

EXPERIMENT 9: REPORT SHEET

RESULTS PART 1 ACTIVITY OF METALS

Metals with copper(II) nitrate

Test	Metal + Cation	Net ionic equation (with phases)
Pb	$\text{Cu}(\text{NO}_3)_2$	
Mg	$\text{Cu}(\text{NO}_3)_2$	
Zn	$\text{Cu}(\text{NO}_3)_2$	

Metals with magnesium sulfate

test	Metal + Cation	Net ionic equation (with phases)
Cu	MgSO_4	
Zn	MgSO_4	
Pb	MgSO_4	

Metals with zinc sulfate

test	Metal + Cation	Net ionic equation (with phases)
Cu	ZnSO_4	
Pb	ZnSO_4	
Mg	ZnSO_4	

Metals with lead(II) nitrate

Test	Metal + Cation	Net ionic equation (with phases)
Cu	$\text{Pb}(\text{NO}_3)_2$	
Mg	$\text{Pb}(\text{NO}_3)_2$	
Zn	$\text{Pb}(\text{NO}_3)_2$	

Metals with silver nitrate

test	Metal + Cation	Net ionic equation (with phases)
Cu	AgNO ₃	
Pb	AgNO ₃	
Mg	AgNO ₃	
Zn	AgNO ₃	

Metals with hydrochloric acid

test	Metal + Cation	Net ionic equation (with phases)
Cu	HCl _(aq)	
Pb	HCl _(aq)	
Mg	HCl _(aq)	
Zn	HCl _(aq)	

Metals with potassium chloride

test	Metal + Cation	Net ionic equation (with phases)
Cu	$\text{KCl}_{(\text{aq})}$	
Pb	$\text{KCl}_{(\text{aq})}$	
Mg	$\text{KCl}_{(\text{aq})}$	
Zn	$\text{KCl}_{(\text{aq})}$	

Results Table 2: Rating the Activity of the Metals in the Experiment

Example: I reacted $\text{Cr}(\text{NO}_3)_2$ [You are not using this solution!] with the solutions in the lab. I saw reactions for the solution with magnesium, and zinc, but not lead or copper. This means chromium metal is more active than copper and lead, so it goes above copper and lead in the chart. Chromium gives up its electrons to the copper cations or the lead cations to make copper and lead metal. The reverse is true for magnesium and zinc. Chromium is less active than magnesium and zinc, so it goes below magnesium and zinc in the chart. Magnesium cations can't take electrons from chromium metal.

Ex: $\text{Cr}(\text{NO}_3)_2_{(\text{aq})}$	Tube 1 Cu	Tube 2 Pb	Tube 3 Mg	Tube 4 Zn
Greater activity	Cr	Cr	Mg	Zn
Lesser activity	Cu	Pb	Cr	Cr
Step 2: $\text{Cu}(\text{NO}_3)_2_{(\text{aq})}$	Tube 1 Cu	Tube 2 Pb	Tube 3 Mg	Tube 4 Zn
Greater activity				
Lesser activity				

Step 3: MgSO_4 (aq)	Tube 1 Cu	Tube 2 Pb	Tube 3 Mg	Tube 4 Zn
Greater activity				
Lesser activity				
Step 4: ZnSO_4	Tube 1 Cu	Tube 2 Pb	Tube 3 Mg	Tube 4 Zn
Greater activity				
Lesser activity				
Step 5: $\text{Pb}(\text{NO}_3)_2$ (aq)	Tube 1 Cu	Tube 2 Pb	Tube 3 Mg	Tube 4 Zn
Greater activity				
Lesser activity				
Step 6: AgNO_3 (aq)	Tube 1 Cu	Tube 2 Pb	Tube 3 Mg	Tube 4 Zn
Greater activity				
Lesser activity				
Step 7: HCl (aq)	Tube 1 Cu	Tube 2 Pb	Tube 3 Mg	Tube 4 Zn
Greater activity				
Lesser activity				

Step 8: $\text{KCl}_{(\text{aq})}$	Tube 1 Cu	Tube 2 Pb	Tube 3 Mg	Tube 4 Zn
Greater activity				
Lesser activity				

Relative ordering of the activity series

1. Arrange, Mg and Zn in order of their activities, listing the most active first.

(1)_____ (2)_____

2. Arrange Cu, Ag and Zn in order of their activities, listing the most active first.

(1)_____ (2)_____ (3)_____

3. Arrange Mg, H and Ag in order of their activities, listing the most active first.

(1)_____ (2)_____ (3)_____

4. Arrange all 6 metals, and hydrogen in an activity series, listing the most active first.

(1)_____ (2)_____ (3)_____ (4)_____ (5)_____ (6)_____ (7)_____

Questions

1. It is observed that tin ($\text{Sn}_{(\text{s})}$) will dissolve in acid, but it will not react with ZnSO_4 solution.
 - a. Where does tin fit in the activity series that you determined? Explain based on how single replacement and redox works.
 - b. What additional test(s) would be needed to determine the precise position of tin in the activity series relative to the other metals?

2. Aluminum is oxidized more easily than zinc.
 - a. What would happen if you mixed together $\text{Zn}_{(s)}$ and $\text{AlCl}_{3(aq)}$?
 - b. What would happen if you mixed together $\text{Al}_{(s)}$ and $\text{ZnSO}_{4(aq)}$?
 - c. Write the net ionic equation for the reaction that would occur.
 - d. Would aluminum be considered an “active” metal?
 - e. Explain why or why not.

3. Iron(III) and cerium(III) ions forms when a cerium(IV) solution is mixed with an iron(II) solution. (The anions don't matter.) Write the balanced equation for the reaction of iron(II) ion with cerium(IV) ion.

4. Titanium(IV) ions react with magnesium metal to yield titanium metal and magnesium ions. Write the balanced equation for the reaction of titanium(IV) ions with magnesium metal.

5. Iron(II) ions are reduced by scandium metal, but not by cadmium metal.
 - a. Which metal is the most active?
 - b. Which is the least?
 - c. Cadmium(II) ions react with iron metal but do not with gallium metal (to make Ga(I) ions). Which is more active, gallium, or iron?
 - d. Gallium ions can be reduced by scandium. Is it more active or less active than scandium? Explain
 - e. Write the order of activity from most to least.

6. Fluorine gas is a great oxidizing agent. Gold will react with bromine, chlorine, iodine, but not fluorine to make the trihalides of gold (III)¹. Fluorine gas reacts with all halides to make fluoride and the appropriate halogen. Chlorine will react with bromide, oxide, and iodide removing them from solution. Bromine will react with iodide, but not with chloride or fluoride. **Watch the nomenclature here! The ending 'ide' indicates an anion.**
- Write the equations for the reactions of the halogens:
 - Chloride reacts with fluorine to make chlorine and fluoride.
 - Chlorine reacts with bromide to make chloride and bromine
 - Bromine reacts with iodide to make bromide and iodine
 - Chlorine reacts with iodide to make chloride and iodine
 - Write the equations for gold reacting with bromine, chlorine, and iodine to make the trihalides of gold (III)
 - Identify the oxidizing and reducing agents in each equation. (How do you know which is which?)²³
 - In the reaction of gold with bromine, the compound gold (III) bromide is formed. The formulae made are very complex, so we will look at the simple monomer AuBr₃.
 - Write the equation for the formation of the monomer AuBr₃ from the reaction of gold metal with bromine. This is the spontaneous direction.
 - Label the oxidizing agent and the reducing agent
 - Write the reaction in the non-spontaneous direction.
 - Label the oxidizing agent and the reducing agent.
 - Is gold a better reducing reagent than bromide? Explain.

¹ <https://www.webelements.com/gold/chemistry.html>

² Remember, these reactions can be written in the reverse direction for the more spontaneous direction.

³ Oxidizing agents and reducing agents are named on the reactant side of the equation