Essential Question

How can we predict an ion’s charge?

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Valence Electrons

- **Valence electrons:** electrons in the outermost energy level
- These are the electrons an atom uses in bonding.

Sodium has 11 electrons arranged 2, 8, 1.

Counting Valence Electrons

- Main-group elements: use the group number.
- Groups 13-18: use the last digit (group 15 → 5 valence electrons).

Moving across period 2, the number of valence electrons climbs from 1 (lithium) to 8 (neon).

Valence Electrons from Configurations

1. Find the highest energy level (*n*) in the electron configuration.
2. Add the s and p electrons in that level.

Chlorine is $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5$.

The Octet Rule

- Atoms gain or lose electrons to get 8 valence electrons.
- 8 valence electrons = a noble gas configuration, which is very stable.

Noble gases like neon already have a full set of 8 valence electrons, and they almost never react.

Metals Lose Electrons

- Metals have 1-3 valence electrons.
- Losing a few is easier than gaining 5-7.
- Lose electrons → positive ion (cation)

Once those 2 are gone, the full level underneath becomes the outer level, with 8 electrons, just like neon.

Nonmetals Gain Electrons

- Nonmetals have 5-7 valence electrons.
- Gaining a few is easier than losing 5-7.
- Gain electrons → negative ion (anion)

With 7 protons and 10 electrons, 7 − 10 = 3−, so the ion is N^{3-}, called nitride.

Fewest Electrons Wins

- Atoms move the fewest electrons possible to reach 8.
- Chlorine: gain 1, not lose 7.

In theory, chlorine could reach an octet by losing all 7 valence electrons.

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Isoelectronic Ions

- **Isoelectronic:** having the same number of electrons
- Each ion matches the electron arrangement of a noble gas.

Nitride, oxide, and fluoride gained electrons.

Charges on the Periodic Table

Group	Valence e^-	Gain or lose?	Charge	Example
1	1	lose 1	1+	Na^+
2	2	lose 2	2+	Mg^{2+}
13	3	lose 3	3+	Al^{3+}
14	4	usually shares instead	varies	C
15	5	gain 3	3−	N^{3-}
16	6	gain 2	2−	O^{2-}
17	7	gain 1	1−	Cl^-
18	8	neither	0	Ne

Example: Predicting a Charge

Try it first!

Predict the charge of a calcium ion. Explain your answer using valence electrons.

Diagram: Periodic table square for calcium: atomic number 20, symbol Ca, atomic mass 40.08.

Example: Using a Configuration

Try it first!

An atom has the electron configuration below. Identify the element, its number of valence electrons, and the charge of its ion.

Diagram: Electron configuration $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^4$.

Example: Matching a Noble Gas

Try it first!

Write the symbol for the ion that aluminum forms. Which noble gas has the same number of electrons?

Big Ideas

- Valence electrons are in the outermost energy level.
- Atoms gain or lose electrons to reach 8.
- Metals lose electrons → cations (+).
- Nonmetals gain electrons → anions (−).