Tools for Materials Science - Challenge n°4 - 40'

"PLASTIC": IF YOU KNOW IT …YOU SORT IT!

Plastic" is much too generic a word: different polymers have different properties and therefore different uses. There are standard identification symbols for each of the commonly used polymers.

Polymers are often sorted by automated flotation using a series of separation tanks where any material which is denser than the liquid falls to the bottom of the tank while materials which are less dense float. Your task is to model the sorting process.

On the table you have different plastic samples (each one with an identification number but NO symbol): some of them you will be definitely able to identify, some others only as "it is A or B". You have also three "tanks" with pure water, a saturated salt solution and glycerol (propane-1,2,3-triol) in them.

1. First place each sample in the water and observe whether it floats or sinks. Record the results.
2. When you have tested all the samples in water, leave them to dry on a piece of paper towel and move on to the salt solution: this time you need only to test the samples which sank in the water. Record the results.
3. Dry off each of the samples and move on to the next "tank": this time you need only to test the samples which sank in the salt solution. Record the results.

CAREFUL! It may seem that ALL samples float on water and other liquids but ... try to stir vigorously or sink them and watch what happens!

Polymer density chart

Common polymers in order of increasing density, compared to three liquids of known density. Polymers listed above the liquid will float in it. Those below will sink. The density of a polymer type can vary within a characteristic range rather than having a single, specific value.

Polymer	Liquid (density in kg/m^3)
PP (polypropylene) **PE** (polyethylene)	***GROUP 1***
	Water 1,0 x 10^3
ABS (acrylonitrile butadiene styrene) **PS** (polystyrene)	***GROUP 2***
	Saturated salt solution 1,14 x 10^3
PMMA (polymethyl methacrylate or "acrylic" or"perspex") **PC** (polycarbonate – *variable density*)	***GROUP 3***
	Propane-1,2,3-triol (glycerol) 1,26 x 10^3
PC (polycarbonate – *variable density*) **PET** (polyethylene terephthalate) **PVC** (polyvinyl chloride)	***GROUP 4***

☞ **OUTPUT WANTED:** **Fill the table given in the answer sheet**

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Answer sheet **GROUP N°_____**

Ch.4 --- "PLASTIC": IF YOU KNOW IT … YOU SORT IT!

Q1 Fill the following table

Sample Number	Floats in:	Sinks in:	Polymer Group
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

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Teacher's notes

Technical notes:

- Recycling is seen as preferable to landfill and Energy Recovery processes because:
  - it reduces the amount of raw material being used;
  - uses less energy than needed to produce the raw materials.
- However recycling has its own environmental costs as well as benefits. For materials to be recycled they first have to be sorted."Plastic" is a much too generic word: different polymers have different properties and so different uses. There are standard identification symbols for each of the commonly used polymers. (*See polymers symbols table in pag.n.1*)
- Most sources of recyclable material provide a random mixture of various plastic types, but recycling processes generally require a single polymer to be used. Therefore, the first step of the recycling process is to sort the input waste stream into its components. The economic viability of recycling plastic materials depends on developing an inexpensive and fast method for sorting dirty, crushed plastic bottles and containers. At present, this sorting process is labour-intensive and represents a significant portion of the costs associated with the recycling process. Automating the sorting process is essential for any large-scale effort. Recycling plants use mostly physical properties for identification and separation of polymers. They are sorted by: density, near-infrared absorption, colour, electrostatic properties, manual separation …
- Polymers are often sorted by automated flotation using a series of separation tanks where any material which is denser than the liquid falls to the bottom of the tank while materials which are less dense float. Polymers are shredded into flakes: items which could trap air or are made of more than one material would give odd results.
- Each liquid only produces a float sink separation, so several tanks with several different liquids might need to be used where there are more polymers to be sorted.
- The different plastic samples can be very easily found and completely free of charge in students' waste bins at home: wrappers, boxes, shampoo or detergent bottles, water and soft drinks bottles, yogurt vases, plastic cutlery, food trays, etc… Ask them to bring them over. Each of them should have an identification number and symbol: it will help you check your density sorting.

Organizational notes:

- Each student will keep a copy of the students' sheet but the group will collectively fill in the answer sheet and give it over to the teacher in charge at the end of the lab.

Correction grid

Mark 2 point for each sample which is put in the right Group

Key to Answer

The correct answers are given by previously testing the same samples the students will have been working on.

The activity is considered propedeutic to project about plastic recycling collection of bottle caps, shredding with Filamaker shredder, extrusion with Felfil extruder + 3D printing of open source files to be customized of lab equipment to enhance the school lab and also of the junior neighbouring schools. See **From Plastic to lab sheet.**

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As an alternative it can be used to complement the activity on the ecoplate Pappami, **Ch10_TEACH_EN_eco alternative to disposable plates**

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