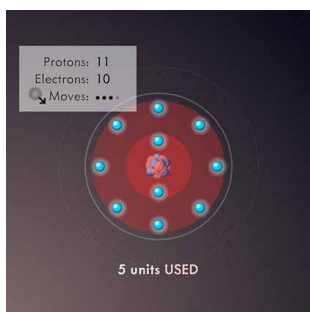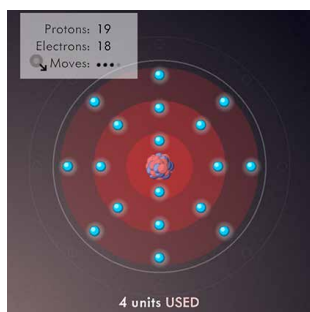
POTASSIUM

ENERGY UNITS USED DECREASE DOWN GROUP 1

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

Protons: 13
Electrons: 12
Moves: •••
6 units USED

FIRST IONIZATION ENERGY

Protons: 13
Electrons: 11
Moves: ••
25 units USED

SECOND IONIZATION ENERGY



Protons: 13
Electrons: 10
Moves: •
53 units USED
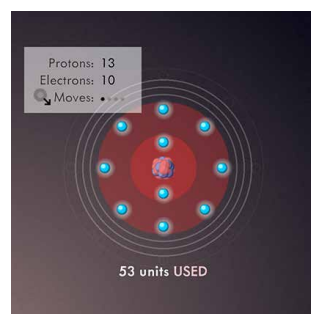
THIRD IONIZATION ENERGY
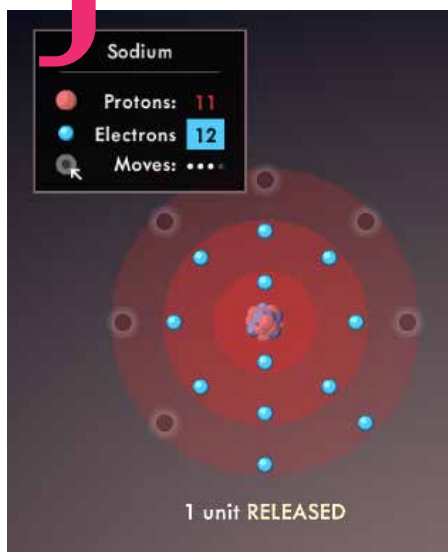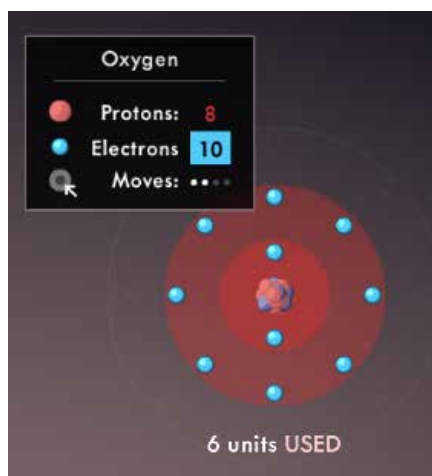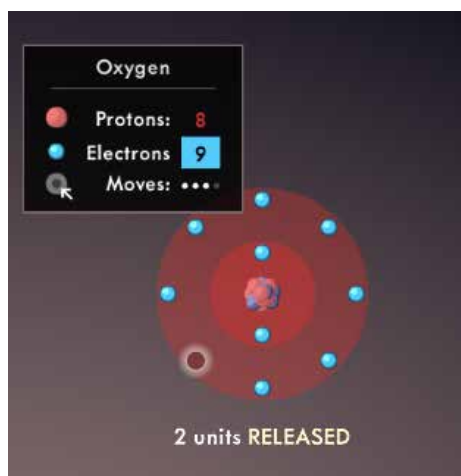
CHEMISTRY CONCEPT:
Player can observe that energy is either released or required to add electrons from an atom.

ADDING ELECTRONS TO NONMETALS IS GENERALLY MORE ENERGETICALLY FAVORABLE THAN ADDING THEM TO METALS.

Sodium
Protons: 11
Electrons: 12
Moves: ••••

1 unit RELEASED

Chlorine
Protons: 17
Electrons: 18
Moves: ••••
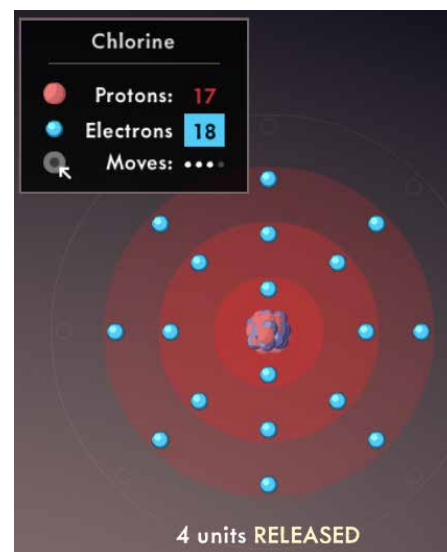
4 units RELEASED

ADDITION OF AN ELECTRON TO SODIUM (METAL) RELEASES LESS ENERGY THAN WHEN ADDED TO CHLORINE (NONMETAL).

Oxygen
Protons: 8
Electrons: 9
Moves: ••••

2 units RELEASED

Oxygen
Protons: 8
Electrons: 10
Moves: ••••

6 units USED

MORE ENERGY IS REQUIRED TO ADD SUCCESSIVE ELECTRONS.

ADDITION OF THE FIRST ELECTRON TO OXYGEN RELEASED 2 UNITS OF ENERGY, WHILE ADDITION OF THE SECOND REQUIRED 8 UNITS OF ENERGY.

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

INCORRECT

CORRECT