

Name: _____ Period: _____ Date: _____

Electronegativity Predicts Bond Type

Learning goal

I can use electronegativity difference to predict whether a bond is nonpolar covalent, polar covalent, or ionic.

Part 1 · Notes

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

Section A · Electronegativity and ΔEN

Word bank

more lopsided · decreases · exactly to the middle · farther away ·
increases · more even · closer to itself · stays the same

- **Electronegativity** (EN) is how strongly an atom pulls on shared electrons in a bond. Across a period, EN _____, and down a group it decreases. Fluorine is the most electronegative element.
- In a bond, both atoms pull on the **same** electrons, like two teams in a tug-of-war. The atom with the higher EN pulls the shared electrons _____.
- To predict what kind of bond forms, compare the two pulls by finding the **electronegativity difference** (ΔEN). Subtract the smaller EN from the larger EN, as shown in the box below.

Remember

$\Delta EN = \text{larger EN} - \text{smaller EN}$ (always positive)

Worked example, H and Cl: $3.16 - 2.20 = \mathbf{0.96}$

Worked example, Na and Cl: $3.16 - 0.93 = \mathbf{2.23}$

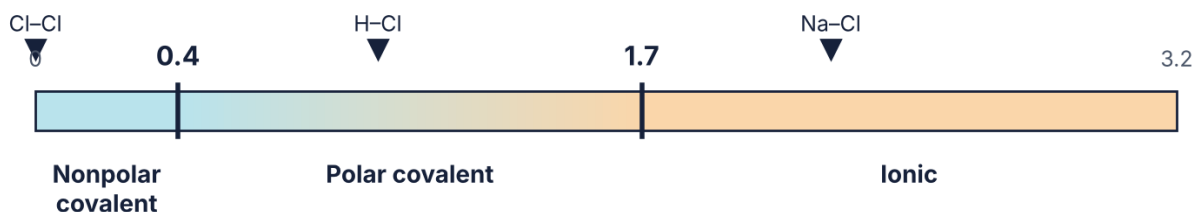
- The bigger the ΔEN , the _____ the tug-of-war.

Section B · Three Kinds of Bonds

Word bank

H · Cl · O · not at all · equally · unequally

Δ EN	Bond type	What the electrons do
less than 0.4	Nonpolar covalent	Shared equally
0.4 to 1.7	Polar covalent	Shared unequally
greater than 1.7	Ionic	Transferred



- **Nonpolar covalent** (Δ EN < 0.4). The pulls are equal or nearly equal, so the electrons are shared _____. Examples: Cl–Cl (0), C–C (0).
- **Polar covalent** (Δ EN 0.4 to 1.7). One atom pulls harder, so the electrons are shared unequally. The atom with the higher EN gets a small negative **partial charge** (δ^-). The other atom gets δ^+ . A bond with a δ^+ end and a δ^- end is a **dipole**. Example: in H–Cl (0.96), Cl is δ^- and H is δ^+ .
- In an O–H bond (Δ EN 1.24), the δ^- end is _____.
- **Ionic** (Δ EN > 1.7). The pull is so uneven that the electron is transferred (C7.01), making ions instead of partial charges. Example: Na–Cl (2.23).

Remember

The C7.01 rule (metal + nonmetal → ionic; two nonmetals → covalent) usually agrees with Δ EN. Δ EN adds something new: it tells you **how polar** a covalent bond is.

Section C · Build the Argument

Word bank

nonpolar covalent · metallic · ionic · polar covalent

- Salt's Na–Cl bonds have a Δ EN of 2.23, so they are _____.
- Wax is built on a backbone of carbon–carbon bonds with a Δ EN of 0, so they are _____. (Wax's C–H bonds, Δ EN 0.35, count as nonpolar too.)
- That's another clue about why salt and wax behave so differently. Now use the periodic table to predict a bond **before** you see any numbers (Part 2, Card 3).

Part 2 · Bond Tug-of-War

Use this EN reference card for every card in Part 2.

Element	H	Li	C	N	O	F	Na	Mg	S	Cl	K	Ca	Br
EN	2.20	0.98	2.55	3.04	3.44	3.98	0.93	1.31	2.58	3.16	0.82	1.00	2.96

Card 1 · Measure (do this after Section A)

For each pair: **(1)** look up both EN values on the reference card. **(2)** Predict where the shared electrons go: toward the atom with the higher EN, or the middle if the ENs are equal. **(3)** Calculate $\Delta\text{EN} = \text{larger EN} - \text{smaller EN}$. The first row is done for you.

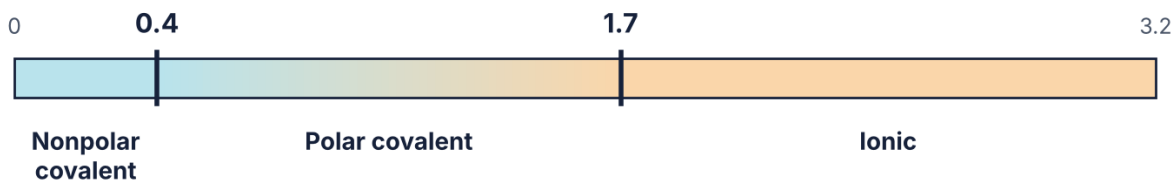
Pair	EN of each atom	Prediction: where do the electrons go?	ΔEN (2 decimals)
<i>Ex: C–H</i>	<i>C 2.55 · H 2.20</i>	<i>a little closer to C (higher EN)</i>	<i>$2.55 - 2.20 = 0.35$</i>
H–Cl			
Cl–Cl			
Na–Cl			
O–H			

Cl–Cl had a ΔEN of 0, but Na–Cl had 2.23. What happened to the shared electrons in each tug-of-war?

Sentence stem: "In Cl–Cl the electrons ____ because _____. In Na–Cl the electrons ____ because _____."

Card 2 · Classify (do this after Section B)

Calculate ΔEN for each pair, find it on the scale, and write the bond type.



Pair	ΔEN	Bond type (nonpolar covalent / polar covalent / ionic)
Br–Br		
C–Cl		
K–Cl		
N–H		
C–C		
Ca–O		
C–O		
Li–F		

C–Cl and K–Cl both contain chlorine, but they are different bond types. Explain why.

Sentence stem: “C–Cl is ___ because its ΔEN is ___, but K–Cl is ___ because ___.”

Card 3 · Predict K + Br (do this in Section C)

Fold the EN reference card under before you start. Use only positions: K is in Group 1, Period 4. Br is in Group 17, Period 4.

My prediction (circle one): nonpolar covalent · polar covalent · ionic

Now unfold the card. EN of K: _____ EN of Br: _____ Δ EN: _____

Bond type: _____

What did you predict, and which trend did you use? Were you right?

Sentence stem: "I predicted ____ because K is ____ on the table and Br is ____, so ____."

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 · Calculating ΔEN

▲ Main questions

T1.1. Find ΔEN for Na (0.93) and Cl (3.16), to two decimal places.

$\Delta EN =$ _____

T1.2. Find ΔEN for C (2.55) and O (3.44), to two decimal places.

$\Delta EN =$ _____

T1.3. In an N–H bond (N 3.04, H 2.20), where do the shared electrons spend more time?

- A. Closer to N
- B. Exactly in the middle
- C. They move to H completely
- D. Closer to H

T1.4. Which pair has the largest ΔEN ? K (0.82), F (3.98), Na (0.93), Cl (3.16), H (2.20), C (2.55), O (3.44)

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

Checkpoint 2 · Classifying bonds

▲ Main questions

T2.1. Classify the bond between Mg (1.31) and O (3.44).

- A. Polar covalent
- B. Ionic
- C. Nonpolar covalent
- D. Metallic

T2.2. Classify the bond between N (3.04) and H (2.20).

- A. Ionic
- B. Nonpolar covalent
- C. Polar covalent
- D. Metallic

T2.3. In the polar bond H–Cl, which end is δ^- ?

- A. H, because it's the smaller atom
- B. Neither end; the charges are equal
- C. Both ends
- D. Cl, because it has the higher EN

T2.4. Which bond is nonpolar covalent?

- A. C–C
- B. Na–Cl
- C. C–O
- D. O–H

Part 4 · Claim, Evidence, Reasoning

Question: Will potassium (K) and bromine (Br) form an ionic or a covalent bond? Use their positions on the periodic table and their electronegativity difference as evidence.

	K	Br
Position	Group 1, Period 4 (left side)	Group 17, Period 4 (right side)
Type	metal	nonmetal
Electronegativity	0.82	2.96
ΔEN	2.14	

Sentence stems (use them if you need them)

I claim that K and Br form a(n) ____ bond.

My evidence is that K's EN is ____ and Br's EN is ____, so $\Delta EN = \text{____} - \text{____} = \text{____}$.

This means ____ because a ΔEN greater than ____ means the electron is ____.

Evidence bank:

K EN 0.82 · Br EN 2.96 · ΔEN 2.14 · K: left side, metal · Br: right side, nonmetal · ionic cutoff 1.7

Claim:

Evidence:

Reasoning:

■ Take it further

Someone says KBr can't really be ionic, because its ΔEN (2.14) is much smaller than NaF's (3.05). Respond.

Glossary · Glosario · Bảng thuật ngữ

English	Español	Tiếng Việt
electronegativity difference (ΔEN): the larger EN minus the smaller EN of two bonded atoms	diferencia de electronegatividad (ΔEN): la electronegatividad mayor menos la menor de dos átomos enlazados	hiệu độ âm điện (ΔEN): độ âm điện lớn hơn trừ độ âm điện nhỏ hơn của hai nguyên tử liên kết
nonpolar covalent bond: a bond in which electrons are shared equally (ΔEN less than 0.4)	enlace covalente no polar: enlace en el que los electrones se comparten por igual (ΔEN menor que 0.4)	liên kết cộng hóa trị không phân cực: liên kết trong đó cặp electron dùng chung không lệch về nguyên tử nào (ΔEN nhỏ hơn 0,4)
polar covalent bond: a bond in which electrons are shared unequally (ΔEN from 0.4 to 1.7)	enlace covalente polar: enlace en el que los electrones se comparten de forma desigual (ΔEN de 0.4 a 1.7)	liên kết cộng hóa trị phân cực: liên kết trong đó cặp electron dùng chung lệch về nguyên tử có độ âm điện lớn hơn (ΔEN từ 0,4 đến 1,7)
partial charge ($\delta+$ or $\delta-$): a small charge on one end of a polar bond	carga parcial ($\delta+$ o $\delta-$): una carga pequeña en un extremo de un enlace polar	điện tích một phần ($\delta+$ hoặc $\delta-$): điện tích nhỏ ở một đầu của liên kết phân cực
dipole: a bond or molecule with a partially positive end and a partially negative end	dipolo: un enlace o molécula con un extremo parcialmente positivo y otro parcialmente negativo	lưỡng cực: liên kết hoặc phân tử có một đầu mang điện tích dương một phần và một đầu mang điện tích âm một phần

Key directions · Instrucciones · Hướng dẫn

English	Español	Tiếng Việt
Predict where the electrons will go, then pull.	Predice adónde irán los electrones y luego tira.	Dự đoán các electron sẽ đi về đâu, rồi kéo.
Subtract the smaller EN from the larger EN.	Resta la electronegatividad menor de la mayor.	Lấy độ âm điện lớn hơn trừ độ âm điện nhỏ hơn.
Place each bond in the correct bin.	Coloca cada enlace en el grupo correcto.	Đặt mỗi liên kết vào đúng nhóm.
Round to two decimal places.	Redondea a dos decimales.	Làm tròn đến hai chữ số thập phân.
Write a claim, evidence, and reasoning.	Escribe una afirmación, evidencia y razonamiento.	Viết nhận định, bằng chứng và lập luận.

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Checkpoint 1 · Calculating Δ EN

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

• Need a boost?

S1.1. In a bond between H (EN 2.20) and Cl (EN 3.16), which atom pulls the shared electrons harder?

Circle one: **H** or **Cl**

S1.2. Find Δ EN for O (3.44) and H (2.20), to two decimal places.

Δ EN = _____

S1.3. In a Cl–Cl bond, both atoms have EN 3.16. What is Δ EN?

- A. 3.16
- B. 6.32
- C. 0

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Checkpoint 2 · Classifying bonds

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

• Need a boost?

Use the ΔEN scale: less than 0.4 nonpolar covalent · 0.4 to 1.7 polar covalent · greater than 1.7 ionic.

S2.1. The ΔEN for H–Br is 0.76. What kind of bond is it?

- A. Polar covalent
- B. Ionic
- C. Nonpolar covalent

S2.2. The ΔEN for Br–Br is 0. What kind of bond is it?

- A. Ionic
- B. Nonpolar covalent
- C. Polar covalent

S2.3. The ΔEN for Na–F is 3.05. What kind of bond is it?

- A. Polar covalent
- B. Nonpolar covalent
- C. Ionic

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Checkpoint 1 · Calculating ΔEN

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

■ Take it furtherH1.1. Without a table: which bond has the larger ΔEN , Li–F or Li–I?

- A. You can't tell without a table
- B. They're equal, because both are halogens
- C. Li–I, because iodine atoms are bigger
- D. Li–F, because F is the most electronegative element and I is much lower in the same group

H1.2. An unknown metal X bonds with Cl (EN 3.16), and the ΔEN is 2.34. Which element is X?

- A. K (0.82)
- B. Na (0.93)
- C. Ca (1.00)
- D. Li (0.98)

H1.3. Explain why the ΔEN of a Cl–Cl bond is 0, and what that means for the shared electrons.

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Checkpoint 2 · Classifying bonds

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

■ Take it further

H2.1. Rank these bonds from least to most polar: C–Cl (C 2.55, Cl 3.16), H–Br (H 2.20, Br 2.96), O–H (O 3.44, H 2.20), Na–Cl (Na 0.93, Cl 3.16).

Least polar _____ < _____ < _____ < _____ Most polar

H2.2. A student says every bond between two nonmetals is nonpolar, because nonmetals share electrons. Which bond proves the student wrong?

- A. O–H (ΔEN 1.24)
- B. C–C (ΔEN 0)
- C. Cl–Cl (ΔEN 0)
- D. Br–Br (ΔEN 0)

H2.3. Using only positions on the periodic table (no numbers), predict whether a bond between cesium (Cs) and fluorine (F) is ionic or covalent. Explain.
