

## MIXTURES

### PROBLEM PRESENTATION / EXPLORATION

- A. Ask students what they think would happen if we would put a magnet into a box of cereal. "Would the magnet have any effect?" Have them look at the content information on the box. (Cereal should be fortified with iron. One example is Total<sup>®</sup>.) Indicate that if we are going to "mine" this cereal for the iron we will have to break it up just like they do when mining for iron out of the ground. Then, maybe, our magnet will have an effect on the iron.
- B. Mining Procedure
1. Here are the instructions that are commonly given in some textbooks.
  2. Pour cereal into a 250 mL beaker up to the 100 mL mark and cover the cereal with 100 mL of warm tap water.
  3. Attach, with a rubber band, a bar magnet to a pop sickle stick. Wrap the stick/magnet combination with a plastic wrap such as Saran Wrap<sup>®</sup>.
  4. Stir the cereal/water mixture with the stick/magnet stirrer for about 3 minutes. A fine mush should result. Allow the mixture to sit for 10 minutes and then stir again. Leave the covered stick/magnet stirrer in the mush while not stirring. Allow it to sit for another 10 minutes. Stir one last time.
  5. Remove the stick/magnet stirrer and hold it over a white piece of paper. Is there any residue attracted to the magnet? (*Elemental iron that is included in food is called food-grade iron filings.*)
  6. Point out that the reason that the magnet did not attract individual flakes was that the flakes had so little iron and that their mass was so great that the magnet was not strong enough to attract entire flakes. However, when the "ore" was pulverized, the iron could be extracted from the other substances in the mixture.
  7. While these instructions probably work, it is much easier if you add a magnetic stirring bar to the beaker and place it on a heater/stirrer hot plate. Heating for about ten minutes with continual stirring results in a reasonable amount of iron filings adhering to the stirring bar.
  8. **A better way to show this phenomenon is to use the individual packets of Instant Cream Of Wheat<sup>®</sup>. You don't have to add any water or any heat. Simply allow the stirring bar to spin for about 30 seconds and when it stops there will be iron filings all over the magnetic stirring bar.**
- C. How can other mixtures that don't contain iron be separated? For example, without touching the mixture with your hands, how would you separate into three different containers a mixture made up of copper BBs, broken up toothpicks, and a spoonful of sugar? You may use other pieces of laboratory equipment, but you may not reach in with your hands and pick out the BBs. (No tweezers either!!) Have separate work stations set up for the students to carry out this separation. Include at the work stations beakers, a funnel, and filter paper (Mr. Coffee<sup>®</sup> filters are fine.)

### CLASS RESPONSE / CONCEPT INVENTION

- A. Various groups should report their technique for carrying out the separation. Have the class decide which was the best one. Why was it the best one? Things that should be considered in making these decisions are the purity of each final substance that they ended up with, and the ease of obtaining the individual pure substances.
- B. Probably the best sequence for carrying out the above separation is to pour the whole mixture into water. The sugar will dissolve; the BBs will sink to the bottom; and the toothpicks will float. The toothpicks can be skimmed off with a spoon or strainer. The remaining mixture (water, sugar, BBs) can now be poured through the filter. The BBs will be caught in the filter paper and the water/sugar mixture will pass through the filter paper. Finally, the water can be evaporated off leaving the sugar crystals.
- C. The idea to be invented at this stage is that the way we separate mixtures is to take advantage of the physical properties of the individual components of the mixture. In

the cereal example, the property that was utilized was the magnetic nature of the iron. Iron is magnetic; cereal is not. In the BB/Sugar/toothpick mixture we took advantage of the large density of the BBs (sank to bottom), the small density of the wooden toothpicks (floated in water), and the solubility of sugar in water. Stress that when separating a mixture we carry out reactions that capitalize on the components' different physical properties. This means that when the substances have been separated, the individual components will retain their original properties; they will not have been changed into some new substance. If chemical changes would have been utilized, the properties of the resulting substances would be different from those that each component in the mixture had at the beginning.

### CONCEPT EXTENSION

- A. Set up the following situations. Instruct the students to carry out the separation of components in each mixture. Have them decide what physical property was utilized in making the separation.
1. Green pieces of paper and red pieces of paper [Color]
  2. 5 circles cut out of green paper, 3 squares cut out of red paper, 6 circles cut out of red paper, and 2 squares cut out of green paper [Shape]
  3. Pour a mixture of marbles and salt crystals through a wire mesh screen [Size]
  4. Place a small piece of chalk and some sugar into a mortar. With the pestle grind it up. Now transfer the mixture into a small beaker. Add about 50 mL of water to the beaker and pour the contents through a filter paper. Catch the liquid in another beaker. [Solubility in water]
- B. The idea of recycling plastics is becoming more of an everyday issue. Presently, we use these materials once and then discard them. There is growing concern about the environmental impact of plastic garbage. In many communities plastics are separated into a container different from the paper and aluminum and are picked up by the city to be recycled. A major drawback to recycling plastics, not experienced in recycling aluminum cans, is that there are many different types of plastics. Before they can be reused they must be separated. What physical property could we use to separate a mixture of various types of plastics?
1. A very simple way to separate a mixture of plastics is to sort them according to their density. As we saw in the DENSITY experiment, a candle will float in water but will sink in rubbing alcohol. Its density is less than water, so it floats; but its density is greater than rubbing alcohol, so it sinks.
  2. If we extend this idea a little farther to the use of more than one liquid, we can sort the plastics according to their density. For example if we had four liquids arranged in density from low to high: rubbing alcohol, water, salt water, and Karo<sup>®</sup> syrup, what would happen if we dropped the candle into each liquid? Since the density of the candle is less than the Karo<sup>®</sup> syrup, the salt water, and the water it would float in each of these liquids. But because its density is greater than that of rubbing alcohol it would sink in only this liquid. If we would take a piece of plastic from a tape cassette box and drop it into each of the liquids, what would happen? It would float in the Karo<sup>®</sup> syrup; it would float in the salt water; it would sink in the water; and it would sink in the rubbing alcohol. From this we can tell that the cassette box must have a greater density than the candle.
  3. The Society of the Plastics Industry, Inc., has developed a voluntary uniform coding system for plastic containers which identifies containers by material type for the convenience of sorting the containers. The code is a three-sided triangular arrow with a number in the center and letters underneath. The number inside and the letters indicate the resin from which the container is made. Each of these plastics differs in density.



Five of the most common types and their densities (g/mL) are listed below:

PP	LDPE	HDPE	PS	PETE
0.90-0.91	0.92-0.94	0.95-0.97	1.05-1.07	1.39

4. Prepare the following liquids
  - a.) 5:1 mixture of rubbing alcohol and water (5 mL of rubbing alcohol for every 1 mL of water)
  - b.) 3:1 mixture of rubbing alcohol and water (3 mL of rubbing alcohol for every 1 mL of water)
  - c.) water (distilled water)
  - d.) salt water (use a 10% NaCl in H<sub>2</sub>O solution; 10 g NaCl for every 90 g H<sub>2</sub>O)
5. Prepare a mixture of plastics. The five liquids indicated in #4 above will not allow the separation of all plastics by density, but it will work on the most common types of plastics available to most classrooms. Some recommended plastics for this activity are
  - a.) plastic from gallon milk jugs, detergent bottles, plastic flowerpots, and plastic lumber (HDPE, HIGH DENSITY POLYETHYLENE)
  - b.) plastic from 2 liter soda bottles, plastic scouring pads, and Mylar tape (cassette & computer) (PETE, POLYETHYLENE TEREPHTHALATE)
  - c.) plastic from catsup bottles or yogurt cups (PP, POLYPROPYLENE)
  - d.) transparent plastic drinking cups, the brittle ones, plastic in cassette tape boxes (PS, POLYSTYRENE)
  - e.) plastic squeeze bottles, the type that are used for misting plants Elmer's<sup>®</sup> glue bottles (LOW DENSITY POLYETHYLENE)
5. Ask the students to separate the mixture of pieces of plastic by taking advantage of the physical property of density. Let them figure out the most efficient order in which they should test the samples that will result in the mixture of plastics being separated into piles having samples with like densities. [Probably should start with the most dense liquid, the salt water. Only the PETE will sink.] After skimming off all the pieces that did not sink in the salt water they should be added to the next most dense liquid, (water). EACH PIECE MUST BE THOROUGHLY DRIED BEFORE ADDING IT TO THE NEXT LIQUID. The remaining pieces can then be added to the water to separate out the next most dense ones. The same procedure should be then carried out in the two rubbing alcohol solutions.]

Liquid	Density g/mL	Plastics That Float in Liquid
Alcohol:Water (5:1)		PP
Alcohol:Water (3:1)	.945	LDPE, PP
Water (Distilled)	1.00	HDPE, LDPE, PP
Salt Water (10%)	1.05	HDPE, LDPE, PP, PS

6. If you prefer, the following scheme could be used to identify samples of plastic. It requires four test liquids, and based upon whether the sample floats or not the sample can be tentatively identified. The alcohol/water

mixture should be 3 parts rubbing alcohol to 2 parts water. The samples could be shredded and added to the liquids. If the sample does not sink immediately, push it down into the liquid with a pop sicle stick.

	Floats in Vegetable Oil	Floats in Alcohol / Water	Floats in Water	Floats in Glycerin
PETE	NO	NO	NO	NO
HDPE	NO	NO	YES	YES
V	NO	NO	NO	NO
LDPE	NO	YES	YES	YES
PP	YES	YES	YES	YES
PS	NO	NO	NO	YES