TITLE: Conductors and Non-conductors

The purpose of this lab is

- **Observe conductivity in a variety of substances**
- **Observe the difference of conductivity in strong, weak, and non-electrolytes using an LED lightbulb and battery**
- **Observe the reactivity of compounds with different conductivities.**
- **Observe how different states of matter effect the conductivity of ionic compounds**
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Reference:

(1) Kateley, L. J., *Introduction to Chemistry in the Laboratory*, *20th Ed.*, Lake Forest College, **2021,** Experiment 3.

Observations and Data:

Demo One: Melting Salt KClO3

- $KClO_4$ – potassium chlorate
  - Conductivity as a solid salt: non-conductive. Ions not mobile.
  - Conductivity as a molten salt: conductive. Ions mobile K+…...
- Orange flame due to burning potassium chlorate

Figure 1. Apparatus for melting $KClO_4$

Conclusion: Mobile ions are needed for conductivity. Liquid ionic salts conduct while ionic solids do not.

Demo Two: Reaction of H_2SO_4(aq) and $Ba(OH)_2$(aq)

- H_2SO_4(aq) -sulfuric acid - strong acid
- $Ba(OH)_2$(aq) - barium hydroxide - strong base

- Mixture turned a dark pink and cloudy – precipitate forming
- Over time the conductivity decreased
- Mixture turned fully white

- Conductivity climbs back up as mixture becomes acidic
- Neutralization of the acid with a base

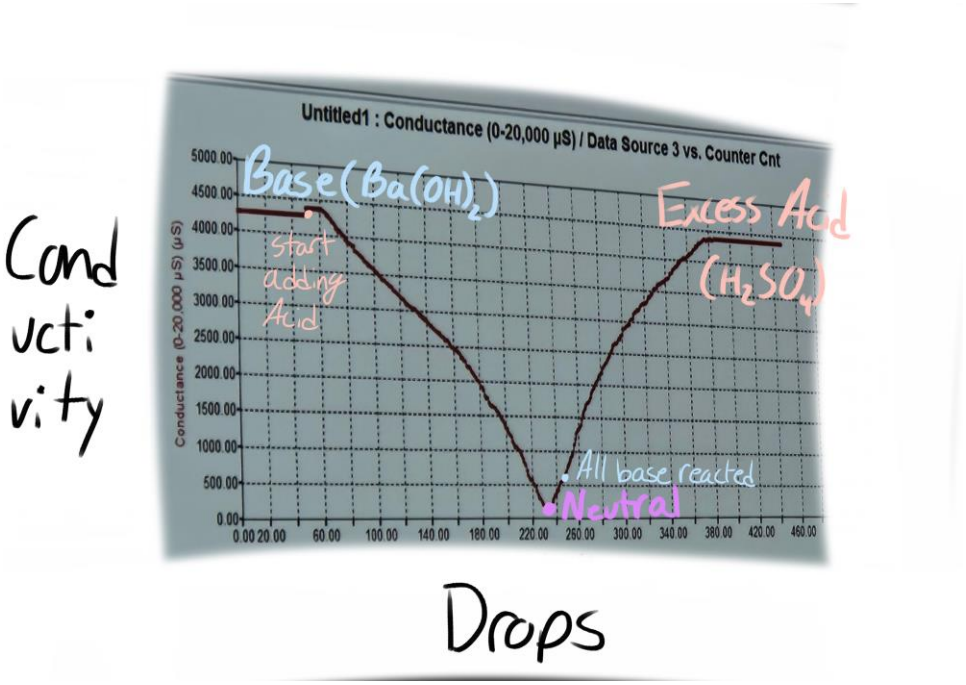

Figure 2. Graph of conductivity of reaction of $H_2SO_4(aq)$ and $Ba(OH)_2(aq)$

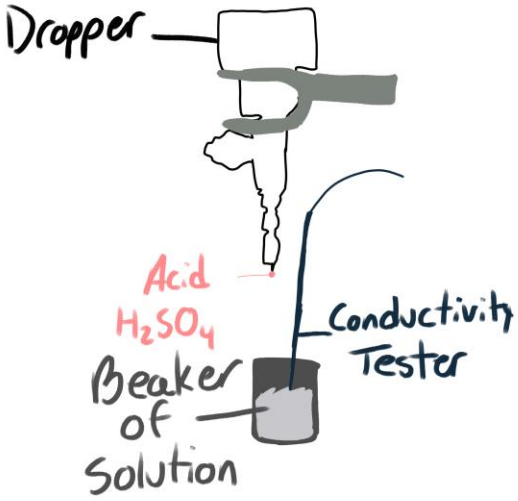

Figure 3. Apparatus for reaction of $H_2SO_4(aq)$ and $Ba(OH)_2(aq)$

Conclusion: Insoluble salts are not conductive even if the reactant that create them are.

Experiment Three: Ionic and Covalent Substances

Substance/Solution	Observations	Strong, weak, or non-conductor	Covalent/Ionic and ionization

Deionized water	Weak light (contamination)	Non-conductor	Covalent and not ionized (H_2O)
0.5M acetic acid	Weak acid Weak light	Weak conductor	Covalent and slightly ionized ($CH_3COO^- + H^+$)
17.4M acetic acid	No light	Non-conductor	Covalent and no ionized (CH_3COOH)
6M HCl	Strong acid Strong light	Strong conductor	Covalent and 100% ionized ($H^+ Cl^- H_2O$)
Aqueous NaCl	Strong light	Strong conductor	Ionic and soluble ($Na^+ Cl^- H_2O$)
95% ethyl alcohol (ethanol)	No light	Non-conductor	Covalent and not ionized ($H_2O\ CH_3CH_2OH$)

- 17.4M acetic acid is less acidic than 0.5M acetic acid because it is oversaturated. Not enough water to break it apart into ions.

Experiment Four: Conductivity and Reactivity of Strong and Weak Acids

H2CO3= H2O CO2

- Marble chips of $CaCO_3$ are white stone.
  - Gas started forming immediately after adding HCl.
  - No reaction with acetic acid
- Mossy zinc is a streaky grey metallic solid.
  - Gas started forming immediately after adding HCl. More bubbling than reaction of HCl and $CaCO_3$
  - No reaction to acetic acid

Acid	Reactant	Conductivity of acid	Reactivity	Reaction equation
6M HCl	$CaCO_3$	Yes, strong conductor	Yes, gas bubbles	$2HCl(aq) + CaCO_3(s) \rightarrow H_2CO_3 + CaCl_2$
6M HCl	Zn	Yes, strong conductor	Yes, gas bubbles	$2HCl(aq) + Zn(s) \rightarrow H_2(g) + ZnCl_2(aq)$
17.4M acetic acid (CH_3COOH)	$CaCO_3$	No, non-conductor	No	N/A
17.4M acetic acid (CH_3COOH)	Zn	No, non-conductor	No	N/A

Figure 4. Reactions
Conclusion: Conductors react with metals while non-conductors do not. There is a correlation between the conductivity of a solution and its reactivity.

Experiment Five: Conductivity and Ionic Reactions

Experiment	Solution/Mixture	Observation	Conductivity	Reaction Equations
5a	0.1M HCl	Strong light	High	$H^+(aq) + Cl^-(aq)$
	0.1M NaOH	Strong light	High	$Na^+(aq) + OH^-(aq)$
	0.1M HCl + 0.1M NaOH	Strong light	High	Molecular: $HCl(aq) + NaOH(aq) \rightarrow H_2O(l) + NaCl(aq)$ Ionic: $H^+(aq) + Cl^-(aq) + Na^+(aq) + OH^-(aq) \rightarrow Cl^-(aq) + Na^+(aq) + H_2O(l)$ Net Ionic: $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$
5b	0.1M CH_3COOH	Weak light	Low	$CH_3COO^- + H^+$
	0.1M NH_3	Weak light	Low	$N^{-3} + 3H^+$
	0.1 CH_3COOH + 0.1M NH_3	Strong Light	High	Molecular: $CH_3COOH(aq) + NH_3(aq) \rightarrow NH_4CH_3OO(aq)$ Ionic: $CH_3COO^-(aq) + H^+(aq) + (aq) \rightarrow NH_4+(aq) + CH_3OO^-(aq)$ Net Ionic: Same as ionic, no spectator ions

Conclusion: The conductivity of reactants does not correlate with the conductivity of the products. Weak conductor reactants can create a strong conductor product, the conductivity could remain unchanged, etc.