THROUGH THICK OR THIN!!!

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Grade Level:
7th and 8th

Discipline:
Physical Science

Goals:
Upon completion of this experiment, the students will:
1. Incorporate the scientific method within the context of specific content material.
2. Hypothesize, explore, analyze, and interpret data within a co-operative learning group.
3. Understand that household products have a scientific basis.

Specific Objectives:
Upon completion of this experiment, students will be able to:
1. Differentiate between high and low viscosity.
2. Collect, graph, and interpret data.
3. Quantitatively measure polymer solids.
4. Experiment with a household example of an emulsion polymer.

Background:
Viscosity is defined as the quality of liquid to resist flow. Materials which have a low resistance to flow, or flow quickly, such as water, have a low viscosity. Liquids which flow slowly, such as honey, have a high viscosity. The Elmer's® glue used in this experiment has a high viscosity due to the fact that it consists of a large number of particles dispersed in water. As the glue is diluted with water, the number of dispersed particles decreases, lowering the viscosity of the resulting liquid.

The particles in Elmer's® glue are polymers. A polymer is a large molecule made up of a large number of smaller molecules (monomers) joined together to form a chain. A few examples of polymers include plastics, protein, nylon, and starch. More specifically, Elmer's® glue is an example of an emulsion polymer where it is prepared by polymerizing an oil-like monomer in water. The actual monomer used is vinyl acetate which after polymerization is known as ploy(vinyl acetate).

An emulsion is a dispersion of one immiscible liquid in another in the form of fine droplets. Surfactants (surface-active agent) are added to emulsions to provide stability. Surfactants are chemical compounds which contain both a hydrophilic (water soluble) moiety and a hydrophobic (water insoluble) moiety.

Why does Elmer's® glue dry clear? When the polymer particles are dispersed in water, light striking the glue is reflected by these discrete particle causing the glue to be opaque. (Figure A) As the glue dries, water evaporates forcing the polymer particles closer together. Since the particles are still discrete, they will still reflect light and the glue remains opaque. (Figure B) As the last of the water evaporates the particles are forced together. This can be compared to two balls of clay which when pushed together with enough force will become one. Now as the light strikes the glue there are no longer any discrete particles to reflect it back and the glue is now transparent. (Figure C)

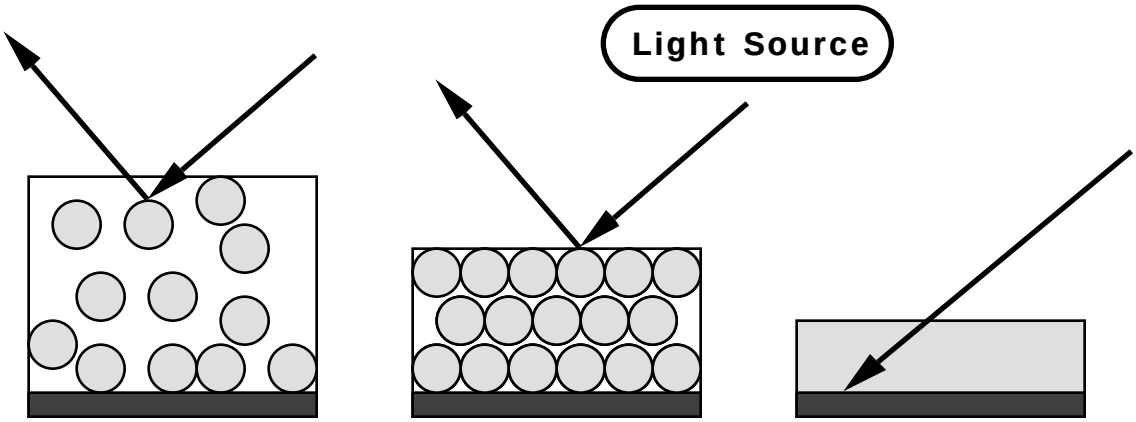

Figure A **Figure B** **Figure C**

Vocabulary:
viscosity
physical change
hydrophobic
polymer
quantitative analysis
hydrophilic
emulsion
surfactant (surface-active agent)

Materials:
funnel
ringstand
clamp
beaker
droppers
graduated cylinder -100 ml
stirring rods
stop-watch
graph paper
watch glass
Elmer's® glue

PART A: VISCOSITY OF EMULSION POLYMER...GLUE

Problem:
To determine if the viscosity of Elmer's® glue will change with various dilutions.

Hypothesis:_______
_____

Procedure:
1. Pour 50 ml of Elmer's® glue into a 100 ml graduated cylinder.
2. Set up the apparatus as shown in Figure 1.

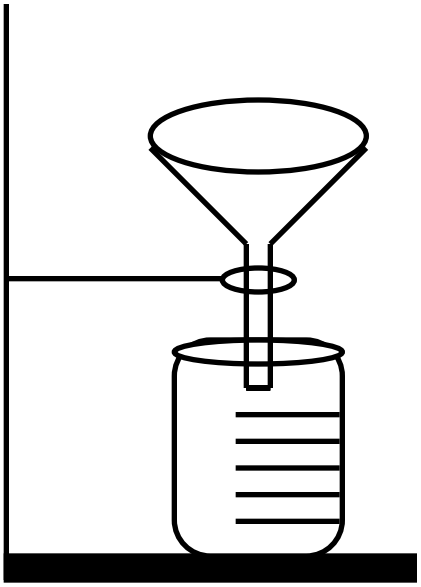

Figure 1

3. Pour glue into funnel. Record the time (sec) it takes for glue to pass through the funnel.

4. Repeat using the various dilutions.
   4a. 30 ml of glue + 20 ml of water
   4b. 20 ml of glue + 30 ml of water
   4c. 10 ml of glue + 40 ml of water
   4d. 5 ml of glue + 45 ml of water

Data Table I

Emulsion Polymer...Glue	**Viscosity Time (sec)**
50 ml (original)	_____
a. 30 ml of glue + 20 ml of water	_____
b. 20 ml of glue + 30 ml of water	_____
c. 10 ml of glue + 40 ml of water	_____
d. 5 ml of glue + 45 ml of water	_____

Interpretations:

1. Graph the results from PART A using viscosity (sec) as a function of water added (ml).

2. Was viscosity affected by the addition of water? Explain.

3. Give two examples of liquids that have a high viscosity.

4. Give two examples of liquids that have a low viscosity.

5. In a practical sense, why does glue have a high viscosity?

Part B: Quantitative Measure of Solid Polymer

Problem:

To determine how the viscosity of Elmer's® glue varies with the quantitative measure of polymer solids.

Hypothesis: _____

_____

Procedure:

1. Mass watch glass and add 1g of original emulsion.
2. Evaporate substance overnight.
3. Mass watch glass with evaporated emulsion.
4. Subtract the mass of the watch glass from the total mass to determine how much solid polymer remains.
5. Determine the % of solid polymer by dividing the final amount by the initial amount of emulsion x 100.
   Example: 0.5g/1g x 100 = 50%
6. Repeat steps 1-5, using the different dilutions from **Part A** lab.
7. Record all data in **Data Table II**.

Date Table II

Dilution	**Initial:**			**Final:**	
	Mass of Watch Glass	Mass of Emulsion + Watch Glass	Initial Mass	Mass of Dried Emulsion + Watch Glass	Final Mass
Original					
a.+20 ml water					
b.+30 ml water					
c.+40 ml water					
d.+45 ml water					

Interpretations:

1. Calculate the % of solid polymer in each dilution using the following formula: % = FINAL MASS/INITIAL MASS X 100
2. Graph the data of viscosity (sec) from **Part A** as a function of % solid polymer.
3. How does the viscosity change as the % solid polymer increases?
4. Compare and contrast the graphs from **Part A** and **Part B**.
5. Provide an analogy to explain how viscosity is related to the solid polymer content.

Teacher Hint:

It is suggested that the class be divided into teams. Each team given the original sample (50 ml) plus one other dilution to test a minimum of two times. Upon completion, all teams will come together to compile data and draw conclusions.

REFERENCES:

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