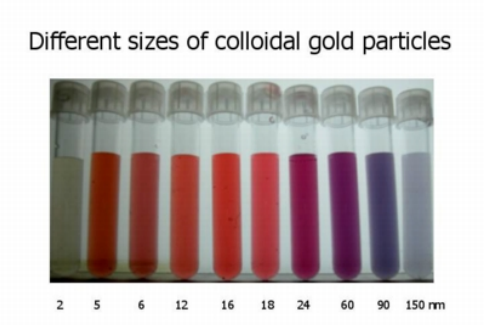
Gold Nanoparticle Lab

Background Info:

Nanoparticle are 10,000 smaller than the diameter of a human hair. Nanoscience explores the properties of these extremely small materials, and develops ways to use them to improve technology. Nanoscience improves technologies for diagnosing disease, generating electricity, improve electronic displays, and many other areas.

The properties of nanoparticle depends on their size and shape. Specifically, the different size particle interact with light differently. For instance, large piece of gold like jewelry appear yellow and shiny while nano-sized pieces of gold range in color from red to blue. The precise color depends on the size of the nanoparticles. The color can be change by getting the nanoparticle to clump together or aggregate, and thus their effective size gets bigger. One way to get nanoparticles to aggregate is adding electrolyte.

Because of this color-changing property, gold nanoparticle can be used as sensor. In our case, the gold nanoparticle are roughly 12-15 nm in size, and will be used as sensor to determine how much electrolyte is in a sports drink.



http://www.ansci.wisc.edu/facstaff/faculty/pages/albrecht/albrecht_web/programs/microscopy/colloid.html

Good resource for Background: http://nanoyou.eu/attachments/501_EXPERIMENT%20C1_Teacher%20document%2014-18.pdf

Aim:

Use gold nanoparticle as sensors, and understand the impact of nanoscale material's structure on its properties.

Materials:

40 ml Gold Colloid	4-2 dram (~3.5 mL) vials	4 disposable plastic pipettes	Deionized Water
Gatorade™	Powerade™	Salt Water (0.5 g salt/10 mL distilled water)	Sugar Water (2 g sugar/10 mL distilled water)
Waste Container	Gloves & Safety Glasses (if		

Adapted from Univesrity of Wisconsin-Madison Nanoscale Scicence and Engineering Center "Gold Nanoparticles as Sensors for Electrolytes in Sports Drinks", http://education.mrsec.wisc.edu/EExpo/sensors/NanogoldSensors_ProgramGuide.pdf, and J. Chem. Educ. 2004 81 544A

	desired)		

Procedure:

Preparation

____ 1) Gather supplies at your table.

____ 2) Predict which solution will have more electrolytes: _____

Experiment for one sport drink

____ 3) Add a drop of one electrolyte to one gold nanoparticle vial.

____ 4) Swirl the vial to mix in the electrolyte.

____ 5) Compare to the original gold solution (How has it changed?).

____ 6) Repeat steps 2-5 until solution is noticeably more purple. Record your observations and the numbers of drops added.

____ 7) Repeat steps 2-6 for the one of the other electrolyte drinks. Be sure to use a new pipette for each electrolyte drink.

____ 8) Get results from two other groups. Record the results in your table and calculate the average number of drops for each solution.

Clean up

____ 13) Add some salt to the used vials. Cap and shake. Note what happens to the solution.

____ 14) Filter your solutions with the filter the teacher has set up.

____ 15) Rinse out the vials with deionized water.

____ 16) Throw away used pipettes, cap the sports drinks, and cap any unused vials with gold nanoparticle solution.

Results:

Total Number of Drops

Solution	**Group 1**	**Group 2**	**Group 3**	**Average**
Gatorade™				
Powerade™				
Sugar Water				
Salt Water				

Conclusions/Questions:

1) Looking at your results, which solution had more electrolyte? (Hint: more electrolyte will require few drops to change the color)

_____

Adapted from Univesrity of Wisconsin-Madison Nanoscale Scicence and Engineering Center “Gold Nanoparticles as Sensors for Electrolytes in Sports Drinks”, http://education.mrsec.wisc.edu/EExpo/sensors/NanogoldSensors_ProgramGuide.pdf, and J. Chem. Educ. 2004 81 544A

2) Why did the gold particles change color with the addition of the electroyte?

_____

_____

_____

3) When cleaning up, why did salt cause the nanoparticles to aggregate (clump together)?

_____

_____

_____

4) Why did you look at the average for 3 tests instead of just using your results to make a conclusion? Why is this important?

_____

_____

_____

5) What is one thing you would do differently if you did the experiment again? Why would you change this?

_____

_____

_____

Adapted from Univesrity of Wisconsin-Madison Nanoscale Scicence and Engineering Center “Gold Nanoparticles as Sensors for Electrolytes in Sports Drinks”, http://education.mrsec.wisc.edu/EExpo/sensors/NanogoldSensors_ProgramGuide.pdf, and J. Chem. Educ. 2004 81 544A

Common Questions

What is the value of the gold in a vial (3 mL)?

Assuming full conversion, the value is a roughly **$0.011** (0.182 g/L*3mL*$42/g*49% Gold assay) compared to the high value of a piece of gold of similar volume is **$2,400** (3mL solution*19.32 g/mL gold density*$42/g). This is because there is only a small amount of gold in in the solution (assuming full conversion: $4.5x10^{-4}$ mol/L or 89 parts-per-million). Current price of gold: http://goldprice.org/

Why do electrolytes make the gold nanoparticles clump together?

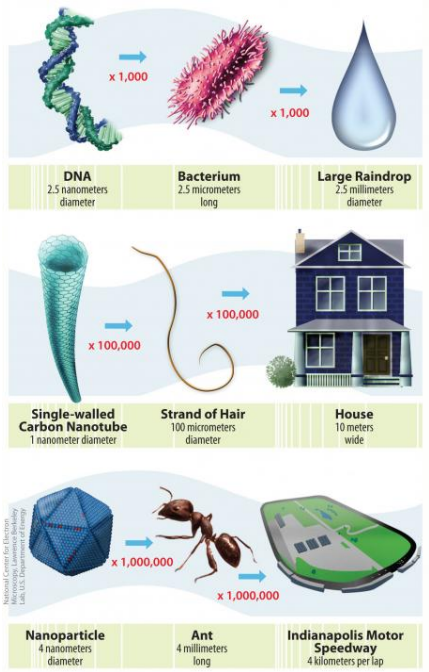
Electrolytes (or salts) are made of two pieces (ions): one has a positive charge (cation) while the other has a negative charge (anion). This two ions split up when dissolved in water. Gold nanoparticle have a negative charge (citrate anion) on their surface, causing the two gold nanoparticle to repel each other (like two magnets of the same pole). When the electrolyte is added, the positive electrolyte ions are attracted to the negative nanoparticle surface, and decrease its negative surface charge that was preventing (repeling) the nanoparticle then from touching. Thus, the nanoparticles clump together because the electrolyte reduces the degree to which the nanoparticle repel each other.

Do scientists use this method to test for electrolytes?

No, there are other ways to test electrolyte levels in a solution. potentiometry or electric current are used often used for these measurements. But, the color change effect of nanoparticle is used to determine their size.

Nano-sized

Adapted from Univesrity of Wisconsin-Madison Nanoscale Scicence and Engineering Center “Gold Nanoparticles as Sensors for Electrolytes in Sports Drinks”, http://education.mrsec.wisc.edu/EExpo/sensors/NanogoldSensors_ProgramGuide.pdf, and J. Chem. Educ. 2004 81 544A



http://www.nano.gov/nanotech-101/what/nano-size

Adapted from Univesrity of Wisconsin-Madison Nanoscale Scicence and Engineering Center “Gold Nanoparticles as Sensors for Electrolytes in Sports Drinks”, http://education.mrsec.wisc.edu/EExpo/sensors/NanogoldSensors_ProgramGuide.pdf, and J. Chem. Educ. 2004 81 544A