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Physical Chemistry P1

Thickness of a Bubble

Chemists have traditionally called the study of collections of molecules **physical chemistry**. Communities of people have some properties which are the result of individuals but only become apparent in a collective group such as the *wave* of a crowd moving in unison. Likewise communities of chemical substances have group properties such as pressure, electric current, and freezing temperature. Physical chemists study such properties then use them to help understand individual events on the molecular scale. Atoms and molecules are so small that our senses are generally unable to directly learn what occurs at that size. So the use of these bulk properties provides a chest of tools to supplement our senses.

Experiment 1

To gain an appreciation for the size of molecules, this investigation attempts to measure the thickness of one of the thinner objects in our world, soap bubbles and oil films. This first procedure was described by Benjamin Franklin by may have been used earlier. It involves putting a tiny but measured amount of oil on a flat surface of water. After measuring the area over which the oil spreads, the average thickness of the oil sheen can be calculated. The amount of oil must be tiny enough and the water surface large enough that the oil can spread without encountering the edge of the water. In addition a means is needed to determine the extent of the spread of the oil.

Procedure 1

Experiment 2

The second procedure involves using the wave nature of light to estimate the thickness of a soap bubble. Light is a transverse electromagnetic wave. Both the electric field and the magnetic field increase and decrease perpendicular to the direction of the light's direction. When the light encounters the electric field (due to surface electrons) in some materials, the interaction causes the reflected emission of a similar light wave. Depending on the surface, this may be a mirror like reflection where the angle of reflected light matches the incidence angle, or scattered such as by the surface of white paper.

A bubble has both an inside and outside surface, both of which may reflect light. If the bubble has the thickness equal half the wavelength of the light, the reflected waves from the inside will be one wavelength behind those reflected from the outside surfaces. These waves will match and so will combine in such a way that the amplitudes of their electric and magnetic fields will add together making a light wave twice as bright as either separate reflection. But in the surfaces are a quarter wavelength apart, the light wave reflected from the inside will be a half wavelength behind that reflected from the outside surface. The waves will be exact opposites so that their combination nearly cancels leaving almost no reflected light. White light is a combination of all colors, such that each color of is a slightly different wavelength extending from red light with a wavelength of about 7×10^{-7}m to blue light with a shorter wavelength of about 4×10^{-7}m. The result is that soap bubbles, depending on their thicknesses, may cause bright constructive combinations for some light colors and the destructive combination of light of other colors. If the bubble is too thin, there may be no constructive reflection and so the surface will seem to disappear with no reflection at all.

Procedure 2

Bubble solution: To make bubble solution,

1. mix 100 to 200 ml of Dawn®, Joy® or other dishwashing liquid with 50 ml of glycerol.
2. Add this to 850 ml of water.

3. Gently stir to combine but avoid prematurely making suds by not shaking.

Increasing the amount of detergent may produce longer lasting bubbles. If you are having difficulty forming bubbles, distilled or deionized water may improves results. Metal ions often in drinking water react with the soap.

Constructive Interference happens when two or more waves come together to form a larger and stronger wave, matching their crests and troughs. Destructive Interference is when two or more waves come together and cancel each other out to make a weaker wave.