2.3 The Reactivity of Metals

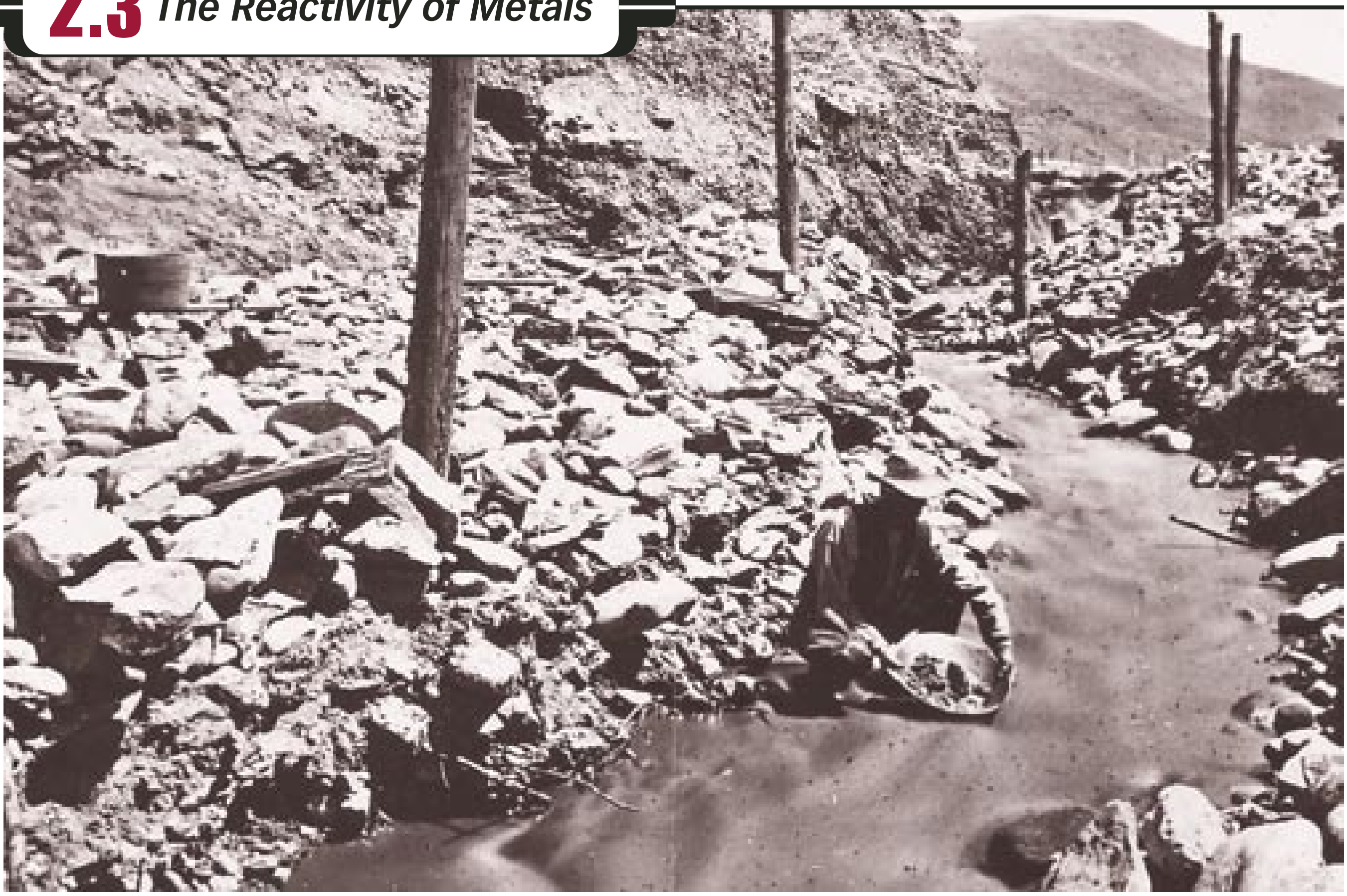


Figure A2.13: Prospectors like this one may have travelled to the Yukon on the Edmonton Overland Trail.

Klondike Gold Rush

In August 1896, gold was discovered in the gravel of a small creek that flowed into the Yukon River. The news of this discovery reached the outside world on July 17, 1897, when the first successful prospectors arrived in Seattle. Within a month, the Klondike Gold Rush had begun. Some historians estimate that over 100 000 people—nicknamed stampeders—participated in this gold rush. Due to the difficulties of travelling through the mountains and the wilderness terrain, only about 30 000 prospectors made it all the way to Dawson City by 1898.

Most prospectors entered the Yukon through the treacherous mountain passes along the border of Alaska. About 2000 people travelled from Edmonton, through Fort Assiniboine, and then on to Peace River Crossing and Fort St. John. This route was called the Edmonton Overland Trail. These people travelled by dogsled in the winter and by pack horses and burros in the summer. During this time Edmonton prospered as an essential supply base and outfitting centre.

The Unique Properties of Gold

Clearly, the prospectors stampeding toward the Yukon were willing to risk all that they owned and even their very lives to strike it rich. Even relatively small amounts of gold can make a person very wealthy. The price of gold can fluctuate. In December of 2005, a small coffee cup filled with fine grains of gold would have been worth over $80 000. What makes gold such a valuable metal? Although gold has an attractive appearance, it is the physical and chemical properties of gold that make it a precious metal.

Figure A2.14: Panning for gold is still a hobby for many people today.

Figure A2.15: Gold has been used for many purposes throughout history.

Gold is the most malleable and ductile metal known. The fact that gold is soft means that it can be easily hammered and stretched into desired shapes. This makes gold ideally suited for making jewellery and other elaborate and intricate objects.

DID YOU KNOW?

A gram of gold can be beaten into a sheet that is 1 m by 1 m, or it can be stretched into an ultrathin wire—thinner than a human hair—that is 3.5 km long.

Unlike metals such as iron and copper, gold does not readily react with other elements. Gold is a very stable metal. Because gold atoms have a strong tendency to keep their electrons, objects made from gold do not tarnish or undergo **corrosion**. At the atomic level, a metal corrodes as its atoms are being oxidized to form metal ions.

Gold is so stable that it can resist the action of most strong acids. From a chemical point of view, gold is almost indestructible. It can be used and reused for centuries.

corrosion: the oxidation of a metal

These properties alone do not totally explain why gold is a precious metal. Another factor to consider is that gold is quite rare. It has been estimated that all the gold in the world that has ever been refined could form a single cube with each side measuring 20 m.

Practice

22. In nature, gold is almost always found as tiny particles that are mixed with stream-bed deposits of sand and gravel. These particles are usually 85% to 95% pure gold.

- **a.** Explain why gold is rarely found in nature in ores where it is combined with other elements.
- **b.** Explain how the tendency of gold to not react with other substances would be helpful to a prospector looking for particles of gold in a stream bed.

23. Gold has been used to make coins for over 2500 years. Identify the properties of gold that make it suitable as a raw material for coins.

Figure A2.16: Long ago, gold was commonly used for currency.

Investigating the Reactivity of Metals

If gold is one of the least reactive metals, which metals are the most reactive? Is there a way to compare the reactivity of one metal relative to another? In the next investigation you will have an opportunity to compare the reactivity of a few metals and their corresponding metal ions in solution.

Investigation

Ranking the Reactivity of Metals and Metal Ions

Purpose

You will collect data to rank the reactivity of copper, zinc, and silver metal. You will also have an opportunity to rank the reactivity of copper ions, zinc ions, and silver ions in solutions.

Science Skills
✓ Performing and Recording
✓ Analyzing and Interpreting

Materials

- small strip of copper
- small strip of zinc
- small strip of silver
- 3, 50-mL beakers
- 20.0 mL of 0.100-mol/L copper(II) sulfate solution, $CuSO_4(aq)$
- 20.0 mL of 0.100-mol/L silver nitrate solution, $AgNO_3(aq)$
- 20.0 mL of 0.100-mol/L zinc nitrate solution, $Zn(NO_3)_2(aq)$
- wax pencil
- several sheets of paper towel
- steel wool

CAUTION!
Use gloves, safety glasses, and a lab apron for this investigation.

Procedure

step 1: Take a strip of copper, zinc, and silver and place each one on a tabletop. Label each strip with the wax pencil.

step 2: Pour 20.0 mL of 0.100-mol/L copper(II) sulfate solution into a 50.0-mL beaker. Label the beaker $Cu^{2+}(aq)$.

step 3: Pour 20.0 mL of 0.100-mol/L silver nitrate solution into a 50.0-mL beaker. Label the beaker $Ag^{+}(aq)$.

step 4: Pour 20.0 mL of 0.100-mol/L zinc nitrate solution into a 50.0-mL beaker. Label the beaker $Zn^{2+}(aq)$.

step 5: Copy the following table into your notebook.

Metal	Solution		
	$Cu^{2+}(aq)$	$Zn^{2+}(aq)$	$Ag^{+}(aq)$
copper			
zinc			
silver			

step 6: Place the copper strip into the $Cu^{2+}(aq)$ solution for 30.0 s.

step 7: Remove the copper strip from the solution, and wipe it dry with a clean paper towel.

step 8: Look for a precipitate on the copper strip and the paper towel—evidence that a chemical change occurred while the strip was in the solution.

step 9: If you see evidence of a chemical change, enter “reaction” in the table. If you do not see evidence of a chemical reaction, enter “no reaction.”

step 10: Remove any residue from the copper strip with steel wool. Wipe clean with a paper towel.

step 11: Repeat steps 6 to 10 by placing the copper strip into the other two solutions.

step 12: Repeat steps 6 to 11 for the zinc and the silver.

step 13: Clean the equipment, and dispose of the waste materials as directed by your teacher.

Analysis

1. According to your observations, list the metals from least reactive to most reactive.
2. According to your observations, prepare a list of the metal ions from least reactive to most reactive.
3. Refer to your answers to questions 1 and 2. Write down any trends you may see with regards to the reactivity of the metal and the reactivity of the metal ion.
4. You need to store a solution that contains copper ions, $Cu^{2+}(aq)$, and have the choice to store it in a container made up of copper, zinc, or silver. In which container would no reaction occur between the copper ions in the solution and the metal atoms of the container? Explain why a reaction between the container and its contents is not desirable.

Comparing the Reactivity of Metals and Metal Ions

One of the properties that makes gold a precious metal is that it tends to not participate in chemical reactions. The data collected from the activity you just completed indicates that silver, too, is not chemically reactive. At the atomic level, chemical reactions occur when electrons are exchanged. Since gold and silver atoms tend to not be chemically reactive, these atoms must not readily lose their electrons to become metal ions. By holding on to their electrons, gold and silver tend not to participate in chemical reactions like corrosion. Gold and silver are very stable metals.

Silver ions, $Ag^{+}(aq)$, on the other hand, were the most reactive of the three metal ions tested in the previous investigation. Because of their tendency to react, you can conclude that silver ions must be able to gain electrons and use them in order to increase stability.

There is a general trend regarding the reactivity of metals and their metal ions.

The more stable a metal atom is, the more reactive it is as an ion.

This trend makes sense because atomic species naturally move to states that have greater stability. If the metallic atom is more stable than a nearby metallic ion, the ions will tend to react to gain electrons and become metal atoms.

Figure A2.17: Iron readily corrodes if it isn't sufficiently protected from the environment.

Is it possible for a metal to be more stable in its ionic form than in its uncharged form? If this were the case, the metallic atom would readily oxidize and easily undergo corrosion. One particular metal, iron, exemplifies this trend in stability. Unless protected, iron readily corrodes. It is estimated that 20% of the iron produced each year is used to replace existing iron that has undergone corrosion!

In the previous investigation, which of the three metals tested was the most reactive? Does the reactivity of this metal suggest that it is also more stable in its ionic form? Does the data you collected support this? Your observations should support a second general trend.

The more stable a metal ion is, the more reactive it is as a metal.

Practice

24. For headphones to reproduce great sound, a good contact must be made between the headphone jack and the source of the tunes—whether it be your stereo or MP3 player. Many manufacturers use a thin coating of gold on the end of the headphone jack to improve the electrical connection between the devices.

Figure A2.18: A thin layer of gold is often used in headphone jacks to improve the electrical connection.

a. Iron is a reasonably good conductor, and it is much cheaper than gold. Explain why iron would be a poor choice as the material to construct headphone jacks? Refer to the stability of iron atoms and iron ions in your answer.

b. The three metals that are the best conductors of electricity are silver, copper, and gold, in that order. Even though copper and silver are better conductors than gold, they have some significant disadvantages. Explain the disadvantages of these conductors compared to gold.

25. State the relationship that exists between the reactivity of a metal and the reactivity of its metal ion.

Ordering Reactivity: The Activity Series

Remember the general rules that govern the reactivity of metal atoms and their metallic ions:

The more stable a metal atom is, the more reactive it is as an ion.
The more stable a metal ion is, the more reactive it is as a metal.

If you create a list that organizes metal ions from most reactive to least reactive, you end up creating a list that organizes metal atoms from least reactive to most reactive. Refer to the following table.

Metal Ions		Metals	
Reactivity in Solutions	Metal Ion	Metal	Reactivity in Solutions
most reactive	$Ag^{+}(aq)$	Ag(s)	least reactive
⋮	$Cu^{2+}(aq)$	Cu(s)	⋮
least reactive	$Zn^{2+}(aq)$	Zn(s)	most reactive

This table can be adjusted to show that gaining electrons changes the metal ions to their other form. The resulting table is a table of reduction half-reactions based on the reactivity of the atoms or ions, or an **activity series**.

activity series: a list of substances in order of reactivity with one another

Metal Ions		Half-Reaction	Metals	
Reactivity in Solutions	Metal Ion		Metal	Reactivity in Solutions
most reactive	$Ag^{+}(aq)$	$+ 1e^{-} \rightarrow$	Ag(s)	least reactive
⋮	$Cu^{2+}(aq)$	$+ 2e^{-} \rightarrow$	Cu(s)	⋮
least reactive	$Zn^{2+}(aq)$	$+ 2e^{-} \rightarrow$	Zn(s)	most reactive

This comprehensive listing of metals based on their reactivity also appears on page 556 and in the Science Data Booklet.

Activity Series for Metals and Metal Ions

Reactions Read as Reductions →

most reactive metal ion on the list → Au^{3+} (aq)

most stable metal atom on the list → Au(s)

Reduction Half-Reaction				
Au^{3+} (aq)	+	$3e^{-}$	→	Au(s)
$Hg^{2+}(aq)$	+	$2e^{-}$	→	Hg(l)
$Ag^{+}(aq)$	+	e^{-}	→	Ag(s)
$Cu^{2+}(aq)$	+	$2e^{-}$	→	Cu(s)
$2\ H^{+}(aq)$	+	$2e^{-}$	→	$H_2(g)$
$Pb^{2+}(aq)$	+	$2e^{-}$	→	Pb(s)
$Sn^{2+}(aq)$	+	$2e^{-}$	→	Sn(s)
$Ni^{2+}(aq)$	+	$2e^{-}$	→	Ni(s)
$Cd^{2+}(aq)$	+	$2e^{-}$	→	Cd(s)
$Fe^{2+}(aq)$	+	$2e^{-}$	→	Fe(s)
$Zn^{2+}(aq)$	+	$2e^{-}$	→	Zn(s)
$Cr^{2+}(aq)$	+	$2e^{-}$	→	Cr(s)
$Al^{3+}(aq)$	+	$3e^{-}$	→	Al(s)
$Mg^{2+}(aq)$	+	$2e^{-}$	→	Mg(s)
$Na^{+}(aq)$	+	e^{-}	→	Na(s)
$Ca^{2+}(aq)$	+	$2e^{-}$	→	Ca(s)
$Li^{+}(aq)$	+	e^{-}	→	Li(s)

most stable metal ion on the list → $Li^{+}(aq)$

most reactive metal atom on the list → Li(s)

← Reactions Read as Oxidations

DID YOU KNOW?

Lithium is used in the rechargeable batteries found in many MP3 players. Lithium is used because of its low molar mass and because the oxidation of lithium is such a strong reaction.

Using the Activity Series

The activity series for metals and metal ions is a valuable tool that can be used in a number of different ways. Like any other tool, it works best if you understand all of its features.

Comparing the Relative Reactivity of Metal Ions—Using the Left Side

According to the listing on the left side of the activity series, the $Cu^{2+}(aq)$ ion is more reactive than the $Zn^{2+}(aq)$ ion. This is indicated by the $Cu^{2+}(aq)$ ion appearing above the $Zn^{2+}(aq)$ ion in the series. This is consistent with the results of the investigation on page 78, as is the placement of $Ag^{+}(aq)$, which appears above the other two ions. The ranking of the reactivity of metal ions is shown on the left-hand side of this table, with the most reactive metal ions placed above the least reactive metal ions.

Comparing the Relative Reactivity of Metals—Using the Right Side

The right side of the series lists the metals in ascending order of reactivity. Metals that appear lower in the series are more reactive than those listed higher in the series. For example, copper metal, Cu(s), is more reactive than silver, Ag(s), and less reactive than zinc, Zn(s). Again, this matches the observations in the investigation on page 78.

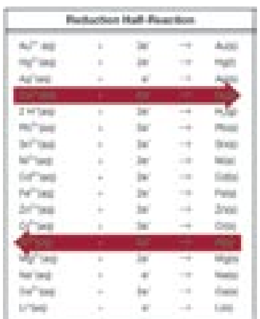
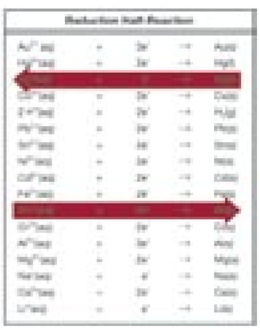
Determining Whether a Reaction will Occur—Using the Half-Reactions

Perhaps the most useful feature of this table is in determining whether a reaction will occur between a metal and a metal ion in solution. A reaction that occurs without the addition of external energy is called a **spontaneous reaction**. You witnessed a spontaneous reaction in the investigation on page 78 when you placed a strip of zinc metal in the solution containing silver ions. You also observed cases where no reaction occurred (when a strip of silver metal was placed in a solution of zinc ions). These reactions are called **non-spontaneous reactions**.

spontaneous reaction: a chemical reaction that occurs without the addition of external energy

non-spontaneous reaction: a chemical reaction that does not occur without the addition of external energy

How is the activity series able to make these predictions? The left side of this series compares the ability of metal ions to gain electrons—the stronger reduction reactions are written nearer the top of the series. The right side of this series compares the ability of metal atoms to donate electrons—the stronger oxidation reactions are written closer to the bottom of the series. So, a spontaneous reaction will occur if a metal ion has a stronger tendency to gain electrons than a metal atom. In this case, the reduction half-reaction for the ion is found closer to the top of the chart. Since reduction cannot occur without oxidation, the metal atom must have a stronger tendency to lose electrons than the metal ion. In this case, the oxidation half-reaction for the metal is found closer to the bottom of the series. Refer to the following table.

Type of Reaction	Activity Series	Position of Half-Reactions	Description
spontaneous		The reduction half-reaction is written above the oxidation half-reaction.	• A stronger tendency to gain electrons (reduction) is combined with a stronger tendency to donate electrons (oxidation). • Electrons are transferred. • A reaction occurs.
non-spontaneous		The oxidation half-reaction is written above the reduction half-reaction.	• A weaker tendency to donate electrons (oxidation) is combined with a weaker tendency to gain electrons (reduction). • Electrons are not transferred. • No reaction occurs.

Example Problem 2.4

A piece of zinc metal is placed in a solution containing $Cu^{2+}(aq)$.

a. Write the reduction and oxidation half-reactions that describe this situation.

b. Locate these half-reactions on the activity series for metals and metal ions. Determine whether the reaction will be spontaneous. Concisely describe what you might observe.

Solution

a. **Reduction half-reaction:** $Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$

Oxidation half-reaction: $Zn(s) \rightarrow Zn^{2+}(aq) + 2e^-$

b. Because the reduction half-reaction is above the oxidation half-reaction, the reaction will be spontaneous. Copper ions would precipitate out of the solution as copper metal, and the zinc metal would enter the solution in the form of zinc ions. A precipitate would be visible, and the solution would start to change colour.

Example Problem 2.5

A piece of gold jewellery is dipped into an acid solution containing $H^+(aq)$.

a. Write the reduction and oxidation half-reactions that describe this situation.

b. Locate these half-reactions on the activity series for metals and metal ions. Determine whether the reaction will be spontaneous. Concisely describe what you might observe.

Solution

a. **Reduction half-reaction:** $2\ H^+(aq) + 2e^- \rightarrow H_2(g)$

Oxidation half-reaction: $Au(s) \rightarrow Au^{3+}(aq) + 3e^-$

b. Because the oxidation half-reaction is above the reduction half-reaction, the overall reaction would be non-spontaneous. There is no transfer of electrons and, thus, no evidence of chemical change. No precipitate will form, and the solution will not change colour.

Practice

26. Describe how you would construct an activity series from data collected during an experiment where a variety of metals were combined with acids.

27. Explain the uses of activity series.

28. Use the activity series to organize the following ions in order of most reactive to most stable.

$Mg^{2+}(aq)$, $Ni^{2+}(aq)$, $Sn^{2+}(aq)$, $Li^+(aq)$, $Cr^{2+}(aq)$, $Ag^+(aq)$

29. Use the activity series to organize the following metals in order of most reactive to most stable.

Cu(s), Zn(s), Cd(s), Sn(s), Pb(s), Fe(s), Ca(s)

30. Copy the following table into your notebook or into a spreadsheet. You will need to add more rows.

Reduction Half-Reaction	Oxidation Half-Reaction	Half-Reaction That First Appears in Activity Series	Reaction Type

Complete the table for each of the following situations.

a. A brick of gold is placed into a silver nitrate solution.
b. A piece of iron is placed into a copper(II) sulfate solution.
c. A piece of zinc is placed into a solution of sodium chloride.
d. An aluminium fishing boat is floating on a lake with a very high concentration of iron(II) ions.
e. A piece of nickel metal is placed into a lead(II) nitrate solution.
f. Acid, containing hydrogen ions, falls onto some iron metal.
g. A piece of silver is placed into a solution of zinc nitrate.
h. Bubbles of hydrogen pass through a solution of gold(III) nitrate.
i. Water that is contaminated with mercury(II) ions is placed in a zinc container.

Oxidizing and Reducing Agents

As you have seen, oxidation and reduction always occur together. This is because if one substance is going to gain electrons, another must lose electrons. As an example, consider the following equation:

$$Zn(s) + 2\ AgNO_3(aq) \rightarrow Zn(NO_3)_2(aq) + 2\ Ag(s)$$

In this reaction, silver gains electrons and the zinc loses them. In other words, the zinc acts as a **reducing agent** because it promotes the reduction of the silver nitrate. Notice that the reducing agent—zinc—lost electrons. So, the reducing agent is oxidized. Some students find this confusing. Focus on the word *agent*. Just as a travel agent makes it possible for other people to travel, a reducing agent makes it possible for something else to be reduced.

reducing agent: a substance that makes the reduction process possible by losing electrons

oxidizing agent: a substance that makes the oxidation process possible by gaining electrons

Similar thinking can be applied to the process of oxidation. In the previous balanced chemical equation, silver nitrate is the **oxidizing agent** because it promotes the oxidation of the zinc. Again, focus on the word *agent* to remind you that the term is describing what the substance does. Since the oxidizing agent—silver nitrate—is gaining electrons, it is being reduced.

Practice

31. The following reaction describes the process of removing silver tarnish, $Ag_2S(s)$, by soaking the item in a hot baking-soda solution in which the container is lined with aluminium foil.

$$3\ Ag_2S(s) + 2\ Al(s) + 3\ H_2O(l) \rightarrow 6\ Ag(s) + Al_2O_3(s) + 3\ H_2S(aq)$$

The baking soda acts to remove impurities on the surface of the aluminium foil and to improve the conductivity of the solution.

a. Identify the substance that is oxidized. Copy the oxidation half-reaction shown on the activity series for this substance to support your answer.
b. Identify the substance that is reduced. Copy the reduction half-reaction shown on the activity series for this substance to support your answer.
c. Refer to the activity series for metals and metal ions. Explain why this is a spontaneous reaction.
d. Identify the oxidizing agent in this reaction.
e. Identify the reducing agent in this reaction.

32. Refer to the activity series for metal and metal ions on page 556.

a. Explain why lithium metal, Li(s), is the strongest reducing agent in the table.
b. Explain why the gold ion, $Au^{3+}(aq)$, is the strongest oxidizing agent in the table.

Investigation

Planning an Experiment Using the Activity Series

Science Skills

✓ Initiating and Planning

It is time for you to be the scientist and design an experiment to further investigate the theory used to construct the activity series.

Purpose

Locate the hydrogen ion in the activity series, and design an investigation that will allow you to test the accuracy of the position of four metals in the activity series relative to hydrogen. For each of the four metals you select, the source of hydrogen ions is a solution of hydrochloric acid. In this test, the evidence of a spontaneous reaction would be the production of a gas (hydrogen), as indicated by bubbling and the disappearance of the metal. A temperature change may also be detected.

Pre-Lab Analysis

1. Concisely describe the circumstances that would allow a spontaneous reaction to occur between the hydrogen ions and one of the metals used in your experiment. Refer to electron transfer and to the terms *oxidation* and *reduction* in your answer.
2. Write the reduction and oxidation half-reactions that describe a spontaneous reaction in this experiment. Use the symbol M(s) to represent one of the metals in the experiment. Assume this metal produces ions with a charge of 2+, represented by the symbol M^{2+}(aq).

Prediction

3. Generate two predictions about which metals in the activity series would spontaneously react with the hydrogen ions and which would not spontaneously react.

Procedure

4. Outline a simple procedure that would allow you to test the predictions in question 3.
5. Describe the safety procedures that should be followed throughout this investigation.

Gold—From Jewellery to High Technology

Consider what you have learned about gold thus far:

- Gold is the least chemically reactive metal in the activity series for metals and metal ions.
- Gold is an excellent conductor that can be stretched into tiny wires that are smaller in diameter than a human hair.

These facts have made gold even more precious than it was before because now, in addition to the jewellery trade, gold has become an essential element for high-tech industries. In personal computers, gold plays a vital role in forming the microthin wires that connect components on a motherboard. Gold is used in the contacts beneath the keys of most computer keyboards and in the contacts at the end of cables that connect external devices, like printers. Because gold does not degrade over time and because it is an excellent conductor, gold is now an essential industrial metal.

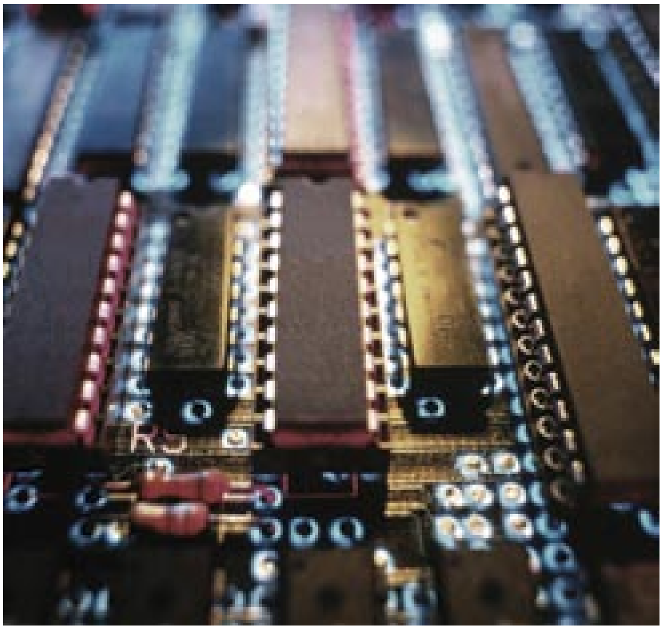


Figure A2.19: Bonding wire is 99.999% pure gold. It is used to connect computer chips to other components.

As high-tech electronics industries continue to grow, the worldwide demand for gold as an industrial metal will increase as well. In 2001, it is estimated that the world used approximately 200 t (tonnes) of gold for electronic applications. Some experts predict that annual demand may reach 300 t (tonnes) in the near future. Given these trends, it will be essential for all waste electronic equipment to be recycled so that the gold can be recovered.

DID YOU KNOW?

Motorized wheelchairs help provide a control over movement and a sense of independence for people with disabilities. These devices could not operate as reliably without gold. The microprocessor—the brains of the computerized control system—is attached with gold wires and gold-coated connectors. Manufacturers use gold because of its resistance to corrosion and because of its excellent electrical conductivity.

2.3 Summary

Some metal atoms are more stable than others. The more stable a metal atom is, the more reactive it is as a metal ion. The reverse is also true. The more stable a metal ion is, the more reactive it is as a metal.

The activity series for metals and metal ions lists metal ions from most reactive to least reactive and metals from least reactive to most reactive. You can use the activity series to predict whether a reaction between a metal and a metal ion will be spontaneous or non-spontaneous.

2.3 Questions

Knowledge

1. Define each of the following terms, and provide an example.
   - a. metal atom
   - b. metal ion
   - c. activity series
   - d. spontaneous reaction
   - e. non-spontaneous reaction
2. Explain the relationship between the reactivity of a metal atom and the reactivity of its metal ion.
3. Describe three observations that would lead you to conclude that a reaction is spontaneous.
4. Describe three observations that would lead you to conclude that a reaction is non-spontaneous.

Applying Concepts

5. You have been given a contract by an employer to design an inexpensive metal container that will be used to store large amounts of water contaminated with lead(II) ions, $Pb^{2+}(aq)$. The solution will need to be stored for a long period of time. Describe suitable materials required to build this kind of container.
6. Describe the properties that make gold such a precious metal to society.
7. Use the activity series to explain why silver is a precious metal, but not as precious as gold.

Photo Credits and Acknowledgements

All photographs, illustrations, and text contained in this book have been created by or for Alberta Education, unless noted herein or elsewhere in this Science 20 textbook.

Alberta Education wishes to thank the following rights holders for granting permission to incorporate their works into this textbook. Every effort has been made to identify and acknowledge the appropriate rights holder for each third-party work. Please notify Alberta Education of any errors or omissions so that corrective action may be taken.

Legend: t = top, m = middle, b = bottom, l = left, r = right

76 (t) U.S.G.S. (b) © 2006 Jupiterimages Corporation **77** (all) © 2006 Jupiterimages Corporation **79** (l) © 2006 Jupiterimages Corporation **82** (earring) © 2006 Jupiterimages Corporation **84** Photodisc/Getty Images **85** © 2006 Jupiterimages Corporation