

Name: _____ Period: _____ Date: _____

Why Atoms Bond

Learning goal

I can explain bonding as atoms reaching stable electron arrangements by gaining, losing, or sharing electrons.

Part 1 · Notes

Fill in each blank using the word bank for that section.

Section A · Why Atoms Bond

Word bank

18 · 2 · half full · released · full · 8 · empty · 4 ·
absorbed · 16 · 6

- A **chemical bond** is a force that holds two atoms together. Almost everything around you, from salt to candle wax to your own body, is made of bonded atoms.
- So why do atoms bond? Look at the elements that **don't**. The **noble gases** (Group 18) almost never bond. Their outer shells are _____.
- A full outer shell is very **stable**: low in energy and unlikely to change. Most noble gases have 8 **valence electrons** (helium has 2).
- Other atoms become stable by bonding. When atoms bond, energy is _____, so the bonded atoms end up **lower in energy** than the separate atoms, the same way a ball rolling downhill ends up lower and more settled.
- The **octet rule** predicts how atoms bond: atoms tend to gain, lose, or share electrons until they have _____ valence electrons, the same arrangement as a noble gas.
- **Refresher**: a **Lewis dot structure** shows an element's symbol with one dot for each valence electron.



Group 1 Group 2 Group 13 Group 14 Group 15 Group 16 Group 17 Group 18

Remember

Groups 1 and 2: the valence electrons equal the group number.

Groups 13–18: **subtract 10** from the group number.

- Oxygen is in Group 16, so it has _____ valence electrons. It needs _____ more to reach an octet.

Section B · Gain, Lose, or Share?

Word bank

lose · transfers · share · protons · loses · gain · neutrons · shares

- An atom can reach a stable arrangement three ways. Which one it uses depends on how many valence electrons it starts with.
- **Metals lose electrons.** Metals have 1–3 valence electrons and low ionization energies, so it's easier to _____ a few electrons than to gain many.
- Sodium loses its 1 valence electron and becomes Na^+ . Its new outer shell is the full shell underneath, so Na^+ has the same electron arrangement as neon.
- Na^+ is still sodium. It has 11 protons, not neon's 10. It's a sodium **ion**, a **cation**.
- **Nonmetals gain electrons.** Nonmetals have 5–7 valence electrons and high electronegativities, so they _____ the few electrons they're missing.
- Chlorine gains 1 electron and becomes Cl^- , an **anion** with the same electron arrangement as argon.
- **Some atoms share.** Carbon has 4 valence electrons. Gaining or losing 4 would take too much energy, so carbon _____ electrons instead.
- In an **ionic bond**, a metal **transfers** electrons to a nonmetal. The ions have opposite charges, so they attract each other. Example: Na^+ and Cl^- in table salt.
- In a **covalent bond**, two nonmetals **share** a pair of electrons. Both atoms need to gain electrons, so neither gives one up. Example: two chlorine atoms share a pair to make Cl_2 .

Remember

Transfer or share? A third type, metallic bonding, comes later in this topic.

Atoms	What happens to electrons	Bond type
Metal + nonmetal	Transferred (metal → nonmetal)	Ionic
Nonmetal + nonmetal	Shared	Covalent

Section C · Salt vs. Wax

Word bank

metallic · covalent · magnetic · ionic

- Back to the question from the start of class: salt melts at 801 °C, but wax melts with just a little warmth.
- **Salt** (sodium chloride) is made of Na^+ and Cl^- ions, held together by _____ bonds.
- **Wax** is made of long molecules of carbon and hydrogen, held together by _____ bonds. Carbon tetrahydride (CH_4) is the smallest member of the same family of molecules. Build it in Part 2, Card 3.

Part 2 · Stability Meter

Use the electron dots from your teacher, or draw the dots. Move electrons until every atom has a stable arrangement: 8 valence electrons (2 for hydrogen).

Card 1 · Single atoms (do this after Section A)

For each atom: count its valence electrons, then decide whether it loses or gains electrons to reach 8. Write the ion it forms.

Now matches which noble gas? After the atom loses or gains, it has the same number of electrons as a noble gas. Name that noble gas. (Hint: losing electrons matches the noble gas in the row **above**; gaining matches the noble gas at the end of the **same** row.)

Argon is already stable: write “none,” “0,” and “no ion.”

Atom	Valence electrons	Lose or gain?	How many?	Ion formed	Now matches which noble gas?
<i>Ex: K</i>	<i>1</i>	<i>lose</i>	<i>1</i>	K^+	<i>argon (Ar)</i>
Na					
Cl					
Mg					
O					
Ar					

Sodium became stable by **losing** 1 electron, but chlorine became stable by **gaining** 1. Why didn't they do the same thing?

Sentence stem: “Sodium ____ because it has only ____, but chlorine ____ because it has ____.”

Card 2 · Pairs (do this after Section B)

Put the two atoms side by side. **Transfer:** move a dot from one atom to the other. **Share:** move one dot from each atom into the middle to make a shared pair that both atoms count.

What forms? Write what you end up with. A transfer makes two **ions** (write both, with charges). Sharing makes a **molecule** (write its formula).

Pair	Transfer or share?	What happens to the electrons	Bond type	What forms? (ions or molecule)
<i>Ex: K + F</i>	<i>transfer</i>	<i>K's 1 electron moves to F</i>	<i>ionic</i>	K ⁺ and F ⁻ ions
Na + Cl				
Cl + Cl				
Mg + O				

Sodium and chlorine **transferred** an electron, but two chlorines **shared**. What was different about the two pairs?

Sentence stem: "When a metal meets a nonmetal, _____. When two nonmetals meet, _____ because _____."

Card 3 · Build carbon tetrahydride, CH₄ (do this in Section C)

Draw your structure in the box below. Follow the steps:

1. Write **C** in the middle of the box. Put its **4** valence electrons around it as dots, one on each side (top, right, bottom, left).
2. Write an **H** next to each side of the carbon (4 H's in all). Each H has **1** valence electron. Draw that dot on the side facing the carbon.
3. Circle each carbon dot together with the hydrogen dot next to it. Each circle is one **shared pair** (one covalent bond).
4. Check: count the dots inside the circles around carbon (it should count **8**). Count the dots in each hydrogen's circle (each should count **2**).

My CH₄ drawing

Carbon counts ____ electrons. Each hydrogen counts ____ electrons. Number of covalent bonds: ____

Driving Question Board: salt is made of ions and wax is made of molecules. Write one question you'd need answered to explain why salt melts at 801 °C and wax melts so easily.

Sentence stems: "I wonder why ____." · "What would happen if ____?"

Part 3 · Checkpoints

How to use this section

1. Answer the ▲ main questions for each checkpoint.
2. Check your answers with your teacher.
3. Your teacher may give you a ● or ■ page for that checkpoint. Finish it before you move on.

Checkpoint 1 · The octet rule and stability

▲ Main questions

T1.1. How many valence electrons does sulfur (Group 16) have?

- A. 6
- B. 8
- C. 2
- D. 16

T1.2. Nitrogen is in Group 15. How many electrons would it need to gain to reach an octet?

- A. 2
- B. 3
- C. 5
- D. 8

T1.3. Which atom already has a stable arrangement?

- A. K
- B. O
- C. Ar
- D. Cl

T1.4. Why do atoms form bonds?

- A. Bonding makes atoms heavier
- B. Bonding turns atoms into noble gases
- C. Bonding adds protons to the nucleus
- D. The bonded atoms have lower energy, so they are more stable

Checkpoint 2 · Gain, lose, or share?

▲ Main questions

T2.1. Which ion does magnesium form?

- A. Mg^{2-}
- B. Mg^{2+}
- C. Mg^+
- D. Mg^{6-}

T2.2. Which pair forms a covalent bond?

- A. K and Br
- B. Na and Cl
- C. O and H
- D. Ca and O

T2.3. Oxygen gains 2 electrons to become O^{2-} . What does O^{2-} have in common with neon?

- A. The same number of protons
- B. The same charge
- C. The same mass
- D. The same number of electrons (10)

T2.4. Why does carbon share electrons instead of gaining or losing them?

- A. Gaining or losing 4 electrons would take too much energy
- B. Carbon already has an octet
- C. Carbon has no valence electrons
- D. Carbon is a metal

Part 4 · Claim, Evidence, Reasoning

Question: Sodium and chlorine bond to make table salt. Why do they bond, and what kind of bond do they form? Use valence electrons and at least one periodic trend as evidence.

	Na	Cl
Type	metal	nonmetal
Valence electrons	1	7
First ionization energy	496 kJ/mol	1251 kJ/mol
Electronegativity	0.93	3.16

Sentence stems (use them if you need them)

I claim that sodium and chlorine form a(n) ____ bond.

My evidence is that sodium has ____ valence electron and a ____ IE, and chlorine has ____ valence electrons and a ____ EN.

This means sodium ____ an electron and chlorine ____ it, so both become ____.

Evidence bank: Na: 1 valence electron · Cl: 7 valence electrons · Na IE 496 (low) · Cl EN 3.16 (high)
· Na^+ and Cl^- attract · metal + nonmetal

Claim:

Evidence:

Reasoning:

■ Take it further

Someone says sodium and chlorine should share an electron, the way two chlorine atoms do. Explain why that's wrong.

Glossary · Glosario · Bảng thuật ngữ

English	Español	Tiếng Việt
chemical bond: a force that holds two atoms together	enlace químico: fuerza que mantiene unidos a dos átomos	liên kết hóa học: lực giữ hai nguyên tử lại với nhau
stable: low in energy and unlikely to change	estable: con baja energía y poca tendencia a cambiar	bền: có năng lượng thấp và ít có xu hướng thay đổi
octet rule: atoms tend to gain, lose, or share electrons until they have 8 valence electrons	regla del octeto: los átomos tienden a ganar, perder o compartir electrones hasta tener 8 electrones de valencia	quy tắc bát tử: nguyên tử có xu hướng nhận, nhường hoặc dùng chung electron cho đến khi có 8 electron hóa trị
ionic bond: the attraction between oppositely charged ions, formed when a metal transfers electrons to a nonmetal	enlace iónico: atracción entre iones de carga opuesta que se forma cuando un metal transfiere electrones a un no metal	liên kết ion: lực hút giữa các ion mang điện tích trái dấu, hình thành khi kim loại nhường electron cho phi kim
covalent bond: a bond in which two atoms share a pair of electrons	enlace covalente: enlace en el que dos átomos comparten un par de electrones	liên kết cộng hóa trị: liên kết trong đó hai nguyên tử dùng chung một cặp electron
Lewis dot structure: an element's symbol with one dot for each valence electron	estructura de puntos de Lewis: el símbolo de un elemento con un punto por cada electrón de valencia	công thức Lewis (sơ đồ chấm electron): kí hiệu nguyên tố với mỗi dấu chấm là một electron hóa trị

Key directions · Instrucciones · Hướng dẫn

English	Español	Tiếng Việt
Move electrons until every atom is stable.	Mueve electrones hasta que cada átomo sea estable.	Di chuyển electron cho đến khi mọi nguyên tử đều bền.
Choose: lose, gain, or share.	Elige: perder, ganar o compartir.	Chọn: nhường, nhận hoặc dùng chung.
Move one electron from each atom into the middle to share a pair.	Mueve un electrón de cada átomo al centro para compartir un par.	Đưa một electron từ mỗi nguyên tử vào giữa để dùng chung một cặp.
Write one question you have.	Escribe una pregunta que tengas.	Viết một câu hỏi em đang thắc mắc.
Write a claim, evidence, and reasoning.	Escribe una afirmación, evidencia y razonamiento.	Viết nhận định, bằng chứng và lập luận.

Name: _____ Period: _____ Date: _____

Checkpoint 1 · The octet rule and stability

- Your teacher gave you this page. Finish it before you move on to the next section.

• Need a boost?

S1.1. Neon (8 dots around Ne) almost never bonds because its outer shell is...

- A. half full
- B. full
- C. empty

S1.2. Chlorine's dot structure has 7 dots. How many valence electrons does chlorine have?

- A. 8
- B. 17
- C. 7

S1.3. The octet rule says atoms tend to end up with how many valence electrons?

- A. 8
- B. 2
- C. 18

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Checkpoint 2 · Gain, lose, or share?

- Your teacher gave you this page. Finish it before you move on to the next section.

• Need a boost?

S2.1. Sodium ($\text{Na}\cdot$) has 1 valence electron. To become stable, it will...

- A. share 1 electron
- B. lose 1 electron
- C. gain 7 electrons

S2.2. A metal bonded to a nonmetal forms a(n)...

- A. noble gas
- B. covalent bond
- C. ionic bond

S2.3. Chlorine gains 1 electron. Which ion does it form?

- A. Cl^-
- B. Cl^+
- C. Cl^{2-}

Name: _____ Period: _____ Date: _____

Checkpoint 1 · The octet rule and stability

■ Your teacher gave you this page. Try these after your main questions.

■ Take it further

H1.1. Hydrogen is stable with only 2 electrons. Why?

- A. Hydrogen reaches 8 by sharing 4 pairs
- B. Hydrogen has 2 protons
- C. Hydrogen is a noble gas
- D. Its only shell holds just 2 electrons, like helium's

H1.2. In BF_3 , boron has only 6 electrons around it, but the molecule is stable. Which statement is correct?

- A. Boron is an exception to the octet rule; it can be stable with fewer than 8
- B. Each fluorine lends boron an extra electron, giving it 8
- C. BF_3 can't exist, so the question is wrong
- D. The octet rule doesn't apply to any compound with fluorine

H1.3. A student says, "Sodium loses an electron because it wants to become neon." Explain what's wrong with this statement.

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Checkpoint 2 · Gain, lose, or share?

■ Your teacher gave you this page. Try these after your main questions.

■ Take it furtherH2.1. Which set lists ions that **all** have the same electron arrangement as argon?

- A. K^+ , Ca^{2+} , Cl^- , S^{2-}
- B. Li^+ , Mg^{2+} , Br^- , O^{2-}
- C. K^+ , Na^+ , F^- , O^{2-}
- D. Na^+ , Mg^{2+} , Cl^- , S^{2-}

H2.2. Aluminum bonds with oxygen. Which describes what happens to the electrons?

- A. Each Al gains 5 electrons to reach an octet
- B. Each Al loses 3 electrons and each O gains 2, so electrons are transferred
- C. Al and O share electrons because both are nonmetals
- D. Each O loses 6 electrons to empty its outer shell

H2.3. Explain why two chlorine atoms **share** electrons instead of one chlorine giving an electron to the other.
