A Crazy Colloid

Formerly Goo Yuck

Revised by Judith Hillen

Topic Area

Chemistry: States of matter - Colloids

Introductory Statement

This activity provides free exploration with an unusual state of matter, a colloid made from corn starch and water. Students will experience a substance that displays the properties of both a liquid and a solid.

Math	Science
Classifying	Observing
Measuring	Comparing
Graphing	Recording data
	Generalizing

Materials

one box (454 g) cornstarch
250 ml of water
one mixing bowl and spoon
one hammer

For each group of students:

- aluminum foil - one 10 cm square
- two clear plastic cups
- plastic zip-lock sandwich baggy
- waxed paper - one 30 cm square
- one wooden clip type clothes pins
- one votive candle

Key Question

In what ways is this substance like a solid and a liquid?

Background Information

Some substances exist in states that do not totally comply with usual definitions of a gas, liquid, or a solid. A colloid is such a substance and will display properties of both a liquid and a solid. This is largely due to the size of the particles of a colloid which are large molecules or clumps of small molecules. The colloidal particles are small enough to move about randomly like the particles of a liquid. But they are also large enough to be bombarded by molecules of the surrounding medium equally on all sides with the result that they do not move much, thus resembling the properties of a solid. These particles range in size from 4 millionths to 4 hundred-millionths of an inch (10-4 to 10-6 millimeters across).

Furthermore, the particles are neither dissolved completely (solution) nor are 'they totally suspended (suspension). Colloid particles are intermediate in size between solutions and suspensions. In a solution, particles do not settle out. For instance, think about sugar dissolved in water. The sugar does not separate out. In a suspension, particles are temporarily suspended and settle out upon standing over a period of time. Here, one may think about muddy water where the sift may settle out after a period of time. Colloidal particles do not settle out (like a solution) but remain dispersed throughout the medium. Solutions also pass unchanged through ordinary filter paper and suspensions may be separated by filter paper. Colloidal particles again behave like a solution as they pass unchanged through filter paper. But colloids behave like suspensions in other ways. For instance, both colloids and suspensions scatter light and may be separated by parchment membrane while solutions cannot.

Thomas Graham, an English chemist is credited with much of the information regarding the behavior of colloids and crystalloids. The name colloid comes from the Greek word ***kolla*** which means glue. Familiar colloids are rubber, plastics, and synthetic fibers. Milk is a colfoid as are gels, gelatin (Jello) and foams.

References for this information include: ***Physics Today,*** World Book Encyclopedia of Science, World Book, Inc. (Chicago, 1987) and Smoot, Price and Smith. ***Chemistry, A Modern Course.*** Charles Merrill Publishing (Columbus, Ohio 1983).

Management Suggestions

It is convenient for the teacher to mix the corn starch and water in one bowl and then distribute an appropriate portion in a plastic cup to each group of students.

Allowing a five minute period of free exploration is helpful before beginning the formal process of the nine tests to be performed. During this period students may record their observations using their senses. While tasting is not harmful to students, it may be in good "taste" to omit it.

You may wish to perform the test for heat under teacher direction or demonstration depending upon the age and responsible nature of the students.

You may wish to discuss appropriate "manners" when exploring this substance. This may curtail throwing or tossing the mixture in playful ways at other classmates or objects.

Procedure

1. Mix cornstarch and water and distribute samples of mixture in clear plastic cups (about a third to one half full) to groups of 4 or 5 students.
2. Allow five minutes for free exploration and recording of observations of physical properties of the mixture.
3. Discuss the properties of liquids and solids. (See Fact Page) Predict whether the mixture is most like a solid or a liquid.

4. Review the nine tests and allow time for students to work through each part - doing and recording their observations and indicating whether it behaves like a liquid or a solid.
5. Each student generalizes the results by writing a paragraph that supports his conclusion.
6. The results may be pictured in a circle graph by using one color for liquid test results and a different color for solid test results. Students may use the graph to help explain their conclusions.

Discussion

1. Which of the tests showed this mixture to be a liquid?
2. Which tests showed this mixture to be a solid?
3. Which tests, if any, were inconclusive?
4. What variables might influence the outcome of this experiment? (Amount of water added, time, etc.)

Extensions

1. See literature correlations - Bartholomew and the OObleck, by Dr. Suess.
2. Research what other "powders" and liquids can be safely mixed to form colloids.
3. Invite a "chemist" to visit and share ideas about simple experiments in chemistry.
4. Research famous chemists and their contributions to science.

Close Call, continued

3. Describe the strategy selected to determine the actual number of objects in the baggy. Many strategies are possible. One is cited here as an example of a very simple yet accurate way to determine a better guess.

Description in Words	Math Svmbols
Use the balance to divide the whole set of beans into two equal parts. Each new part is one half.	B=all the beans b/2 = 1/2 of the beans
Return one half of the beans to the jar and use the balance to divide the remaining one half into two equal parts.	1/2 divided by 2 = 1/4 of beans
Return one part (one fourth) to the jar and again use the balance to divide the one fourth into two equal parts now called one eighth.	1/4 divided by 2 = 1/8 of beans
Return one eighth of the beans to the jar and use the balance to divide the remaining one eighth beans into two equal parts.	118 divided by 2 = 1/16 beans
Place one sixteenth into the jar and count the remaining one sixteenth. Multiply the number in one part (130) by the number of parts (16) to get the total number in the jar. Compare to the actual count. (actual = 2085)*	16 X 130 = 2080 beans

*This experience actually occurred as described in a classroom. The feeling of successful reward was spontaneous and powerful when the discovery of the actual count proved them to be "off" by only 5 out of 2085.

4. How many different strategies are there for determining the number of objects in the baggy? Describe them.
5. What happens to our strategy when the size of the objects in the jar is not uniform? Suppose we have a jar of buttons of two or three different sizes.
6. Discuss the amount of error. Amount of error may be expressed as the relationship between the amount of error and the actual amount. It may be expressed as a fraction or a decimal or a percent.

Blocks, continued

that build spatial sense and spatial visualization abilities. They first involve students in visualizing and constructing three-dimensional objects by looking at two-dimensional plans for those objects, and then turn around and ask that they look at a three-dimensional object and create an appropriate set of plans for the object.

References

Moses, Barbara. "Developing Spatial Thinking in the Middle Grades: Designing a Space Station." Arithmetic Teacher 37 (February 1990): 59-63.

Middle Grades Mathematics Project. Spa&L *Visua~ization*. Reading, MA : Addison-Wesley Publishing Co., 1987.

Summer, continued

axis causes the Northern Hemisphere to be pointed toward the sun. Because of this, there are more hours of daylight during the summer and the temperature rises. Six months later, the earth is at a point in its orbit around the sun where the Southern Hemisphere is pointed toward the sun. When the earth is in this position, there are fewer hours of daylight in the Northern Hemisphere and the temperatures tend to be colder. There are many other factors that affect the temperature during the summer and winter, but the main factor is that the number of hours of daylight changes because of the tilt of the earth's axis.

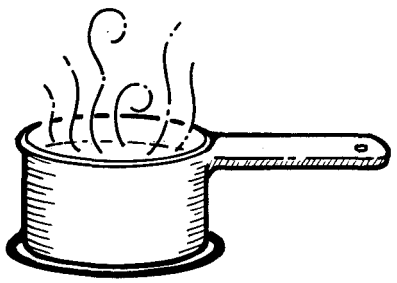
Included in this issue is an AIMS activity called Sun*shine*. In this activity students record the times of sunrise and sunset weekly for a period of 13 weeks. From this data, students are able to determine how the amount of daylight varies during a longer period of time. If students begin this activity early in the school year and continue throughout the year they will notice how the length of daylight steadily changes. This activity will help students begin to answer the question posed at the Harvard graduation. If you help them understand why this happens with good modeling and clear explanations, your students will be on the road to scientific literacy. Good luck!

A Crazy Colloid

Matter: Properties of Liquids and Solids

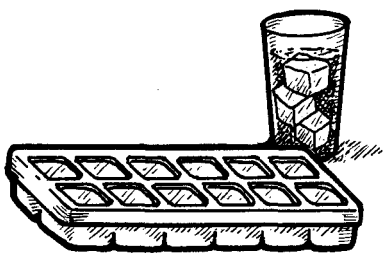
Solids:

* do not change shape easily
* will not allow another solid to pass through them easily
* are usually visible
* have a definite shape
* have a definite size
* become liquid when heated
* when cooled remain solid



Liquids:

* change shape easily (take the shape of the container)
* will allow a solid to pass through easily
* may be visible or invisible
* have a definite size (volume)
* when heated become gas
* when cooled become solid



Scientist

A Crazy Colloid

Prediction: the mixture is a

Liquid Solid
(circle one)

Observation:

1. You have 5 minutes for free discovery and observation. Return the mixture to its container at _____ o'clock.
2. Record your observations.

Color: _____

Texture: _____

Shape: _____

Smell: _____

Other: _____

A Crazy Colloid

Scientist

Experiment:

Do each test

Record your results

1. The quick finger poke test

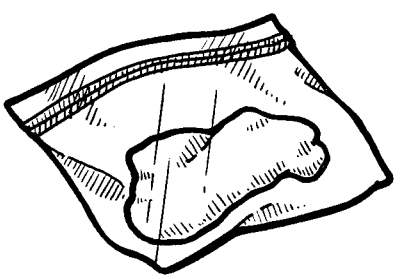
Try to poke your finger into the mixture so that the tip of your finger touches the bottom of the cup. To make sure that this is the quick finger poke test, try to touch the bottom of the cup in 1 second.

2. The slow finger poke test

Try to poke your finger into the mixture so that the tip of your finger touches the bottom of the cup. In order to make sure that this is the slow finger poke test, take 10 seconds to touch bottom.

3. Conformity test

Put the mixture into another container or a plastic baggie. Check to see if the mixture takes the shape of the container or stays in its original shape.



4. Pour test

Try to pour the mixture from one cup to another.

Scientist

A Crazy Colloid

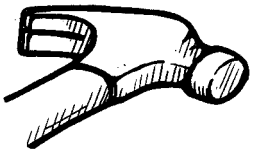
(Experiments, cont.)

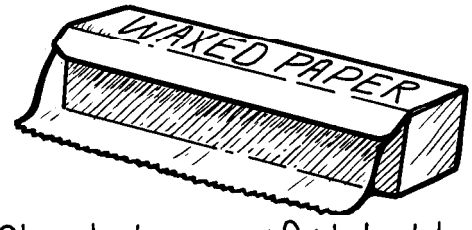
5. Bounce test

Hold the mixture 50 cm up from the table / desk. Drop it.

6. Shatter test

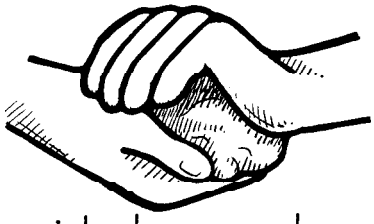
Put the mixture in waxed paper on the table / desk. Hit the mixture with a hammer.





7. Shape test

Try to form the mixture into a ball. Check to see if it holds its shape for 5 seconds.

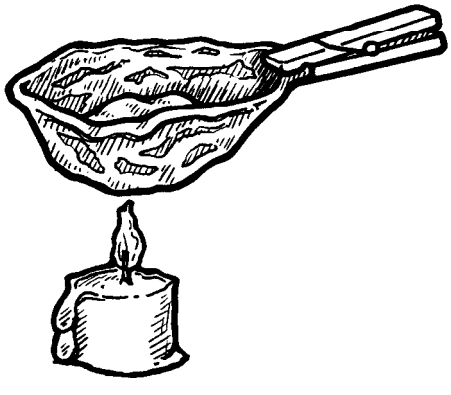


8. Heat test

Make a bowl out of foil. On one side leave a bump where you can clip a clothes-pin. Heat one teaspoon of the mixture in the bowl over a votive candle.

9. Cool test

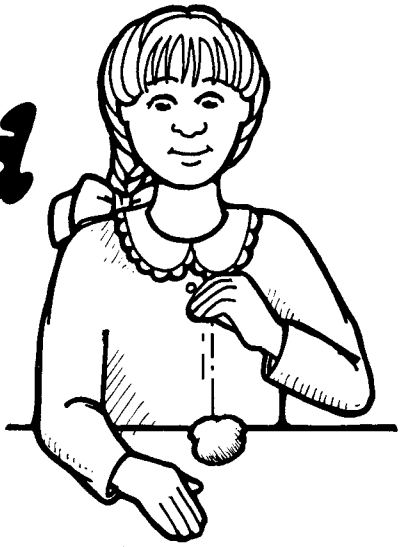
Let the mixture cool to room temperature.



Scientist _____

A Crazy Colloid

Observation Record Sheet



Test	Observations	Liquid	Solid
1. The quick finger poke test			
2. The slow finger poke test			
3. Conformity test			
4. Pour test			
5. Bounce test			
6. Shatter test			
7. Shape test			
8. Heat test			
9. Cool test			
	Total		

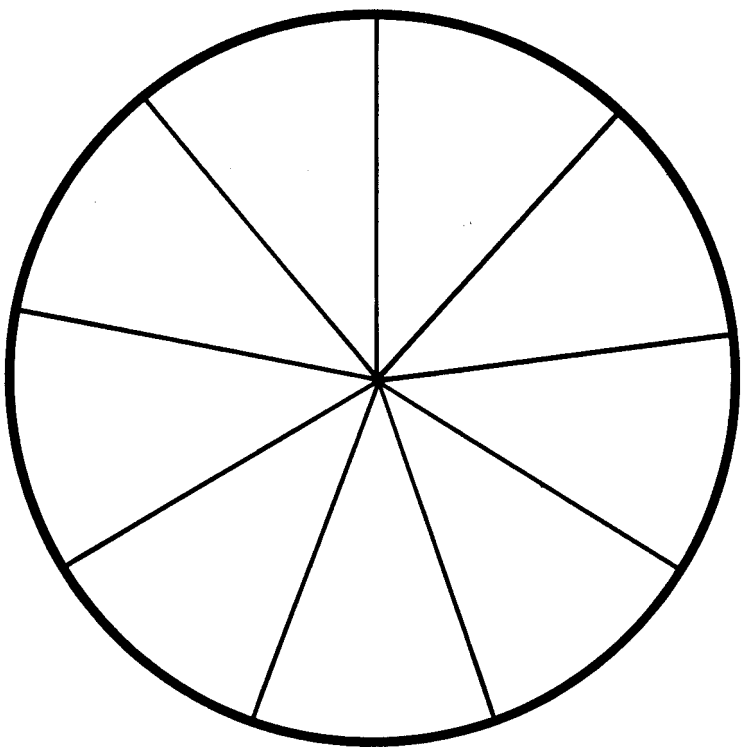
Is this colloid a liquid or a solid ? _____

Write a paragraph that supports your conclusion.

Scientist

A Crazy Colloid

- Color in a section for each test result.
- Use one color for liquid test results, and another for solid.
- If a result falls into both categories fill in half with each color.
- Keep like results together.



According to your test results is the mixture a liquid or a solid ? Why ?