

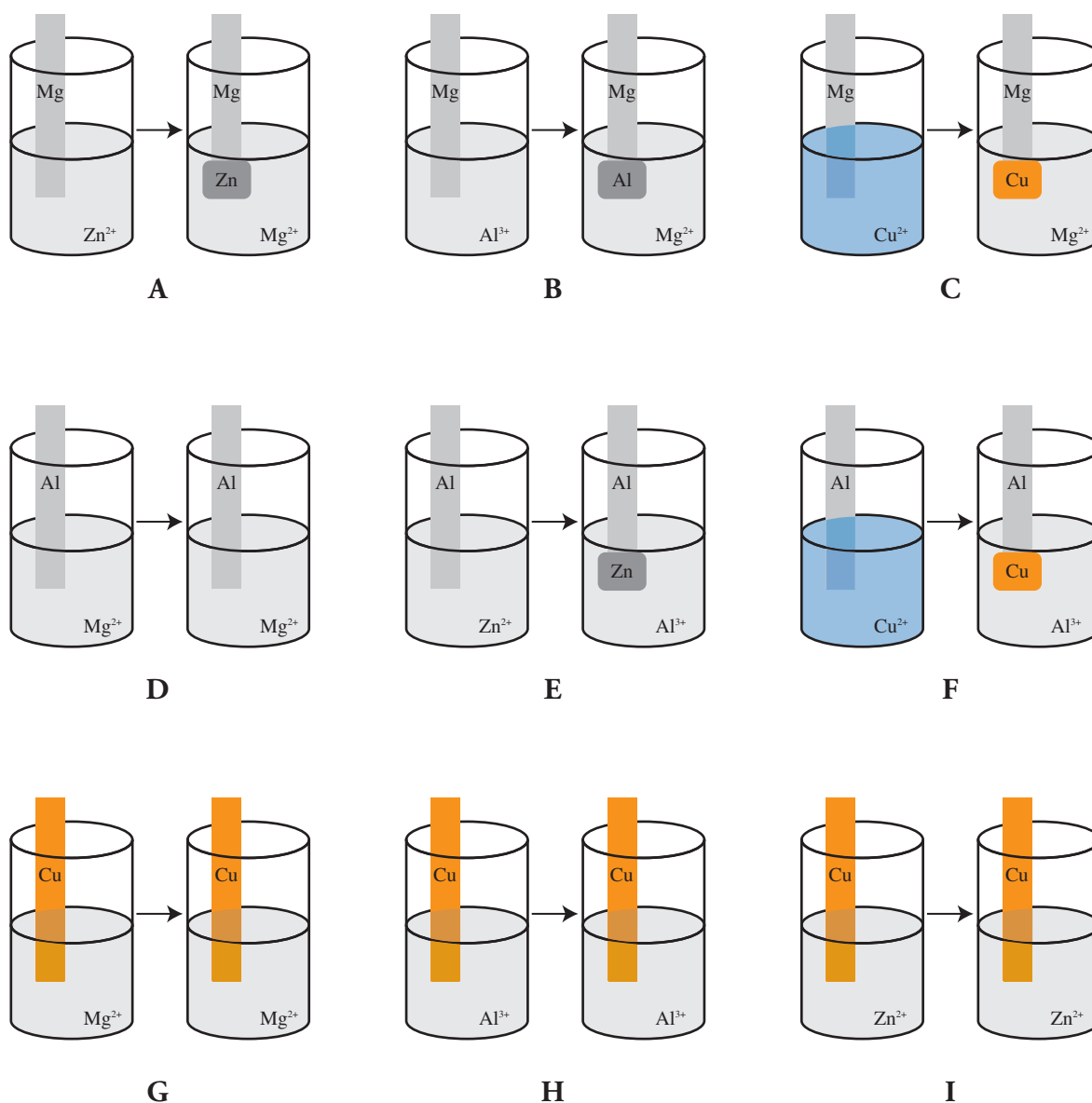
The Activity Series

Which metals lose their electrons more easily?

Why?

One of the chemical properties of metals is that they form cations in chemical reactions. This requires them to lose their electrons, or be oxidized. However, electrons need to go somewhere, so some metals will tend to stay in their neutral state. Which metals are better at making cations and which are better staying neutral? That is the question we will explore in this activity.

Model 1 – Reactivity of Metals



Note: Water molecules and spectator ions have been left out of these diagrams for ease of analysis.

1. Which ions, sodium (Na^+) or nitrate (NO_3^-), are more likely to be the missing “spectator ions” in the beakers of Model 1? Explain your reasoning.
2. Examine the diagrams in Model 1.
 - a. List two pieces of evidence from Experiment A in Model 1 that indicate a reaction has occurred.
 - b. List two pieces of evidence from Experiment G in Model 1 that indicate no reaction occurred.
3. Circle the letter below each experiment in Model 1 that resulted in a reaction.
 - a. Write a single replacement reaction under the beakers in each experiment to illustrate the reaction. Ignore the spectator ions.
 - b. Circle the species in each of the reactant beakers that underwent oxidation.
 - c. Draw an arrow from one species in each of the reactant beakers to another species in the reactant beaker to show how the electrons were transferred in the reaction.
4. Find the two experiments in Model 1 that involve aluminum and magnesium.
 - a. Will aluminum give its electrons to magnesium?
 - b. Will magnesium give its electrons to aluminum?
 - c. Which metal, aluminum or magnesium, is better at giving up electrons?
5. Find the two experiments in Model 1 that involve aluminum and copper.
 - a. Will aluminum give its electrons to copper?
 - b. Will copper give its electrons to aluminum?
 - c. Which metal, aluminum or copper, is better at giving up electrons?
6. Predict what might happen if you put a piece of metal in a solution of its own ion (copper metal in a Cu^{2+} solution or magnesium metal in a Mg^{2+} solution).





7. An **active metal** readily gives up its electron(s) and is oxidized. There are four metals involved in the reactions of Model 1—magnesium, aluminum, copper, and zinc. Rank these metals from “least active” to “most active” based on the data in Model 1. Support your ranking with an explanation.

Least active $\xrightarrow{\hspace{15em}}$ Most active

8. Using your ranking in Question 7, draw a reaction diagram like those in Model 1 for the combinations below to illustrate whether a reaction occurred or not.

a. Zinc metal in Mg^{2+} solution

b. Zinc metal in Cu^{2+} solution

9. In chemistry we say “magnesium ions replace copper ions in solution” when a reaction occurs. Using your ranking in Question 7, determine which of the statements below are true and which are false.

a. Magnesium ions replace aluminum ions in solution.

b. Copper ions replace zinc ions in solution.

c. Zinc ions replace magnesium ions in solution.



Model 2 – The Activity Series

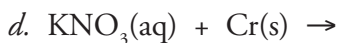
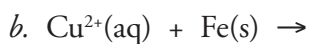
10. The activity series shown in Model 2 to the right is a ranking, similar to the one you did in Question 7, of several metals.

a. Are the more active metals at the top or at the bottom? Explain.

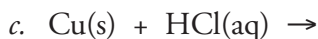
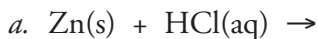
b. Label Model 2 with “most active” and “least active” in the appropriate locations.



11. Use the activity series in Model 2 to predict whether a reaction will occur when the following reactants are mixed.



12. Although hydrogen is not a metal, it is included in the activity series. Consider reactions *a–c* and predict whether the metal shown in each case will react with acid. If the metal will react, complete and balance the equation.



13. In old westerns, we often see a desperate prospector get very excited when he sees a vein of gold in the wall of his mine. It is true that gold, silver, and copper are typically found in nature as metals. On the other hand, potassium, calcium, and magnesium are never found as metals in nature. They are only found as ions dissolved in water (oceans and ground water) or in ionic compounds in rocks (ores). Explain these observations of nature using the ideas of the activity series.

Li
Rb
K
Ba
Ca
Na
Mg
Al
Mn
Zn
Cr
Fe
Co
Ni
Sn
Pb
H
Cu
Ag
Hg
Pt
Au

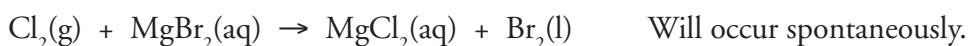
Activity Series of Metals

Extension Questions

14. Plumbers often use a “dielectric union” joint to join pipes of different types. For example copper pipes in a house might need to be joined with lead pipes in the main water supply. The dielectric union is a plastic joint which will not conduct electricity. Propose an explanation for why a copper pipe can't simply be welded directly to a lead pipe.
15. Ships and recreational boats often have large chunks of zinc attached to their hulls in order to prevent corrosion (oxidation) of the metal parts in the hull or engine. The latter are typically made of iron alloys. Explain why zinc is a good metal to use for this purpose.
16. Shown below is an activity series for nonmetals that ranks the ability of different nonmetals to accept electrons in a redox reaction.

(Least active) $P < S < I < Br < O < Cl < F$ (Most active)

The activity of chlorine and iodine, for example, can be compared in the following reactions.



Predict if the combinations of reactants in *a–d* will result in a chemical reaction. If a reaction will occur, complete and balance the equation.

