

Acid-Base & Redox Reactions

(Chapter 18)

Student Learning Outcome: Classify acids and bases, recall the properties and environmental effects of acid rain, describe the process of oxidation/reduction reactions and applications, and restate the process of electrolysis and applications.

1. *What is an acid? What is a base?*
2. *How is the relative strength of an acid or base determined?*
3. *What does pH balanced mean?*
4. *What is “acid rain”?*
5. *What is a redox reaction?*
6. *How do batteries and fuel cells work?*
7. *What is electrolysis?*
8. *What is the redox process in corrosion and combustion?*

What is an acid? What is a base?

- ❖ Acids contain a relatively high number of H^+ and H_3O^+ ions, and are substances that donate hydrogen ions.

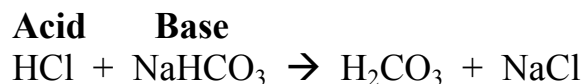
Proton Donor

- ❖ Bases contain a relatively high number of hydroxide (OH^-) ions, or are substances that accept a hydrogen ions.

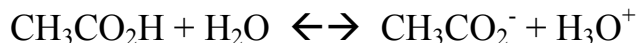
Proton Acceptor

- ❖ Substances that do not contain OH^- can act like bases.

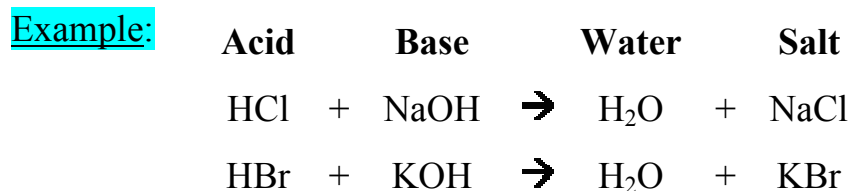
Example: Baking soda (NaHCO_3)



Question: Which is the acid? Which is the base?



- ❖ The neutralization reaction of an acid and a base will always produce water and a salt (an ionic bond).



How is the relative strength of an acid or base determined?

- ❖ Strength depends on ionization.
- ❖ **Strong acids completely ionize in water** (always donate a proton)
 - ✚ HNO₃ - nitric acid
 - ✚ HCl - hydrochloric acid
 - ✚ H₂SO₄ - sulfuric acid
- ❖ **Strong bases completely ionize in water** (always donate an OH⁻ ion)
 - ✚ LiOH - lithium hydroxide
 - ✚ NaOH - sodium hydroxide (lye)
 - ✚ KOH - potassium hydroxide (lye)

Go To: http://www.wisc-online.com/objects/index_tj.asp?objID=GCH6204

- ❖ The relative number of H⁺ and OH⁻ ions in a solution determines whether a solution is acidic, basic, or neutral.
 - Acidic: more H₃O⁺ than OH⁻ ions.
 - Basic: more OH⁻ than H₃O⁺ ions.
 - Neutral: equal concentrations of H₃O⁺ and OH⁻ ions

What does pH balanced mean?

- ❖ pH stands for “Power of Hydrogen”
- ❖ A substance that is truly pH balanced has an equal number of acid and base ions; it is neutral.

pH	Solution
1 to 6	Acidic
7	Neutral
8 to 14	Basic

Question: If the water you drink has a pH of 6.8, is it acidic, basic, or neutral?

Some Common Substances

Substance	pH
Battery Acid	0.5
Stomach acid	1.5 – 2.0
Cola	2.5
Orange Juice	3.5
Beer	4.5
Coffee	5.0
Hair and Skin	5.5
Milk	6.5
Human blood	7.34 – 7.45
Hand soap	9.0 – 10.0
Ammonia	11.5
Bleach	12.5

❖ Blood has buffers to help control the natural pH your body needs.

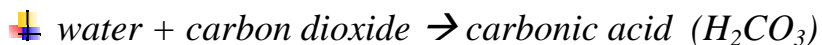
Questions:

1. There are actually two reasons it is not a good idea to mix bleach and ammonia to clean your bathroom. What are these reasons?

2. What do you think can change the pH of blood?

What is “acid rain”?

- ❖ Acid rain is rain, snow, sleet, or fog with more than the normal level of acidity.
- ❖ Rainwater is naturally acidic with a pH of **5.6 to 6.2**.
- ❖ **Acid Rain** is rain that has a pH of less than 5.
- ❖ Water naturally reacts with CO₂ in the atmosphere, forming a weak acid.



Question: Where would you expect a higher level of acidity in the atmosphere, Wyoming or California? Why?

❖ **Living near an ocean can decrease the acidity in rainwater.**

➤ Oceans are basic and absorb CO_2

❖ In areas where the weather is dry, acids may combine with dust and smoke and fall to the ground. This is called **dry deposition**.

➤ About half of the acidity in the atmosphere falls back to earth through dry deposition.

❖ Human-produced exhaust emissions of sulfur and nitrogen oxides can lower the pH to between 4.0 and 5.5!

⚡ sulfates + water \rightarrow sulfuric acid (H_2SO_4)

⚡ nitrates + water \rightarrow nitric acid (HNO_3)

❖ Acid rain is harmful to plants, animals, and people.

Question: It what ways is acid rain harmful to plants, animals, and people?

Go To: http://epa.gov/acidrain/effects/surface_water.html#a1 (half way down)
<http://www.sciencephoto.com/media/183674/enlarge>
<http://science.howstuffworks.com/nature/climate-weather/atmospheric/acid-rain2.htm>

What is a redox reaction?

❖ **Redox reactions involve a transfer of electrons, and often the addition or subtraction of oxygen.**

❖ In **oxidation**, a reactant **loses electrons**.

➤ Oxygen is added.

❖ In **reduction**, a reactant **gains electrons**.

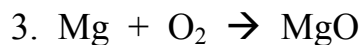
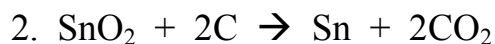
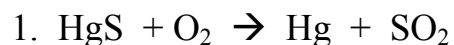
➤ Oxygen is removed.

❖ The two processes, oxidation and reduction, always occur simultaneously.

➤ One substance loses electron (oxidation)

➤ One substance gains electrons (reduction)

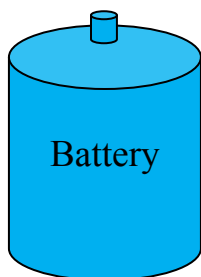
Question: Which reactants are oxidized and which are reduced?



How do batteries and fuel cells work?

❖ Batteries have 2 diodes; one that is oxidized and one that is reduced.

- Redox reactions in an acidic solution free electrons.
- Electrons are lost at one diode, flow through a system, and then are gained at the other diode.



anode	cathode
Material is oxidized	Material is reduced
Material loses electrons	Material gains electrons
Negative	Positive
Electrons flow away	Electrons attracted

Questions:

1. Why do dry cell batteries have the shorter shelf life?
2. Where do you store your batteries? Why?
3. What type of battery is in your cell phone?

❖ **A fuel cell contains two reactants in separate reservoirs that convert chemical energy to electrical energy when combined.**

- Hydrogen gas is oxidized.
- Oxygen gas is reduced.
- The waste product is pure water vapor.

Go To: <http://www.youtube.com/watch?v=yowRvfFtMgQ&feature=related>
<http://www.youtube.com/watch?v=esuAIB4NVi0>

Question: What is the basic difference between a battery and a fuel cell?

What is electrolysis?

❖ **Electrolysis is the use of electric current to cause chemical change.**

- Electric energy is added to a substance.
- The result is a chemical change.

Go To: <http://www.youtube.com/watch?v=OTEX38bQ-2w>

Example: Extracting metals from ores. $\text{Al}_2\text{O}_3 \rightarrow \text{Al}_2 + \text{O}_2$

Questions:

1. What are the coefficients needed to balance the chemical equation in the example?
2. Why do metals have a tendency to combine with oxygen?

❖ **Electric current can be used to force chemical reactions to reverse.**

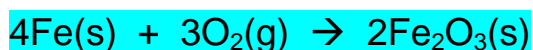
Questions:

1. How do you recharge your cell phone battery?
2. Why do you think cell phone batteries can only be recharged a certain number of times?
3. Which lasts longer, a new car battery or a recharged car battery? Why?

What is the redox process in corrosion and combustion?

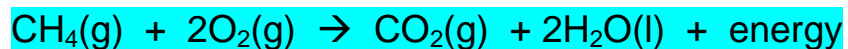
❖ **Corrosion is a redox reaction between a metal and oxygen (O_2).**

❖ When iron combines with oxygen from the atmosphere, the result is “rust”.



Question: Is the iron oxidized or reduced?

- ❖ **Combustion is a redox reaction between a non-metal and oxygen (O₂).**
- ❖ Instead of a transfer of electrons, there is a re-positioning of electrons in the chemical bonds.



- ❖ Combustion reactions are exothermic!

Go To: http://www.youtube.com/watch?v=UygUcMkRy_c