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# Happy/Sad Balls

Catalog No. AP1971 Publication No. 1971

## Introduction:

Happy and Sad balls appear the same, but do they have the same properties? Bounce the balls, put them in the freezer, heat them in boiling water, compare their densities—observe the very interesting results.

## Concepts:

- Polymers
- Density

## Materials:

Happy/Sad Ball Set
Boiling water bath
Freezer or ice water bath
Glycerin

## Procedure:

***Bouncing Ball Activities:***

1. Drop a Happy Ball onto a hard surface (tile or cement floor preferred). Describe its behavior.
2. Repeat this procedure with a Sad Ball. Describe its behavior.
3. Repeat this procedure with both balls simultaneously, dropping them from a measured height. Measure how high they bounce.
4. Find a volunteer. Ask the subject if he/she can drop a ball and spin around and catch it before it bounces a second time. Demonstrate this using the Happy Ball. Switch the balls and hand the subject the Sad Ball.
5. Different formulations of Super Balls producing bright colors or translucent balls have different resiliencies. Obtain a number of different colored Super Balls and have a ball bouncing contest. Line up students and have them drop the balls at the same time to see which bounces higher.

***Effect of Temperature on the Happy/Sad Ball:***

1. Put both balls in a freezer or beaker of ice water. Drop both balls. Does their behavior change when they are cold? The Sad ball becomes even less elastic when frozen and will not bounce at all.
2. Boil both balls in a beaker of water. At about 85 °C, the Happy ball will float to the surface. When the water starts boiling, carefully remove the balls from the beaker and drop them onto the floor. The Sad ball will now bounce better than it did at room temperature.

***Comparing Densities:***

1. Place the Happy and Sad balls in a tall beaker half full of water. Do the balls float or sink? (*Note:* Save the water for step 3). What does this tell about the density of the balls?
2. Place the Happy and Sad balls in a tall beaker half full of glycerin (glycerol). Observe. Glycerin has a specific gravity of approximately 1.3 g/mL.
3. Pour the water from step 1 into the beaker of glycerin containing the balls. Observe and compare the specific gravities before mixing the glycerin and water.
4. Mix the glycerin and water. Observe.

## Discussion:

The Happy Ball is a sphere having an extremely high resilience factor in excess of 90% and a high coefficient of friction. These two qualities cause the ball to react in an extraordinary and unpredictable manner when bounced or struck. Thus, any spin applied to the ball will be accentuated when it rebounds from a hard surface.

The Happy Ball has a specific gravity of 1.03 g/mL (the specific gravity of water is 1.0 g/mL). It is composed of about 100 parts polybutadiene, 0.5 to 15 parts sulfur vulcanizing agent, and 5 to 15 parts of filler such as hydrated silica, carbon black or lithium oxide. The sulfur vulcanizing agent is added in excess to products such as automobile tires (which contain about 3 parts sulfur) to produce cross-linking between polybutadiene chains resulting in the high resiliency. The ball is molded at a pressure of between 500 and 3,000 p.s.i. for 10 to 30 minutes at a temperature of 285–340 °F (140–171 °C). This produces the Happy Ball with the properties described above. In addition, it has been found that these balls also exhibit an ability to conserve energy. That is, when bounced, the ball will dissipate very little of the energy imparted to it in the form of heat.

The Sad Ball may be composed of several different materials. Common materials used are butyl rubber and a block co-polymer of poly(styrene-butadiene) or a block co-polymer of poly(vinyl-butadiene). These materials have a specific gravity of 1.17 g/mL and have a structure that has a low resiliency, low elasticity, and the ability to absorb energy. Thus, when the ball is dropped, it does not bounce.

These properties make the Sad Ball material useful for a number of applications. The poly(styrene-butadiene) co-polymer is used in automobile tires where it helps to absorb some of the bumps encountered on the highway. This type of material has also found use in lining the ballistic containers used by bomb squads (these look like big trash cans). Should a bomb explode, this material will absorb a significant amount of energy.

## Safety Precautions:

Wear protective eyewear. A Happy Ball can rebound in unexpected directions. Take care in bouncing the ball so that it does not hit anyone or anything with sufficient force to cause injury or damage. When dropping a Sad Ball from a high location, take care that it does not hit anything that can be damaged.

## Disposal:

The glycerin and water solution may be rinsed down the drain with excess water according to Flinn Suggested Disposal Method #26b. Please consult your current *Flinn Chemical & Biological Catalog/Reference Manual* for proper disposal procedures.


## Acknowledgment:

Special thanks to Mr. David A. Katz, Associate Professor of Chemistry, Community College of Philadelphia, who provided us with the instructions for this activity.


## Materials for experiments with *Happy/Sad Balls* are available from Flinn Scientific, Inc.:

| Catalog No. | Description | Price/Each |
|---|---|---|
| AP1971 | Happy/Sad Balls | Consult Your Current *Flinn Catalog/Reference Manual.* |
| G0007 | Glycerin, 500 mL | |



 