

Name: _____ Period: _____ Date: _____

Transition Metals & Roman Numerals

Learning goal

I can name and write formulas for compounds with metals that can have more than one charge.

Part 1 · Notes

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

Section A · Metals with More Than One Charge

Word bank

2+

- The metals you've named so far have **one** charge: sodium is always Na^+ and calcium is always Ca^{2+} . Many transition metals can lose different numbers of electrons, so they have a **variable charge**. Iron can be Fe^{2+} or Fe^{3+} , and copper can be Cu^+ or Cu^{2+} .

Metal	Ions	Metal	Ions
iron	Fe^{2+} , Fe^{3+}	lead	Pb^{2+} , Pb^{4+}
copper	Cu^+ , Cu^{2+}	manganese	Mn^{2+} , Mn^{4+}
tin	Sn^{2+} , Sn^{4+}	chromium	Cr^{2+} , Cr^{3+}

Zinc (Zn^{2+}) and silver (Ag^+) have only one charge.

- So the group number can't tell you the charge. **The formula can.** The negative ions' charges are known, and the compound is neutral, so:

Remember

metal charge = total negative charge ÷ number of metal ions

FeCl_3 : three Cl^- give -3 . One iron ion must be $+3$: Fe^{3+} .

Fe_2O_3 : three O^{2-} give -6 . Two iron ions share $+6$, so each is $+3$: Fe^{3+} .

- In CuO , one O^{2-} gives -2 , so the copper ion is _____.

Remember

Watch the shortcut. "Un-criss-crossing" (reading the subscripts backward) only works if the formula wasn't reduced. PbO_2 would give " Pb^{1+} ", but two O^{2-} give -4 , so the lead is really **Pb^{4+}** . Always use the total charge.

Section B · The Stock System

Word bank

charge · zinc chloride

- Because iron can be 2+ or 3+, “iron chloride” could mean FeCl_2 or FeCl_3 . The **stock system** adds a **Roman numeral** in parentheses to show the metal ion's charge: FeCl_2 is **iron(II) chloride** and FeCl_3 is **iron(III) chloride**.

I	II	III	IV
1	2	3	4

- The Roman numeral gives the metal ion's _____, not how many metal atoms there are. Cu_2O has two copper atoms, but each is Cu^+ , so it's **copper(I) oxide**.

Remember

Naming with a Roman numeral

- Find the metal's charge from the formula (Section A).
- Write the metal's name, then the charge as a Roman numeral in parentheses: copper(II).
- Add the negative ion's name. No prefixes.

- Worked example: PbO_2 .** Two O^{2-} give -4 , so lead is Pb^{4+} : **lead(IV) oxide**.
- Worked example: $\text{Fe}_2(\text{SO}_4)_3$.** Three SO_4^{2-} give -6 . Two iron ions share $+6$: Fe^{3+} . **Iron(III) sulfate**.
- Metals with only one charge never get a numeral: ZnCl_2 is _____, and AgNO_3 is silver nitrate.

Section C · From Name to Formula

Word bank



- Going the other way is easier, because the name **tells** you the charge.

Remember

Name → formula

1. The Roman numeral gives the metal's charge: iron(III) → Fe^{3+} .
2. Find the negative ion's charge: oxide → O^{2-} .
3. Balance the charges (C7.04). Use parentheses for 2 or more polyatomic ions (C7.06).

- **iron(III) oxide:** Fe^{3+} and O^{2-} : two Fe^{3+} (+6) and three O^{2-} (-6) → **Fe_2O_3** .
- **copper(II) nitrate:** Cu^{2+} and NO_3^- : one Cu^{2+} needs two NO_3^- → **$\text{Cu}(\text{NO}_3)_2$** .
- **tin(II) fluoride**, the “stannous fluoride” in toothpaste: Sn^{2+} and F^- → **SnF_2** .
- The formula for copper(I) chloride is _____.

Part 2 · Practice

Card 1 · Find the charge (do this after Section A)

Charge frame: metal charge = total negative charge ÷ number of metal ions. Then name it with the right Roman numeral.

Formula	Negative ions (total charge)	Number of metal ions	Metal's charge	Name
FeCl ₃				
Fe ₂ O ₃				
CuO				
Cu ₂ O				
PbO ₂				
FeSO ₄				

Cu₂O and CuO both contain only copper and oxygen. How did you show that the copper ions have different charges?

Sentence stem: "In Cu₂O, one O²⁻ is shared by ____ copper ions, so each is _____. In CuO, _____."

Card 2 · Name it (do this after Section B)

Find the metal's charge. Only metals with more than one charge get a Roman numeral.

Formula	Metal's charge	Needs a numeral? (yes / no)	Name
FeCl ₂			
CuCl ₂			
SnF ₂			
MnO ₂			
Cr ₂ O ₃			
ZnO			

Card 3 · Write the formula (do this after Section C)

The numeral gives the metal's charge. Balance the charges; use parentheses for 2 or more polyatomic ions.

Name	Ions (with charges)	Formula
iron(II) oxide		
copper(II) sulfate		
lead(II) iodide		
tin(IV) oxide		
chromium(III) chloride		
silver nitrate		

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 · Find the metal's charge

▲ Main questions

T1.1. What is the charge on each iron ion in Fe_2O_3 ?

- A. 3+
- B. 3-
- C. 6+
- D. 2+

T1.2. What is the charge on each copper ion in Cu_2O ?

- A. 4+
- B. 1+
- C. 2+
- D. 1-

T1.3. What is the charge on the manganese ion in MnO_2 ?

- A. 1+
- B. 4-
- C. 4+
- D. 2+

T1.4. What is the charge on the iron ion in $\text{Fe}(\text{NO}_3)_3$?

- A. 3-
- B. 1+
- C. 9+
- D. 3+

Checkpoint 2 · Name with Roman numerals

▲ Main questions

T2.1. Name Fe_2O_3 .

- A. iron(II) oxide
- B. iron(III) oxide
- C. diiron trioxide
- D. iron oxide

T2.2. Name Cu_2O .

- A. dicopper oxide
- B. copper(II) oxide
- C. copper(I) oxide
- D. copper oxide

T2.3. Name PbO_2 .

- A. lead(II) oxide
- B. lead(II) dioxide
- C. lead oxide
- D. lead(IV) oxide

T2.4. Which compound's name does **not** need a Roman numeral?

- A. ZnO
- B. PbO
- C. FeO
- D. CuO

Checkpoint 3 · Formula from name

▲ Main questions

T3.1. What is the formula for iron(III) oxide?

- A. FeO_3
- B. Fe_2O_3
- C. FeO
- D. Fe_3O_2

T3.2. What is the formula for tin(II) fluoride?

- A. Sn_2F
- B. SnF
- C. SnF_2
- D. SnF_4

T3.3. What is the formula for lead(IV) oxide?

- A. Pb_4O
- B. Pb_2O_4
- C. PbO_4
- D. PbO_2

T3.4. What is the formula for copper(II) nitrate?

- A. $\text{Cu}(\text{NO}_3)_2$
- B. CuNO_3
- C. CuNO_{32}
- D. Cu_2NO_3

Part 4 · Claim, Evidence, Reasoning

Question: FeCl_2 and FeCl_3 are both made of iron and chlorine, but they are different compounds with different names. Explain why they need different names.

	FeCl_2	FeCl_3
Looks like	pale green solid	dark brown solid
Chloride ions per iron	2	3
Charge of each Cl^-	-1	-1

Sentence stems (use them if you need them)

I claim that FeCl_2 and FeCl_3 need different names because ____.

My evidence is that in FeCl_2 the chlorides give ____, so iron is ____, and in FeCl_3 ____.

This means the name must show ____, because iron can ____.

Evidence bank: two $\text{Cl}^- = -2$ · three $\text{Cl}^- = -3$ · Fe^{2+} · Fe^{3+} · iron(II) chloride · iron(III) chloride · variable charge · the numeral gives the charge

Claim:

Evidence:

Reasoning:

■ Take it further

Someone says NaCl and KCl don't need numerals, so FeCl_3 shouldn't either. Respond.

Glossary · Glosario · Bảng thuật ngữ

English	Español	Tiếng Việt
variable charge: when a metal can form ions with different charges, like Fe^{2+} and Fe^{3+}	carga variable: cuando un metal puede formar iones con cargas diferentes, como Fe^{2+} y Fe^{3+}	điện tích thay đổi: khi một kim loại có thể tạo ion với điện tích khác nhau, như Fe^{2+} và Fe^{3+}
stock system: the naming system that shows a metal ion's charge with a Roman numeral, as in iron(III) chloride	sistema Stock: el sistema de nombres que indica la carga del ion metálico con un número romano, como en cloruro de hierro(III)	danh pháp Stock: cách gọi tên ghi điện tích của ion kim loại bằng số La Mã, như sắt(III) clorua
Roman numeral: I, II, III, IV...; in a compound's name it gives the metal ion's charge	número romano: I, II, III, IV...; en el nombre de un compuesto indica la carga del ion metálico	số La Mã: I, II, III, IV...; trong tên hợp chất, nó cho biết điện tích của ion kim loại

Key directions · Instrucciones · Hướng dẫn

English	Español	Tiếng Việt
Set the metal's charge until the charges balance.	Ajusta la carga del metal hasta que las cargas se equilibren.	Chỉnh điện tích của kim loại cho đến khi điện tích cân bằng.
Pick the name with the right Roman numeral.	Elige el nombre con el número romano correcto.	Chọn tên có số La Mã đúng.
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 · Find the metal's charge

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

• Need a boost?

S1.1. In FeCl_3 , each Cl^- is -1 . What is the charge on the iron ion?

- A. 3^-
- B. 3^+
- C. 1^+

S1.2. In CuO , the O^{2-} is -2 . What is the charge on the copper ion?

- A. 2^-
- B. 1^+
- C. 2^+

S1.3. In PbCl_2 , what is the charge on the lead ion?

- A. 2^+
- B. 1^+
- C. 4^+

Name: _____ Period: _____ Date: _____

Checkpoint 2 · Name with Roman numerals

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

• Need a boost?S2.1. FeCl_3 contains Fe^{3+} . What is its name?

- A. iron trichloride
- B. iron(III) chloride
- C. iron chloride

S2.2. CuO contains Cu^{2+} . What is its name?

- A. copper oxide(II)
- B. copper(I) oxide
- C. copper(II) oxide

S2.3. Does ZnCl_2 need a Roman numeral?Circle one: **No** or **Yes**

Name: _____ Period: _____ Date: _____

Checkpoint 3 · Formula from name

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

• Need a boost?

Charge frame: metal charge = total negative charge ÷ number of metal ions

S3.1. Iron(II) chloride is Fe^{2+} and Cl^- . What is the formula?

- A. FeCl_2
- B. FeCl
- C. Fe_2Cl

S3.2. Copper(I) chloride is Cu^+ and Cl^- . What is the formula?

- A. Cu_2Cl
- B. CuCl
- C. CuCl_2

S3.3. What does the (III) in iron(III) oxide tell you?

- A. There are 3 iron atoms
- B. There are 3 oxide ions
- C. The iron ion has a 3+ charge

Name: _____ Period: _____ Date: _____

Checkpoint 1 · Find the metal's charge

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

■ Take it further

H1.1. Which compound contains iron with a 2+ charge?

- A. Fe_2O_3
- B. FeCl_3
- C. $\text{Fe}_2(\text{SO}_4)_3$
- D. FeSO_4

H1.2. A student “un-criss-crosses” PbO_2 and says lead is 1+. What's the mistake?

- A. PbO_2 was reduced; two O^{2-} give -4 , so the lead ion is 4+
- B. Lead is always 2+
- C. The student is right
- D. Oxygen is -1 in this compound

H1.3. Explain how to find the charge on copper in CuCl_2 , and why its name needs a Roman numeral.

Name: _____ Period: _____ Date: _____

Checkpoint 2 · Name with Roman numerals

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

■ Take it furtherH2.1. Name $\text{Fe}_2(\text{SO}_4)_3$.

- A. diiron(III) sulfate
- B. iron(III) trisulfate
- C. iron(II) sulfate
- D. iron(III) sulfate

H2.2. A student names CuCl_2 "copper(II) dichloride." What's the fix?

- A. copper(II) chloride: the numeral gives the charge, and ionic names use no prefixes
- B. copper chloride
- C. copper(I) chloride
- D. Nothing; it's correct

H2.3. Cu_2O has two copper atoms, but its name is copper(I) oxide. Explain what the "I" tells you.

Name: _____ Period: _____ Date: _____

Checkpoint 3 · Formula from name

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

■ Take it further

H3.1. What is the formula for iron(III) hydroxide?

- A. $\text{Fe}(\text{OH})_3$
- B. FeOH_3
- C. Fe_3OH
- D. $\text{Fe}(\text{OH})_2$

H3.2. Which name and formula match?

- A. copper(I) oxide, CuO
- B. manganese(IV) oxide, MnO_2
- C. iron(II) oxide, Fe_2O_3
- D. tin(IV) fluoride, SnF_2

H3.3. Write the formula for iron(III) sulfate and show that the charges balance.
