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Density of Compact Disks

(Project CLVE: Chemical Laboratories with Video Enhancement)

Submitted by: Mary E. Harris, Polymer Ambassador from Missouri, mharris@jburroughs.org



Purpose: to make an aqueous sodium chloride solution and find its density so that the solution will separate two very similar polymers: polycarbonate from a CD and poly (methyl methacrylate) or Plexiglas.

Hypothesis: If a beaker of pure water has objects in it such that a red object is floating and the blue one is on the bottom while a green one is resting in the middle of the liquid, then one can assume that the relative densities of the three objects are: _____

Background: A compact disc (CD) can store up to seventy-four minutes of music which means it can store the entire *Ninth Symphony* by Beethoven. A CD is 12 cm in diameter in order to accommodate 74 minutes of playing time or more than 783 megabytes of data. The 1.2 mm thick polymer used to make the disc is polycarbonate. (Lexon is a trademark for polycarbonate.) The surface of the plastic is pitted with grooves in a long spiral track that is the stored data. The polycarbonate is covered with a very thin coating (0.1-0.2 micrometers) of aluminum. The bumps in the spiral are read by a laser in the CD player. The CD player has a laser that aims the beam through the polycarbonate layer and reflects off the aluminum layer. The reflection of light off of the bumps is detected by the electronics in the player and read as bits that make up bytes of information. (www.electronics.howstuffworks.com)

The final layer is another polymer called acrylic which is sprayed onto the aluminum surface and then the label is on top of that. Polycarbonate was chosen for the base of the CD because it can withstand high temperatures and humidity without deforming. Any slight imperfection in the plastic disc will lead to distortion when the CD is read. (*Polymer Chemistry*, David Teegarden, 2004)

Materials: (for a pair or students)

- CD (ready for the trash -- with or without a printed label)
- Pliers and heavy scissors for cutting the CD
- Small pieces of Plexiglas

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NaCl (Morton Coarse Kosher Salt)

Tap water

Plastic pipets

Two 100 mL beakers

Balance

10 mL graduated cylinder

Safety goggles

Procedure: Plan your own procedure to accomplish the purpose as stated above. Prepare a data table.

Conclusions: Write a lab report when you have achieved the separation of the two polymers in a solution of NaCl in water. Find the density of the solution and estimate the densities of the two plastics.

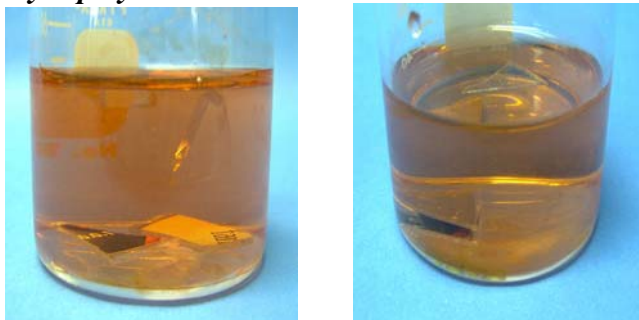
Extensions: Another challenge is to try the separate two pieces of CDs where one piece is only the clear plastic (no aluminum layer) and the other piece has the label and aluminum layers still on the piece.

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Teacher Notes for Density of Compact Disks

The picture on the left shows transparent Plexiglas floating (in the foreground) and two labeled pieces of a CD on the bottom of a colored salt solution. The picture on the right shows the separation of colorless (triangle shape) polycarbonate floating and aluminum-layer polycarbonate on the bottom in a colored salt solution.



Overview: This is an inquiry laboratory where students should have some prior experience with solution density and observing objects float or sink in the solution.

National Science Education Standards Addressed for Grades 9-12:

Content Standard A: Doing and Understanding Scientific Inquiry

Content Standard B: Structure and Properties of Matter

Content Standard E: Understanding about Science and Technology

Safety Notes: There are no chemical safety hazards but students need to wear safety goggles.

Procedural suggestions:

Some labeled CDs can be cut with heavy scissors and some can be easily broken with pliers. The non-labeled ones will have the aluminum layer peel off the polycarbonate as it is broken into pieces. Plexiglas can be hammered into shards or broken with pliers if it is thin enough. Lucite is a trademark for Plexiglas.

It takes about a 25% by mass salt solution to see the separation. Kosher salt is recommended because it makes a transparent, colorless solution. The Plexiglas will float and the polycarbonate (clear or silvered) will sink in a solution with a solution measured density of about 1.17 g/cm^3 . Using two polycarbonate pieces (clear plastic and aluminum-coated plastic), the solution that separated Plexiglas and polycarbonate may have to be adjusted to a slightly more concentration of salt to see the difference in these two CD pieces.

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The literature states that Plexiglas or poly(methyl methacrylate) has a density of 1.16-1.20 g/cm³ and polycarbonate has a density of 1.20-1.22 g/cm³. Using an electronic balance and a 10 mL graduated cylinder, the density that separated the two plastics was 1.17 g/cm³. These graduated cylinders are not very accurate for precise volume measurements.

The QuickTime movie on our web page shows the separation of these two plastics in a sodium chloride solution. The extension idea of separating the two pieces of CD (clear plastic and aluminum-coated plastic) is also in the movie.

Equipment: Kosher salt can be purchased at a grocery store. Plexiglas may be purchased at a plastics company or hardware store. Students will have compact disks they no longer want or use.

Visit www.polymerambassadors.org for video enhancement

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