Conductivity of a Solid

Properties of Solids

Concepts

- Conductivity
- Ionization
- Dissociation

Materials

Potassium hydroxide, KOH, 5 g
Water, distilled or deionized
Alligator cords, 3
Battery, 9V
Candle, 5″ × 1¼″
Demonstration buzzer
Matches
Paperclip, large, 2
Rubber stopper, size 00, one-hole
Rubber stopper, size 1, two-hole
Support stand
Test tube, 16 × 100 mm
Test tube clamp

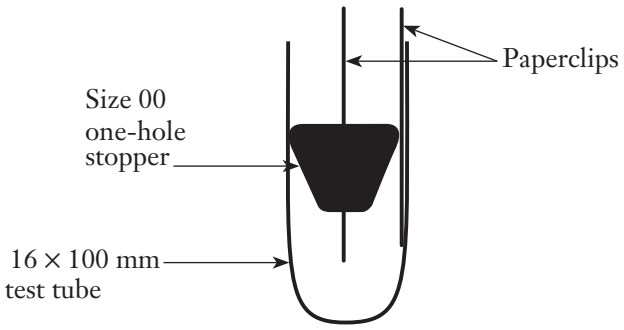
Safety Precautions

Potassium hydroxide in contact with skin results in severe blisters; strongly corrosive as a solid and as a solution; very harmful if swallowed; extremely dangerous to eyes. Wear appropriate face and body protection if making solutions; potassium hydroxide generates large amounts of heat while dissolving. Wear chemical splash goggles, chemical-resistant gloves and a chemical-resistant apron. Wash hands thoroughly with soap and water before leaving the laboratory. Follow all laboratory safety guidelines. Please review current Material Safety Data Sheets for additional safety, handling and disposal information.

Procedure

Part A. Dissociation

1. Place enough potassium hydroxide pellets into a 16 × 100 mm test tube to fill a depth of 2 cm.
2. Use a test tube clamp to attach the test tube to the support stand.
3. Open two large paperclips so they are linear.
4. Insert the first paperclip through the hole of the size 00 one-hole stopper.
5. Gently slide the size 00 one-hole stopper into the test tube with one paperclip through its hole as directed in step 3 and slide the other paperclip into the test tube along side the size 00 stopper. See Figure 1 below.



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6. Insert the size 1, two-hole stopper into the top of the test tube so that each paperclip goes through one of the holes resulting in a paperclip coming out of each of the two holes.
7. Attach one of the alligator cords to the positive terminal of the 9 volt battery and connect the other end to one of the paperclips.
8. Connect the second alligator cord to the second paperclip. Attach the other end to one of the contacts of the demonstration buzzer.
9. Using a third alligator cord, connect the demonstration buzzer to the open end of the 9 volt battery.
10. Light the candle and gently rotate it so that the bottom of the test tube is surrounded by its flame.
11. Observe what happens as the potassium hydroxide begins to melt. *Note:* The buzzer should sound if all the alligator cords are connected correctly.
12. Extinguish the candle and rub the bottom of the test tube with an ice cube. *Note:* The buzzer should no longer sound after approximately 10 seconds.
13. *Optional* Re-light the candle and the buzzer will again sound.

Part B. Ionization

1. Place approximately 3 grams of potassium hydroxide in 100 mL of distilled or deionized water and stir.
2. Remove the paperclips with the alligator cords attached and place them in the KOH solution. *Note:* The leads should not touch.
3. The buzzer should sound indicating that potassium solution is a conductor.

Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures governing the disposal of laboratory wastes. The remaining solid potassium hydroxide as well as the potassium hydroxide solution may be disposed of according to Flinn Suggested Disposal Method #10.

Discussion

Substances that conduct an electric current when dissolved or melted are called *electrolytes*. Electrolytes contain moveable free *ions* (charged atoms or molecules). The moveable ions carry the electric charge through the solution thus creating an electric current. Salt water is an electrolyte because table salt is an ionic compound that dissociates (breaks up into simpler components) in water, forming positively charged sodium ions and negatively charged chloride ions. Other electrolytes include other salt solutions, tap water, and acids and bases such as vinegar and ammonia, respectively. Solutions that do not contain moveable free ions and therefore cannot conduct an electric current are called *non-electrolytes*, e.g., alcohol, distilled water, and sugar water. Sugar is a molecule formed by covalent bonding and does not dissociate in water.

During Part A of this demonstration the potassium hydroxide compound is heated. As the potassium hydroxide molecules are heated the molecule undergoes *dissociation* into K^+ and OH^- ions. The potassium and hydroxide ions are conductors of electricity. During part B both the potassium and hydroxide ions are hydrated by water. When potassium hydroxide and water are combined in a reaction is an example of *ionization*.

The audio conductivity tester is an open circuit with a battery connected to a high-pitched buzzer. When an electrical conductor comes in contact with both electrodes, the circuit is completed and a sound is emitted. The demonstration buzzer is very sensitive to the flow of electrons in a current. In any electric circuit, substances vary in conductivity. Good conductors will produce a high frequency tone, and substances with a lower conductivity will produce a low frequency tone. As the concentration of ions increases in a solution, the current also increases, thus increasing the pitch and volume of the buzzer tone.

Connecting to the National Standards

This laboratory activity relates to the following National Science Education Standards (1996):

Unifying Concepts and Processes: Grades K–12
Evidence, models, and explanation
Content Standards: Grades 5–8
Content Standard B: Physical Science, properties and changes of properties in matter
Content Standards: Grades 9–12
Content Standard B: Physical Science, structure and properties of matter, chemical reactions

References

Conducting Solutions, http://scifun.chem.wisc.edu/homeexpts/CondTester/SolutionConductivity.htm (Accessed December 2008).

Flinn Scientific—Teaching Chemistry™ eLearning Video Series

A video of *Conductivity of a Solid* activity, presented by Irwin Talesnick is available in *Properties of Solids*, part of the Flinn Scientific—Teaching Chemistry eLearning Video Series.

Materials for *Conductivity of a Solid* are available from Flinn Scientific, Inc.

Catalog No.	Description
AP7279	Audio Conductivity Tester—Demonstration Kit
P0058	Potassium Hydroxide, Pellets, 100 g
GP6064	Test Tubes without Rims, 16 5 100 mm
AP2220	Rubber Stoppers, Size 00, 1 Hole
AP2311	Rubber Stoppers, Size 1, 2 Hole
C0192	Candles, Plumbers, Pkg/4
AP6052	Alligator Cords
AP6856	Demonstration Buzzer

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.