Recycling Plastic – neither as easy nor as complicated as we think

Cynthia Cudaback, PhD, OceanAndYou.com

"This plastic package is recyclable! That's great, right?" Well, no, not really. There are several issues.

- Recyclable is not the same as Recycled
- There are 7 types of plastic, which can't be mixed together.
- Only 2 types of plastic can be recycled curbside in most cities.
- Plastic bottles are rarely made into more plastic bottles.
- You can learn about different plastics by measuring their densities.

Recycled Vs Recyclable

Most kids don't know that plastic is made from oil. Make sure to tell them this, and connect it with the oil spill in the Gulf of Mexico. The vast majority of plastic bottles are made from new oil, not from other plastic bottles. Water bottles are often proudly labeled "recyclable!", which is essentially meaningless. All plastic bottles are recyclable. If the bottle were made out of recycled material, it would say so. The "please recycle me" label is simply passing the buck.

The recycled/recyclable issue relates to the three arrows on the recycling triangle. Contrary to popular myth, they do not stand for "reduce-reuse-recycle" but rather for the three stages of the recycling process.

- Step 1: you put your used whatever in the bin
- Step 2: the recycling company throws away whatever it can't sell. The good stuff is made into something new.
- Step 3: you buy something made from recycled materials

So … don't buy "Recyclable", buy "Recycled"

Types of Plastic

Most plastic containers have the  symbol on them, but few are commercially valuable. Cities need to make a profit on their recycling efforts, and only two types of plastic are profitable:

- #1 PET plastic with a narrow neck (soda and water bottles)
- #2 HDPE plastic with a narrow neck (milk and water jugs, detergent & shampoo bottles)

Google the name of your city and "curbside recycling." I checked Raleigh, Berkeley and New York, all of which accept only the plastics listed above. Interesting detail: bottles with narrow necks are blown like glass, and the viscosity of the molten plastic affects its re-usability. I suppose that, like glass, the bottles are just melted down and re-blown. Actually, plastic bottles mostly get turned into fleece jackets and the like, unless they're dumped in a Chinese landfill. But in theory, it's the easiest type of plastic to recycle.

Notice a major item missing from this list? Plastic bags! Plastic grocery bags are the biggest contaminant in Raleigh's recycling stream. If you put them in your bin, they'll end up in a landfill. Take them to the grocery store; the store trucks take food to the stores and bags back to a central location. Better choice: bring your own reusable bag.

Properties of Plastic

Density

The article you're reading is inspired by a lesson plan from Recycleguys.org. They provide a lot of useful information, but I took a class in which their "plastics density" lesson plan was mis-interpreted. So here's an alternate form of their lesson, which I hope is clearer.

Different types of plastic have different densities, and it's fun for kids to measure density. You can get a tube full of chopped up plastics from NAPCOR.com, or you can use real trash. Here's the thing – all plastics have densities very close to 1 g/ml, which is the density of water (one gram per milliliter). For example, soda bottles happen to be made of the densest plastic, at 1.38 g/ml, so that type of plastic should just barely sink in water. But, if you try to sink a soda bottle that has even a tiny air bubble, it will float.

The existing lesson plan suggests seeing whether a soda bottle will float with the lid on. I asked the class leader "are we measuring the density of plastic or air?", and she earnestly said "we're measuring the density of plastic". That's just plain wrong. Density, as we all can recite, is mass per unit volume. The volume of an empty water bottle is mostly air. Of COURSE it floats - it's just like a beach ball. We know glass is denser than water, but glass bottles float just fine.

Clearly, the bottle-with-lid step is confusing – I recommend either skipping it or providing a more expanded buoyancy lab. For the plastic density lab, I recommend:

- keep it simple - you don't need all 7 types of plastic.
    - soda bottles are PET #1 with a density of 1.38-1.39 g/ml (happens to be the densest plastic)
    - plastic soda lids are polypropylene #5 with a density of 0.90-0.91 g/ml (the least dense plastic - handy, that)

- remember that to measure the density of a substance you must fill it completely with water and submerge it – no air bubbles. That means

    - you need a reasonably deep tub, and you have to be willing to get your hands wet
    - you need to cut the tops off your bottles and push the plastic right under the water

- I recommend this order of operations
    - start with just a cut off soda bottle and its lid – the former will sink and the latter will float
    - explain to the kids that density is a fundamental property of a material, and that plastics of different density can't be melted together
    - allow some free play with different types of plastic – the differences are quite subtle, and the kids might not correctly identify floating and sinking, but they'll have fun

Response to Heat

Different plastics have different melting points. For example #1 PET plastic melts above 250^{o}C and #2 HDPE melts above 120^{o}C. According to BerryPlastics some PET bottles can soften and deform if filled with water above 60^{o}C (140^{o}F). The Recycleguys suggest filling plastic bottles with warm tap water to demonstrate that the bottles soften up. When I tried this experiment using a 2L soda bottle, I found that a bottle with water in it feels different from an empty bottle, but I could not clearly identify a thermal effect. Once when camping, I poured boiling water into a disposable plastic cup, and the cup crumpled dramatically, but I have not been able to replicate the effect in my kitchen. So measuring thermal effects on different plastics is left as an exercise for the reader.