

Electron Clue Trail

Use periodic patterns to explain reaction outcomes.

HS-PS1-2 "Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties..."

NAME _____

DATE _____

1 READ AND MARK _____ Read it twice

YOUR JOB Underline statements about electron movement or electron sharing. Circle group, charge, or bond patterns that could serve as evidence in an explanation, then number the steps of one reaction explanation you find.

Patterns Predict Products

- ① Atoms react when their outermost, or valence, electrons can move or be shared to make more stable outer electron arrangements. In main-group elements, an atom's column helps predict this behavior. Group 1 metals usually lose one valence electron and form 1+ ions. Group 2 metals usually lose two and form 2+ ions. Group 13 metals usually lose three and form 3+ ions. Metals on the left side of the periodic table tend to lose electrons because those outer electrons are relatively easy to remove during reactions.
- ② Nonmetals on the right show the opposite pattern. Group 17 nonmetals usually gain one electron and form 1- ions, while Group 16 nonmetals usually gain two and form 2- ions. An ionic compound forms when total positive and negative charges balance. A Group 2 metal and two Group 17 nonmetal atoms, for instance, make a neutral formula with a 1:2 ratio. The formula records the smallest whole-number ratio of ions, not a count of valence electrons. Magnesium is a Group 2 metal, and oxygen is a Group 16 nonmetal.
- ③ Not all main-group reactions involve electron transfer. During combustion, a carbon-containing fuel reacts with oxygen, and atoms share electrons in covalent bonds. Carbon has four valence electrons and commonly forms four bonds. Oxygen has six valence electrons and commonly forms two bonds. When methane burns completely in sufficient oxygen, the atoms rearrange into carbon dioxide and water: $\text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O}$. The equation conserves each kind of atom. This outcome fits the bonding patterns because carbon has four bonds total, and each oxygen has two. Energy is released as new bonds form.

2 ANSWER WITH EVIDENCE Use the passage

- 1 Lithium is a Group 1 metal, and fluorine is a Group 17 nonmetal. Predict what happens to electrons and state the ion each atom forms.

- 2 Potassium is a Group 1 metal, and sulfur is a Group 16 nonmetal. What is the simplest formula of their ionic compound? Explain how the charges balance.

- 3 A Group 13 metal is represented by M, and a Group 17 nonmetal is represented by X. Write the simplest ionic formula and explain the ratio of ions.

- 4 In a complete combustion reaction, three carbon atoms become carbon dioxide. How many CO₂ molecules form, and how many oxygen atoms are in those molecules? Use the bond patterns to explain.

3 YOUR TURN Your own words

A student claims that magnesium and oxygen form MgO₂ because oxygen gains two electrons. Construct or revise an explanation for the reaction outcome. Include electron movement, the ions formed, the correct formula, and why the ion ratio is neutral.

PART 1 • READ AND MARK

Underline statements about electron movement or electron sharing. Circle group, charge, or bond patterns that could serve as evidence in an explanation, then number the steps of one reaction explanation you find. Accept any marking that follows this job and points at the right text.

PART 2 • ANSWERS

#	QUESTION	ANSWER
1	Lithium is a Group 1 metal, and fluorine is a Group 17 nonmetal. Predict what happens to electrons and state the ion each atom forms.	Lithium loses one electron and forms Li⁺. Fluorine gains one electron and forms F⁻.
2	Potassium is a Group 1 metal, and sulfur is a Group 16 nonmetal. What is the simplest formula of their ionic compound? Explain how the charges balance.	K₂S. Two K⁺ ions balance one S²⁻ ion.
3	A Group 13 metal is represented by M, and a Group 17 nonmetal is represented by X. Write the simplest ionic formula and explain the ratio of ions.	MX₃. One M³⁺ ion is balanced by three X⁻ ions.
4	In a complete combustion reaction, three carbon atoms become carbon dioxide. How many CO ₂ molecules form, and how many oxygen atoms are in those molecules? Use the bond patterns to explain.	Three CO₂ molecules form, containing six oxygen atoms. Each carbon makes four bonds, while each oxygen makes two bonds, so each carbon dioxide molecule has one carbon and two oxygen atoms.

PART 3 • YOUR TURN (SAMPLE ANSWER)

Magnesium loses two valence electrons to form Mg²⁺. Oxygen gains two electrons to form O²⁻, so one of each ion balances the charges and the formula is MgO, not MgO₂.

Accept explanations that correctly connect magnesium's Group 2 pattern to Mg²⁺ and oxygen's Group 16 pattern to O²⁻. The response must state that a 1:1 ratio produces neutral MgO and must distinguish ion charge from the formula subscript.