

4.6 Conductivity of liquids and solutions

Subject: Conductivity, electrolytes, acids/bases

Description: The conductivity of different solutions and liquids is compared qualitatively using a light bulb conductivity meter. The salinity sensor can be used to get a more quantitative measurement.

Materials:

conductivity meter (device with several orange light bulbs in series or the single bulb apparatus)*

Vernier Salinity Sensor, computer, and interface*

8 100 mL beakers

vinegar‡

ammonia (from grocery store) ‡

sugar‡

isopropyl alcohol‡

DI water‡

tap water

0.1M Hydrochloric acid (HCl)‡

0.1M Sodium hydroxide (NaOH)‡

(other household chemicals including: cleaners, baking soda, etc) ‡

bottle of Gatorade as a prop

*Shared item. Located on the shelf with the bins. The Vernier salinity sensor and interfaces are located in the drawers opposite the bin storage shelves. For instructions see the sensor page on the website or refer to the spec sheet included with the sensor.

‡Alcohol is located in the flammable storage cabinet. HCl and NaOH are located in the cabinets under the hood. Household chemicals are located in the solutions cabinets. The sugar solution should be made and disposed of on the same day.

Pre-class Preparation:

1. Label all beakers to avoid confusion.
2. Pour 50 ml of each solution into the pre-labeled beakers.

Procedure:

1. Plug in conductivity meter.
2. Place the electrodes of the conductivity meter into each of the solutions.
3. Dip the electrodes in DI water in between solutions to clean them (and to demonstrate that DI water doesn't conduct electricity).
4. The intensity of the light(s) will be proportional to the strength of the electrolyte solution.

Discussion:

Solutions of electrolytes conduct electricity by the motions of ions in solution. Hydrochloric acid is a strong acid and sodium hydroxide is a strong base. This means that they dissociate 100% in water into their respective ions. This makes them strong electrolytes and will produce a brighter light because there are more ions in solution.

Vinegar is a weak acid and ammonia is a weak base which means that only a portion of the molecules will dissociate into ions, while some remain as molecules. This makes them weak electrolytes, and they will produce a dimmer light because there are fewer ions in solution.

The sugar solution and isopropyl alcohol are non-electrolytes – there are no ions in solution- and will not produce light at all. Distilled water does not conduct electricity, but since tap water contains some ions it will conduct electricity producing a dim light.

Safety:

Be sure not to touch the electrodes of the conductivity apparatus while plugged in. Hydrochloric acid is corrosive. Sodium hydroxide is caustic. Both can irritate the skin or cause burns. Ammonia can irritate the skin and its vapors can irritate mucous membranes. Acetic acid can irritate skin and its vapors are irritating to the eyes and respiratory system. Use proper protective equipment including gloves and safety glasses.

Disposal:

Be sure solutions are within the proper pH range. These can be flushed down the sink with water.

References:

1. B.Z. Shakhashiri; *Chemical Demonstrations: A Handbook for Teachers of Chemistry*; Wisconsin; Volume 3; p 326-328 (variation)