

Name: _____ Period: _____ Date: _____

Reactivity Lab: Metals in Water and Acid

Learning goal

I can observe how metals react, and explain the differences using distance from the nucleus and how many electrons each metal must lose.

Safety check (read, then initial each line)

- _____ Goggles on before any chemicals are out.
- _____ Never touch calcium with bare hands. It reacts with the moisture on your skin.
- _____ HCl is an acid. If it touches your skin, rinse with water and tell your teacher.
- _____ The gas made today is hydrogen, which is flammable. No flames at the bench.
- _____ Phenolphthalein contains alcohol. Keep it capped.

How this lab works

1. **Observe first.** Record exactly what you see, even if it seems "wrong." Observations aren't graded for right answers.
2. **Then zoom in.** After each table, your teacher shows you what the atoms were doing.
3. **Then explain.** Answer the questions using what you saw and what you learned.

Part 1 · Alkali Metals in Water (video)

Watch the video. You can't do this one at the bench: these **alkali metals** are too reactive for a classroom. Watch the metal **and** the water.

Metal	Bubbles	Movement	Color	Speed	What I saw (8+ words, in my own words)
Circle one →	<i>none · a few · steady · lots</i>	<i>unchanged · shrinking · gone · moving around</i>	<i>no change · faint pink · bright pink · cloudy white</i>	<i>nothing yet · slow · medium · fast</i>	<i>When I added ____, the ____ started to ____.</i>
Lithium					
Sodium					
Potassium					

After you zoom in (Zoom In 1)

In the animation, which atom lost its outer electron fastest? Where is that electron compared with the others?

Sentence stem: “___ lost its electron fastest because its outer electron is ___.”

Q1. Which alkali metal was the most reactive?

- A. Potassium
- B. Sodium
- C. Lithium

Q2. The reactivity of the alkali metals _____ as you move down the group.

- A. decreases
- B. increases
- C. stays the same

Q3. Explain why potassium is more reactive than lithium. (What's different?)

Part 2 · Alkaline Earth Metals in Water

Magnesium and calcium are **alkaline earth metals** (Group 2). **Phenolphthalein** is an **indicator**: it turns pink when the water becomes a **base**.

Procedure

1. Add a small piece of magnesium to one test tube and a small piece of calcium to another.
2. Add one drop of phenolphthalein to each test tube.
3. Use a pipette to add enough water to cover the metal.
4. Record your observations in the table below. **Watch for at least 1 minute.** Magnesium is slow.
5. Carefully dump the solids and liquids into the waste beaker. Rinse with the water bottle until clean (no pink!).

Metal	Bubbles	Movement	Color	Temp.	What I saw (8+ words, in my own words)
Circle one →	<i>none · a few · steady · lots</i>	<i>unchanged · shrinking · gone · moving around</i>	<i>no change · faint pink · bright pink · cloudy white</i>	<i>no change · a little warm · hot</i>	<i>When I added ____, the ____ started to ____.</i>
Magnesium					
Calcium					

After you zoom in (Zoom In 2)

Look back at **your** observations for Mg and Ca. Which thing you saw matches something in the animation?

Sentence stem: "I saw ____ in my test tube. In the animation, that was ____."

Q4. Which of the elements above was the most reactive?

Circle one: **Magnesium** or **Calcium**

Q5. The reactivity of the alkaline earth metals _____ as you move down the group.

A. stays the same B. decreases C. increases

Q6. Explain why you see a difference in the reactivity of the alkaline earth metals. (What's different?)

Part 3 · Activity Series of Some Metals in HCl

This time the metals go into hydrochloric acid (HCl). Watch both tubes closely, and don't give up on the aluminum too early.

Procedure

1. Place a small piece of each metal in a **separate** test tube.
2. Add enough HCl to **barely** cover the sample. Don't fill the test tube.
3. Record how each metal reacts with HCl in the table below. Record aluminum **right away**, then again **after 2 minutes**.
4. After completing your observations, dump the test tubes into the waste beaker and rinse with water.

Metal	Bubbles	Movement	Temp.	Speed	What I saw (8+ words, in my own words)
Circle one →	<i>none · a few · steady · lots</i>	<i>unchanged · shrinking · gone · moving around</i>	<i>no change · a little warm · hot</i>	<i>nothing yet · slow · medium · fast</i>	<i>When I added ____, the ____ started to ____.</i>
Magnesium					
Aluminum · first look					
Aluminum · after 2 minutes					

After you zoom in (Zoom In 3)

Did your aluminum match the animation? What did you see at first, and what changed after 2 minutes?

Sentence stem: "At first, my aluminum _____. After 2 minutes, _____. This happened because _____."

Q7. Which of the elements above was the most reactive?

Circle one: **Magnesium** or **Aluminum**

Q8. Explain why you see a difference in the reactivity of the elements above. (What's different?)

Q9. Why did aluminum seem to do almost nothing at first?

- A. Aluminum has no valence electrons
- B. Aluminum doesn't react with acid
- C. The HCl was too weak
- D. A thin oxide layer coated the metal, and the acid had to eat through it first

Conclusion · Claim, Evidence, Reasoning

Question: In your lab, calcium reacted faster than magnesium, and magnesium reacted faster than aluminum. Use **your observations** and the data below to explain both results.

	Mg	Ca	Al
Shell holding the outer electrons	3	4	3
Pull on outer electrons (Zeff)	+2	+2	+3
Electrons lost when it reacts	2	2	3
Energy to remove them all (kJ/mol)	2,189	1,735	5,139

Sentence starters (use them if you need them)

Claim: Calcium is the most reactive because ____, and aluminum is the least reactive because ____.

Evidence: In my lab, I saw _____. The data shows _____.

Reasoning: Metals react by losing electrons. Electrons that are _____ are easier to lose, so _____.

Claim:

Evidence (include at least one thing YOU observed):

Reasoning:

Glossary · Glosario · Bảng thuật ngữ

English	Español	Tiếng Việt
alkali metal: an element in Group 1 (except hydrogen); very reactive metals with 1 valence electron	metal alcalino: elemento del Grupo 1 (excepto el hidrógeno); metales muy reactivos con 1 electrón de valencia	kim loại kiềm: nguyên tố nhóm 1 (trừ hiđro); kim loại rất hoạt động có 1 electron hóa trị
alkaline earth metal: an element in Group 2; reactive metals with 2 valence electrons	metal alcalinotérreo: elemento del Grupo 2; metales reactivos con 2 electrones de valencia	kim loại kiềm thổ: nguyên tố nhóm 2; kim loại hoạt động có 2 electron hóa trị
reactivity: how readily an element gains, loses, or shares electrons to bond with other elements	reactividad: la facilidad con que un elemento gana, pierde o comparte electrones para enlazarse con otros elementos	khả năng phản ứng: mức độ dễ dàng một nguyên tố nhận, nhường hoặc dùng chung electron để liên kết với nguyên tố khác
indicator: a substance that changes color to show whether a solution is acidic or basic	indicador: sustancia que cambia de color para mostrar si una solución es ácida o básica	chất chỉ thị: chất đổi màu để cho biết dung dịch có tính axit hay bazơ
phenolphthalein: an indicator that is colorless in acids and water, and turns pink in a base	fenolftaleína: indicador que es incoloro en ácidos y agua, y se vuelve rosado en una base	phenolphtalein: chất chỉ thị không màu trong axit và nước, chuyển sang màu hồng trong bazơ
base: a substance that makes hydroxide ions (OH^-) in water	base: sustancia que produce iones hidróxido (OH^-) en el agua	bazơ: chất tạo ra ion hiđroxit (OH^-) trong nước
oxide layer: a thin coating that forms when a metal reacts with oxygen in the air; it can slow down other reactions	capa de óxido: recubrimiento delgado que se forma cuando un metal reacciona con el oxígeno del aire; puede hacer más lentas otras reacciones	lớp oxit: lớp phủ mỏng hình thành khi kim loại phản ứng với oxi trong không khí; nó có thể làm chậm các phản ứng khác
hydrogen gas (H_2): a flammable gas made when reactive metals react with water or acid	gas hidrógeno (H_2): gas inflamable que se forma cuando metales reactivos reaccionan con agua o ácido	khí hiđro (H_2): khí dễ cháy tạo ra khi kim loại hoạt động phản ứng với nước hoặc axit

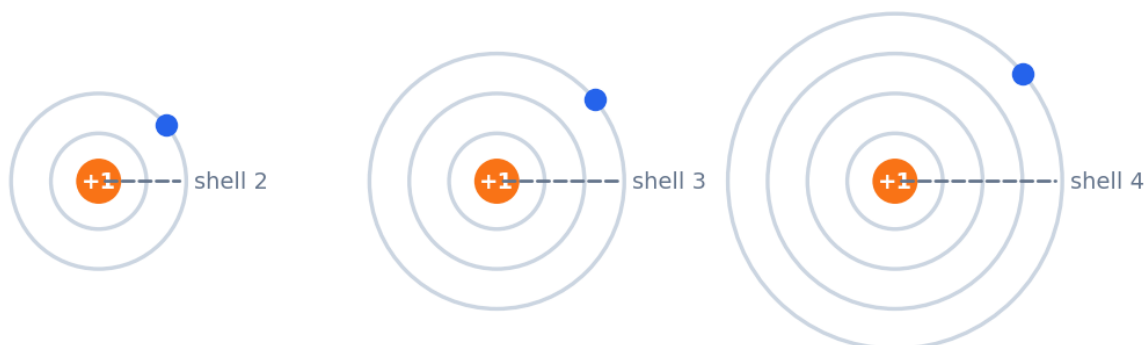
Key directions · Instrucciones · Hướng dẫn

English	Español	Tiếng Việt
Goggles on before any chemicals are out.	Ponte las gafas de seguridad antes de sacar cualquier sustancia química.	Đeo kính bảo hộ trước khi lấy bất kỳ hóa chất nào ra.
Never touch calcium with bare hands.	Nunca toques el calcio con las manos descubiertas.	Không bao giờ chạm vào canxi bằng tay trần.
Record what you see before you continue.	Anota lo que observas antes de continuar.	Ghi lại những gì em quan sát được trước khi tiếp tục.
Watch for at least 1 minute.	Observa durante al menos 1 minuto.	Quan sát ít nhất 1 phút.
Look again in 2 minutes.	Vuelve a observar en 2 minutos.	Quan sát lại sau 2 phút.
Add enough HCl to barely cover the sample.	Agrega suficiente HCl para apenas cubrir la muestra.	Thêm HCl vừa đủ ngập mẫu.

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Zoom In 1 · Alkali metals in water

Your teacher gave you this card after you recorded your Part 1 observations.



Lithium (Li)

pull on outer electrons: +1

Sodium (Na)

pull on outer electrons: +1

Potassium (K)

pull on outer electrons: +1

This is why you saw...

Bubbles: that's hydrogen gas. Each metal atom gives its 1 outer electron to the water, which splits into H_2 gas and OH^- .

Pink: OH^- makes the water a base, and phenolphthalein turns pink in a base.

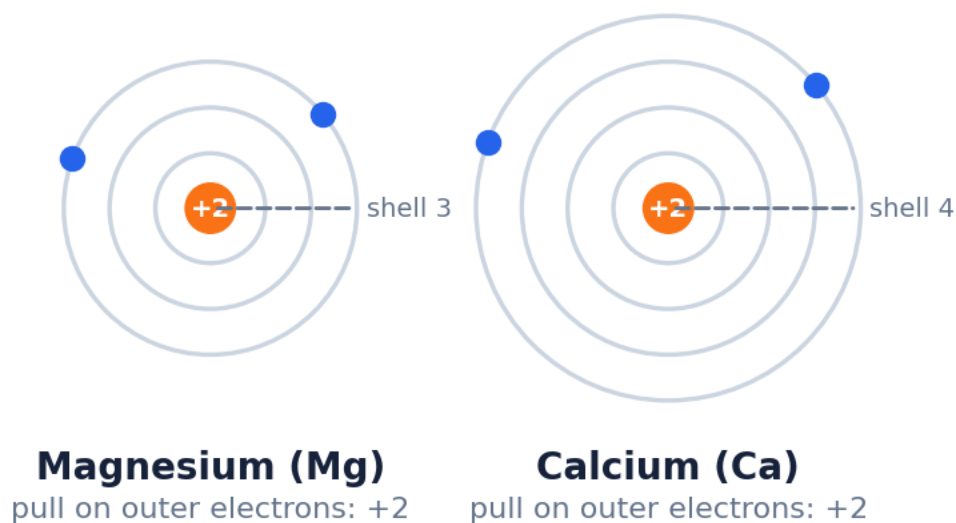
Potassium reacted fastest: its outer electron is in shell 4, the farthest from the nucleus, so it's the easiest to pull away.

Equation: $2\text{Na} + 2\text{H}_2\text{O} \rightarrow 2\text{NaOH} + \text{H}_2$

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Zoom In 2 · Mg vs. Ca in water

Your teacher gave you this card after you recorded your Part 2 observations.



This is why you saw...

Pink: the water turned basic (OH^-), and phenolphthalein turns pink in a base.

Cloudy white in the calcium tube: calcium hydroxide doesn't fully dissolve.

Calcium reacted faster: same pull (+2), but its outer electrons are one shell farther out (shell 4 vs. shell 3), so they're easier to remove.

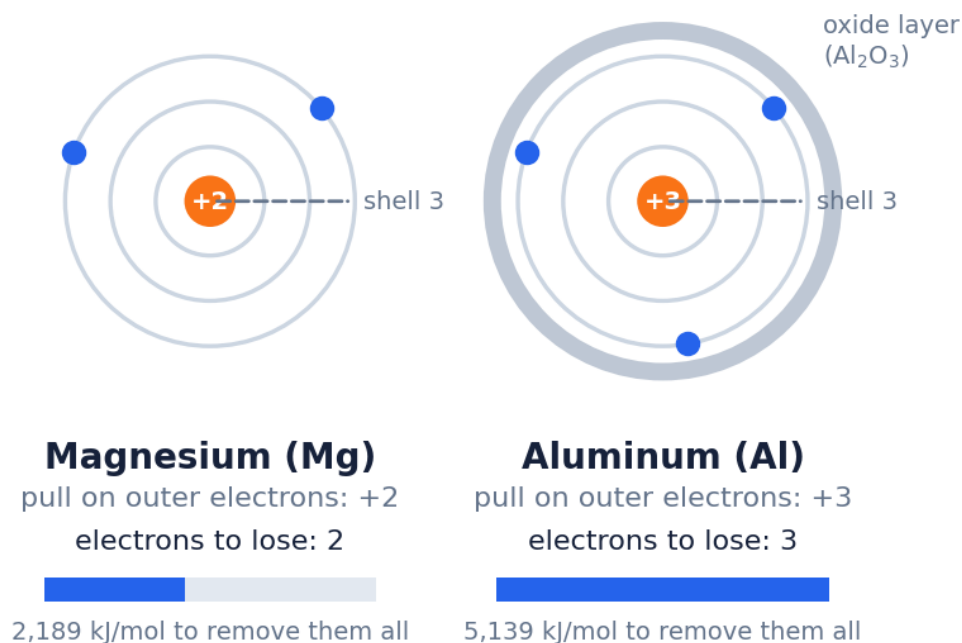
Warm tube: the reaction releases energy.



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Zoom In 3 · Mg vs. Al in HCl

Your teacher gave you this card after you recorded your Part 3 observations.

**This is why you saw...****Bubbles:** H^+ ions from the acid take electrons from the metal and pair up as H_2 gas.**Aluminum did almost nothing at first:** a thin oxide layer (Al_2O_3) coats it. The acid has to eat through that before the metal can react.**Magnesium fizzed faster:** Mg only has to lose 2 electrons, Al has to lose 3, and Al's nucleus pulls harder (+3 vs. +2). Removing all three takes much more energy (5,139 vs. 2,189 kJ/mol).