RECYCLED AGAIN (1.5 HOURS)

In this activity, students will design a procedure for separating five types of recyclable materials based on their physical properties.

Overview

Topic: Sorting Recyclables

Real World Science Topics:

- An exploration of how to use physical properties to sort materials.
- An exploration of how recycling plants sort recyclable materials.

Objective

Students will gain an understanding of how physical properties can be used to sort recyclable materials.

Materials Needed for Each Team of 3–4 Students

at least 3 clean, empty steel cans (such as soup cans)
at least 3 clean, empty aluminum cans (such as soda cans)
at least 3 clean, empty 2-liter plastic bottles
at least 3 pieces of crumpled paper
at least 5 glass marbles (must sink in water)
drinking straw
2 buckets
water
strong magnet
scissors
twine or rope
3 meter sticks (alternative: rigid materials that can be used as a frame)
masking tape

Materials Needed for Demonstration

sand (with pieces large enough that they do not pass through a normal window screen)
plastic beads, 0.5-cm diameter (must float in water)
piece of window screen (available at hardware stores) or a sieve
clear bowl
water

Standards Met

National Science Standards Addressed

Content Standard A: Science as Inquiry Students:

- Develop descriptions, explanations, predictions, and models using evidence.
- Think critically and logically to make the relationships between evidence and explanations.
- Identify a simple problem and propose a solution.

Content Standard B: Physical Science

National Technology Standards Addressed

Use models and simulations to explore complex systems and issues.

Contribute to project teams to produce original works or solve problems.

Sources:

National Science Teachers Association
http://books.nap.edu/html/nses/overview.html#content
National Council of Teachers of Mathematics
http://standards.nctm.org/document/chapter5/index.html
National Educational Technology Standards
http://cnets.iste.org/currstands/cstands-netss.html

STEPS FOR *RECYCLED AGAIN*

1. **Warm-up Activity:** Start by mixing the plastic beads into a large cup of sand. Ask the students to list differences between the beads and the sand. They will probably list size and color first. They may also say that the two are made out of different materials. Next, ask them how they could use these properties to sort the beads from the sand, aside from picking the beads out by hand. Some students may suggest that you could use a screen to separate them because they are different sizes. Produce a piece of screen and show that in fact you can do this, but that some of the sand particles are still too big to pass through the screen. Then show students a bowl of water. Ask how they could use the bowl of water to separate the two materials. Show them that the sand is denser than the beads, so the sand will sink in the water, but the beads will float. Explain that **density** is an important property when sorting materials.

2. Distribute the *Recycled Again* handout and materials to each group of 3–4 students. Each group should have a bucket of water, a magnet, and a bucket of recyclables that has at least 3 pieces of each type of material (paper, plastic bottles, steel cans, aluminum cans, and glass marbles). Explain that most recycling plants receive paper, plastic, metal, and glass recyclables; however, for this activity you have replaced glass bottles with marbles, because marbles are less likely to break.

3. Explain to the class that some recycling plants receive the recyclables just like the students have—all mixed up. This is called single-stream recycling. Tell students that their job is to find a way to separate the materials in their buckets without picking each out by hand. Ask them why handpicking the materials would not be practical. They might say that it would be unsafe to handle garbage, or that it would take a lot of time to sort through all a town's garbage.

4. Have the students analyze the five types of materials they have in front of them. Ask them to make a list of differences in the look and feel of the materials, as well as how the recyclables interact with the other materials used in the lab, such as the magnet or the water. Have them record their observations on the handout. Explain that the handout also lists key properties of each material, such as size and weight, that will guide students toward a productive design later in the lab.

5. Remind students that their goal is to create a procedure that will allow them to sort out the materials in front of them without picking out the pieces individually. Students are given a set of tools that they can use as part of their procedure. However, if they think of other tools that might be useful and are readily available, they should be encouraged to use them. Tell the students that they only have to come up with a list of steps for separating their recyclables—they do not have to figure out how to move the recyclables from one step to the next in their procedures.

6. Steel cans are the easiest material to separate. Student should see that you can use a magnet to attract the steel cans, while leaving everything else behind.

7. Students may come up with some very unique solutions for extracting the paper. One of the best ways to separate the paper is simply to blow on it. The paper is generally lighter than the plastic bottles and aluminum cans. Students can use the straw for this.

8. The density of the marbles suggests an immediate solution to this sorting problem. When the remaining materials are placed in a bucket of water, the marbles will quickly sink, while aluminum cans and bottles will float because they are full of air.

9. The last separation is the most difficult. Plastic and aluminum have similar properties: both are non-magnetic and have roughly the same density. This step will likely have the greatest variety of answers. If the students are having trouble, remind them of the Warm-up activity. Making a screen is one possible idea that students will think of to separate these final two materials.

10. Once students have designed their systems, have them test them out. To set up the test, it is best to push many desks together to form a row. Tell students that they can move the objects by hand from step to step after they have been sorted. For example, if students sort out the marbles by placing them in water, they can then pull the materials that float out of the water with their hands and place them back in the main bucket.

11. **Wrap-up Activity:** Lead a discussion of the results of the activity. Have groups volunteer to explain their procedures to the class. Ask them to identify the most effective or easiest parts of their designs. Ask them which materials were the most difficult to separate. Ask them whether they think their designs could be adapted for a large-scale recycling plant. Discuss with them which parts of the plan would work on a large scale and which would need to be modified.

Tell students that real recycling plants use some of the same techniques, but they also use high-tech devices to which students do not have access. For example, just like most students in this activity, a real recycling plant uses magnets to sort out the metal cans. On the other hand, newer recycling plants use cameras to recognize plastic bottles. The cameras then trigger short bursts of air that blow the plastic bottles off the conveyor belt and into the proper container.

Recycled Again **Extension Activity**

To extend this activity, invite students to research any recycling programs in their community. They should be able to find information on recycling on the website of their local government. In particular, students should find out whether their community has single-stream recycling, what types of materials are and are not recycled, and where the main recycling plant is located. Explain that many towns ship their recyclables to larger plants far from the locality.

RECYCLED AGAIN
BACKGROUND INFORMATION

Why recycle?

Most materials that we use today are processed from raw materials such as ore, trees, or sand. It requires a lot of energy to extract these natural resources from the environment and make them into products. There is also environmental damage to consider. Removing trees for paper can destroy a forest ecosystem. To access metal ore, miners may remove entire hillsides. Recycling reduces the amount of energy involved in the production process, and it also reduces the environmental damage. Some materials used in computers and other electronics may also be toxic. It is better to recycle those materials than to put them into a landfill.

What types of materials are recycled?

Many materials are recycled. Originally, only common materials such as paper, steel cans, and plastic were recycled. Some cities have begun recycling yard waste and using it as compost. The latest push is to recycle computers and other electronics. Worldwide sales of electronic devices of all kinds have skyrocketed, and so have the toxic materials that make up many key parts. Electronics companies are mandated by law in some countries to recycle their products.

How are materials sorted for recycling?

Older recycling plants require the person who is discarding the waste to sort it beforehand. This approach can be costly for municipalities. Special trucks are needed to transport the sorted garbage. It also discourages people from recycling, because they need multiple waste containers in their homes. More modern facilities are able to process all types of recyclables at once in a process called single-stream recycling. They do this using a mixture of simple and complex procedures. Steel and iron are removed using magnets. Paper is sorted by spinning the mass of recyclables in a bowl-shaped container. The less dense paper rises to the top and is easily separated. More complex techniques separate different types of plastics. Special optical scanners can recognize different types of plastics. The scanners control small bursts of air, which blow the targeted plastics off the conveyor belt and into the appropriate hopper. Optical scanners also separate different colored glass bottles, which are then crushed.

What are the advantages and disadvantages of single-stream recycling?

Single-stream recycling encourages people to recycle because they only need one recycling bin. It also eliminates the need for special trucks. A disadvantage of single-stream recycling is that mixing the recyclables together may cause contamination. The sorting procedures are not perfect, so different types of materials do get mixed together sometimes. It also takes more energy to sort the materials than to have people sort them before they discard them.

Key Vocabulary
Density: the mass of an object divided by its volume
Single-stream recycling: a recycling technique in which all of the materials are sorted at the plant instead of beforehand

TEACHER HANDOUT FOR *RECYCLED AGAIN*

Name _____ **Date** _____

How are the recyclable materials in this lab similar, and how are they different?

Size

[There are many different sizes. Marbles are small, whereas plastic bottles are large. Cans are in between.]

Attraction to magnets

[Only the steel cans are attracted to magnets.]

Weight

[A piece of paper is the lightest. Marbles are small, so they are also light. The cans and bottles are larger and weigh more.]

Does it sink in water?

[Marbles and steel cans sink. Aluminum cans and bottles will sink if they are filled with water. Paper will eventually sink if you allow it to get too wet.]

Write down the steps you used to separate these five materials.

1. [I used a magnet to attract the steel cans.

2. I used the straw to blow the crumpled paper away from the rest of the materials.

3. Then, I put the rest of the materials in a bucket of water. The marbles sank, and the bottles and cans floated.

4. Finally, I made a screen out of meter sticks and rope and used that to separate the large plastic bottles from the smaller cans.]

Were these techniques effective? If not, how could you have improved them?

[Separating the paper by blowing on it was tough because you had to blow right on it. If we had a fan, it could have been put on a setting that would blow away the paper but not the heavier materials.]

STUDENT HANDOUT FOR *RECYCLED AGAIN*

Name _____ **Date** _____

How are the recyclable materials in this lab similar, and how are they different?

Size

Attraction to magnets

Weight

Does it sink in water?

Write down the steps you used to separate these five materials.

Were these techniques effective? If not, how could you have improved them?