Teacher's Preparatory Guide

Mixtures and Nanotechnology

Purpose:
The purpose of this unit is to help students make the connection that the classification of mixtures is based on the size of particles. This connects to two of the Big Ideas in Nanoscale Science and Engineering (Stevens, Sutherland, and Krajick 2009). The first is Size and Scale or factors relating to size and geometry of materials which help describe matter and predict its behavior. The second is Size-Dependent Properties that can change with scale. In particular, as the size of a material transitions from the bulk to atomic scale, it often exhibits unexpected properties that lead to new functionality.

Time required:
Two 50 min class periods or one 90 min block

Level:
Middle and high school; Physical science and chemistry

Teacher Background:
Mixtures do not always contain the same proportions of the substances that make them up. This makes them different from a substance which is either an element or compound. A substance cannot be broken down into simpler components and maintain the properties of the original substance. The classification of mixtures depends on size of the particles that they are composed of and how these particles are distributed within the mixture.

Nanoscience involves the investigation of matter that exists in the size range of 1-100 nanometers in one direction. This becomes important in the classification of mixtures because solutions are mixtures that have particles that are smaller than one nanometer and colloids are mixtures that have particles that are between one and 100 nanometers. Because of this small size, mixtures exhibit unique properties. For example, gravity is no longer is as important as are intermolecular forces so the particles do not settle out. The particle size also determines whether light is scattered.

Following are some definitions that teachers can use in the discussion of mixtures. This discussion can be done before the lesson or developed along with the lesson.
Heterogeneous Mixture- The different materials can be distinguished from each other.
Homogeneous Mixture- Contains two or more gaseous, liquid, or solid substances evenly distributed throughout.
Suspensions- Heterogeneous mixture containing a liquid in which visible particles will settle out
Solution-Particles are so small that they can not be seen with a light microscope and will not settle to the bottom of their container. Light will pass through without scattering.

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Colloid- Like a heterogeneous mixture it contains varying proportions of materials; like a solution its particles will not settle out; but unlike a solution it will scatter light.
Emulsion- Colloid made up of a liquid dispersed in a liquid.
Sols and Gels- Colloid make up of a solid dispersed in a liquid.
Aerosols- Colloid of liquid or solid dispersed in a gas.
Tyndall Effect- The scattering of light when a light is sent through a colloid.

Materials:

- Classification Cards of various objects (one set per group)
- Clear containers of water, hydrogen peroxide, water with salt, water and dirt, water and milk or starch (one set per group)
- Laser pointer
- Sheets of flip chart paper or butcher block paper and painter's tape
- Markers of assorted colors

Advance Preparation:
Print out, laminate and cut apart enough cards so that you have a set for each group of 3-4 students
Prepare containers (one set per lab group) Put numbers on the containers. (One ounce size clear bottles/jars work well)

#1. = Bottle of water
#2. = Bottle that has been filled with hydrogen peroxide
#3. = Solution container will be small container of water with addition of small amount of salt
#4. = Suspension will be small container of water with addition of small amount of dirt
#5. = Colloid will be water with addition of a few drops of milk or starch

Safety Information:
Caution students that they are not to point laser pointers into eyes. They are also not to open any of the containers.

Directions for the Activity
1. **Show containers** prepared in advance to groups. Ask students if they think that all of these containers belong together in the classification of matter? Give students an opportunity to provide some opinions. Two of the containers contain substances and three contain mixtures.
2. Tell the students that two of the bottles do not belong with the rest and today they will be deciding how they could use characteristics to separate these containers.
3. **Distribute sets of cards, markers, and sheets of paper** to each group. Direct students to separate cards using some classification scheme that the group decides on. They are to list their groups on a sheet of paper and put what classification scheme they used to separate groups. Tell groups where to post their group's flip chart sheets.
4. After sheets have been put on walls, **allow students to discuss** any similarities or differences that are shown on the class group sheets. Let several groups discuss how they separated their cards.
5. **Distribute student worksheets** and have students complete part A.
6. **Tell them to gather up their cards** and now complete part B of the data sheet into two groups: Homogeneous Mixtures and Heterogeneous Mixtures.

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7. After students have put new sheets on wall, **allow students to discuss** if there are any differences in what is listed. Ask if any listed objects need to be moved. **Discuss** what they think a good definition of these two groups should be. Answers are on teacher version of student worksheet that follows.
8. **Direct students to complete Part C** on the worksheet for the Heterogeneous Mixture group of cards. Have students divide cards into colloids and other Heterogeneous mixtures. Have students post sheets on the wall. **Allow students to discuss** any differences. Discuss what a definition for these two groups could be. Make sure that students mention the size of the particles or ask if the size of the particles has anything to do with the separation of the groups. Answers are on teacher version of student worksheet that follows.
9. **Tell students** to use the cards that are in the colloids group to complete the chart on the worksheet under part D. **Discuss** the results of the chart. Introduce students to the terms sol, emulsion, foam, aerosol, and ask where on the chart they think these words belong? Answers are on the teacher version of student worksheet that follows.
10. S**tudents** will next look at the cards that were placed in the Homogeneous Mixture group. Have them complete Part E on the worksheet. **Discuss** the charts on their worksheet. Suggested answers are on teacher version of student worksheet that follows.
11. **Have students look at the original containers**. Ask them to decide how these containers could be separated. Discuss: The bottle of water (1) and bottle of peroxide (2) are substances. The bottle with salt (3 = solution), the bottle with dirt (4 = suspension) and the bottle with milk (5 = colloid) are mixtures. Solution is homogeneous mixture and suspension and colloid are heterogeneous mixtures.
12. **Have students complete** Analysis questions and **discuss**. Suggested answers are on teacher version of student worksheet that follows.
13. Distribute concluding activity sheet and have students complete for homework or during the next class period. A suggested graph follows in the Teachers Prep .

Student Worksheet
(with answers)
Mixtures and Nanotechnology

Introduction:

Mixtures do not always contain the same proportions of the substances that they are composed of. This makes them different from a substance. The classification of mixtures depends on the size of the particles that make them up and how these particles are distributed within the mixture.

Objective:

After completing the worksheet you will be able to produce a graphic representation of all the information gathered.

Materials

- Set of cards
- Painter tape
- Large sheets of paper
- Assorted markers

Procedure:

Part A:

1. Separate the cards you have been given into groups based on a classification scheme that your group decides on. List below your groups and the characteristic on which the divisions were made.

Characteristic__Example solid, liquid, gas_____

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Groups Example divisions below

Solid	Liquid	Gas
gelatin, steel, granite, gems, dirt, tossed salad, concrete, marshmallows, dry soup mix, butter, muddy water	milk, soft drink, ocean water, vinegar, antifreeze	smoke, cloud,

2. Using markers and a sheet of chart paper, list your classification groups and tape to the wall.

Part B:

1. Gather up cards and separate cards into two groups. One will be Homogeneous Mixtures and one will be Heterogeneous Mixtures. List the cards under each group below.

Heterogeneous	Homogeneous
gelatin, milk, cloud, gems, smoke, granite, dirt, tossed salad, concrete, muddy water, marshmallows, butter dry soup mix	vinegar, bottles soft drink, antifreeze, ocean water, steel

2. Using markers and a sheet of chart paper, list your classification groups and tape to wall.
3. After discussion with other groups make any changes in your groups that you feel are needed.
4. Write a definition for Homogeneous and Heterogeneous Mixtures

Heterogeneous- two or more materials that can be distinguished and easily separated.
Homogeneous- two or more gaseous, liquid or solid materials that are evenly distributed within the mixture.

Part C:

1. Gather up cards from the Heterogeneous Mixture group. Do not disturb the cards in the other group. You will need them later. Separate the cards in your heterogeneous mixture group and separate into two groups -- colloids and other heterogeneous mixtures.

Colloids	Other Heterogeneous Mixture
gelatin, milk, cloud, gems, smoke, marshmallows, butter	granite, dirt, tossed salad, concrete, muddy water, dry soup mix

2. Using markers and a sheet of chart paper, list your classification groups and tape to wall.
3. After discussion with other groups make any changes in your groups that you feel are needed.
4. Write below a definition for colloids. Like heterogeneous mixture it contains varying proportions but like solutions its particles will not settle out.

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Part D:

1. Complete the following chart by placing the terms below in the square where they belong: Beaten egg white, Blood, Butter, Cheese, Cloud, Colored gems, Dust in air, Floating soap, Fog, Gelatin, Marshmallows, Milk, Smoke, Spray deodorant, Whipped cream

Title of Chart:_____Types of colloids_____

Dispersed Particles	Dispersing Medium		
	Solid	Liquid	Gas
Solid	colored gems	blood, gelatin	smoke, dust in air
Liquid	butter, cheese	milk	spray deodorant, fog, clouds
Gas	marshmallows, soap that floats	whipped cream, beaten egg whites	

2. After placing all terms on the chart decide on a title for the chart.
3. Discuss with your group which of your above groupings would the following terms go with: sol, emulsion, foam, aerosol. Write a definition to each term:

Sol-Colloids of solids in liquids such as colored gems, blood, and gelatin
Emulsion-Colloids of liquids in liquids or liquids in solids such as butter, cheese, and milk
Foam-Colloids of gas in liquids such as whipped cream and beaten egg whites
Aerosol-Colloids of solids or liquids in gas such as smoke, dust in air, spray deodorant, fog and clouds

Part E:

1. Complete the following chart by placing the terms below in the square where they belong. Air, Antifreeze, Carbonated water, Dental amalgan, Ocean water, Steel, Vinegar

Title:____Types of Homogeneous Mixtures or Solutions_____

Solute	Solvent		
	Solid	Liquid	Gas
Solid	dental amalgan steel	ocean water *	
Liquid		antifreeze vinegar	

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Gas		carbonated water ocean water*	air

*Depends on whether you are showing dissolved oxyen or dissolved salts.

2. After placing terms on chart, as a group, decide on a title for the chart.

Analysis: Answer the questions below -

1. How is a compound similar to a homogeneous mixture? Made up of two or more substances evenly distributed. How is it different? Compounds are chemically combined and solutions can be separated.
2. Distinguish between a substance and a mixture. Substances are always made up of the same particles or ratio of particles. Mixtures do not always contain the same proportions of the substances that they are composed of. Give two examples of each. Substances: hydrogen and water Mixtures: air and brass
3. Describe the differences between colloids and suspensions. Colloids have particles that are two small to settle out and suspensions have particles that will settle out over time. Both will scatter light. See figure for particle size.
4. Why do the words "Shake well before using" indicate that the fruit juice is a suspension? Because some of the particles in a suspension are large enough that they will settle out over time.

5. In terms of suspensions and colloids, compare and contrast a glass of milk and a glass of fresh squeezed orange juice. The milk in a glass of milk is a colloid, it will not settle over time, but fresh orange juice will have particles of the pulp that will settle to the bottom over time.
6. Do any classification schemes have anything to do with sizes? Yes Explain. Classification schemes for mixtures are dependent on the size of the particles and whether they are large enough to be seen or settle out. Solutions have particles that are smaller than 1 nm, colloids have particles that are between 1 and 100 nanometer, and suspensions have particles that are larger than 100 nm.
7. Do the sizes of particles determine how substances behave? Yes Explain. The particles of colloids and suspensions are large enough to scatter light while the particles of a solution are too small to scatter light.

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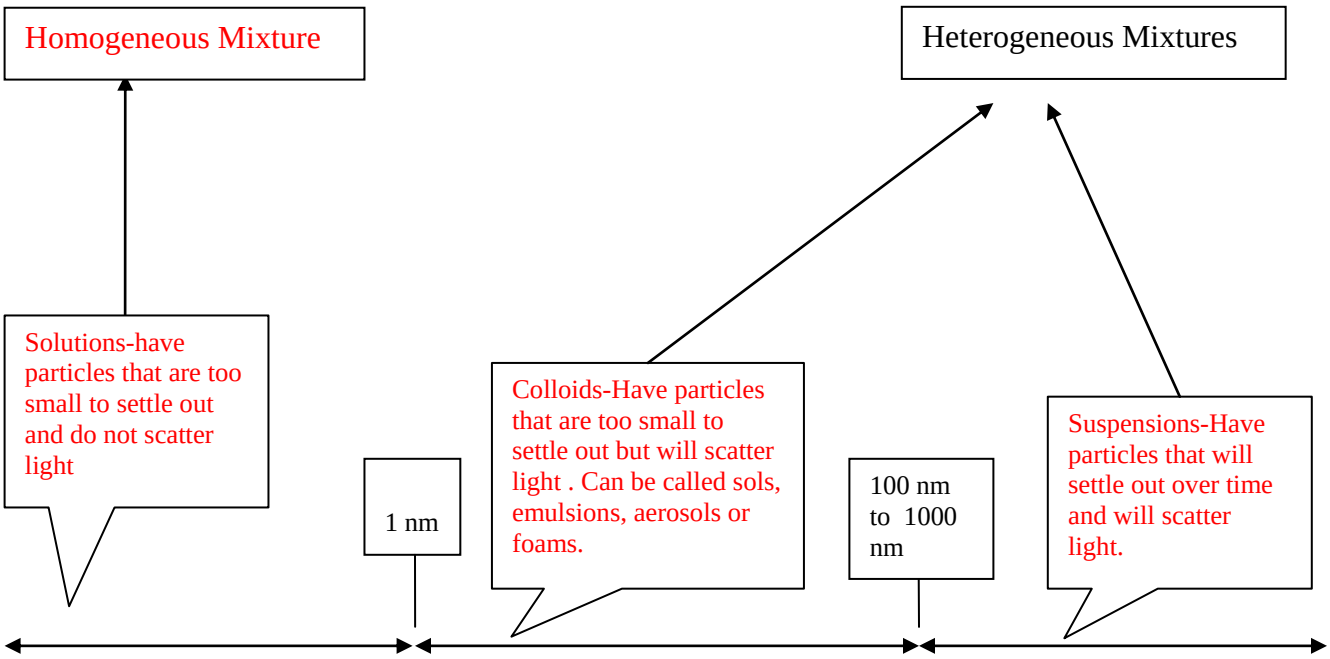
Concluding Activity:

Summarize the information that you learned today on this sheet incorporating the diagram below. Be sure to use terms correctly.



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Cleanup:
Have students reshuffle cards and rubber band together, take down papers on wall and place cards, containers and markers in designated location.

Assessment:
Concluding graph can be turned and checked for correct use and location of terms and information

Resources:
To learn more about nanotechnology, here are some web sites with educational resources:
www.nnin.org
www.nisenet.org
http://education.mrsec.wisc.edu/Edetc/index.php
http://www.nsec.wisc.edu/
http://nano-cemms.illinois.edu/education

National Science Education Standards (Grades 5-8)
Content Standard A: Science as Inquiry
- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

Content Standard B: Physical Science
- Properties and changes of properties

National Science Education Standards (Grades 9-12)
Content Standard A: Science as Inquiry
- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

Content Standard B: Physical Science
- Structure of atoms
- Structure and properties of matter

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