centre de développement pédagogique

pour la formation générale en science et technologie

PRACTICAL AND THEORETICAL CAPSULE

COMMON PLASTICS

May 2008

WORKING DOCUMENT

Objective:

The objective of this capsule is to draw up a resume of the origins of various plastics and to simplify the identification of common plastics in the laboratory.

Since the field of plastics is so vast, our experiments will be limited to those plastics usually found in the recycling bin.

Carbon cycle

The most common elements on Earth are oxygen and silicon. Carbon comes in 14th. Since the Earth is a living planet, carbon is a part of a cycle by which it is held and released. This cycle involves the lithosphere, the biosphere and the oceans.

For the past several years, alarms have been sounded concerning climate change and the human activities that play an important part in these changes. Well, carbon is one of the principal components of greenhouse gases which include carbon dioxide (CO_2) and methane (CH_4). A fragile balance must be maintained between fixed carbon and carbon that is present in the atmosphere. The greenhouse effect is in fact, a contributor to the development of life, to its maintenance and to climate regulation.

There are two kinds of carbon: organic and inorganic. Organic carbon, as its name implies, originates from living organisms. It can bound to other carbon, hydrogen, nitrogen and phosphorus atoms, in so called "organic" molecules, or in hydrocarbons. Inorganic carbon does not originate in living organisms; rather, it mainly comes from atmospheric carbon dioxide or from carbon present in limestone ($CaCO_3$).

For a detailed, but understandable, explanation, the Planète Terre de l'Université Laval website is an excellent resource:
http://www.ggl.ulaval.ca/personnel/bourque/intro.pt/planete_terre.html

From geological deposits to polymers:

Plastics are generally petroleum derivatives. While petroleum is exploited and consumed at an astounding rate, the plastics industry accounts for a mere 3% of this number.

Crude oil is refined by fractional distillation and it is from naphtha, one of these fractions that monomers originate. Monomers are organic molecules (C-H-O-N-S), made up of a high number of atoms (macromolecules). These macromolecules are then assembled into long chains of carbon and oxygen called polymers. This process is called polymerisation.

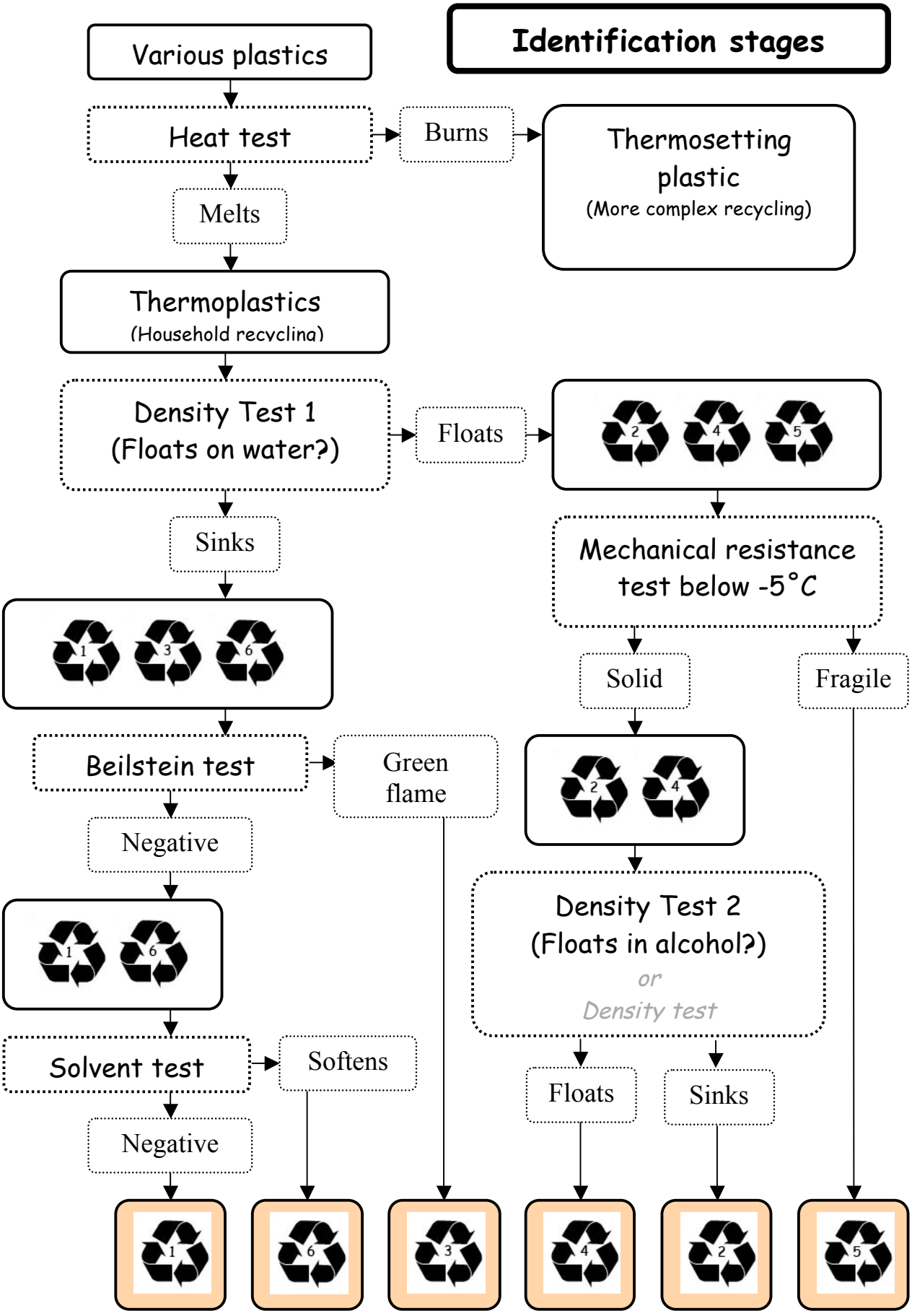
Here is an excellent website where a vast quantity of information pertaining to plastics can be found:
http://www.plasticseurope.org/Content/Default.asp?PageID=499

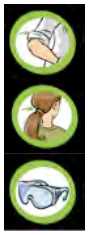
Plastics identification codes:

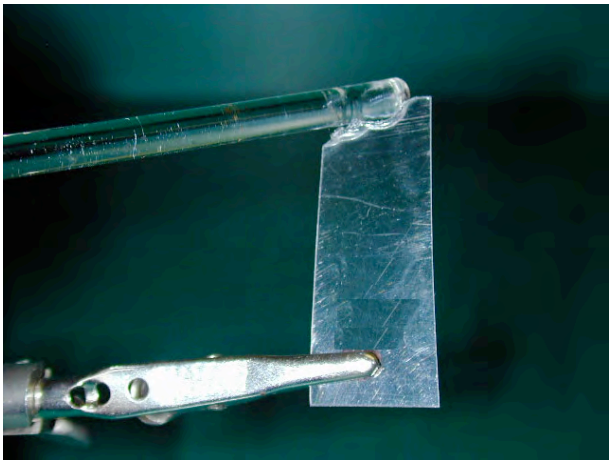
Code	Name	Properties	Uses	Recycling
 PETE or PET	**Polyethylene terephthalate**	•Transparency •Heat resistance •Pressure resistance	•Pop bottles •Juice bottles	•Carpets •Clothing •Bags •Bottles
 HDPE or PE-HD	High density polyethylene	•Resistance to chemical products •Ease of shaping •Good resistance to gas and humidity permeation	•Liquid detergent bottles •Milk, juice, water and margarine containers •Bags inside cereal boxes	•Oil bottles •Floor tiles •Fencing •Playground equipment •Garbage cans •Drain pipes
 PVC or V P	Polyvinyl chloride	•Transparency •Resistance to chemical products	•Shampoo bottles •Hand soap bottles	•Pipes •Bottles (non food) •Mud guards •Floor tiles •Cables •Speed bumps
 LDPE or PE-BD	Low density polyethylene	•Flexibility at low temperatures •Moderate transparency •Allows for a good seal (bottle stopper)	•Bread bags •Freezer bags •Squeezable bottles (honey, mustard…)	•Shipping/handling envelopes •Garbage bags •Floor tiles •Garbage cans

 PP	Polypropylene	•High fusion point •Good resistance to chemical products and to fats	•«Ziploc» type containers •Margarine containers •Drinking glasses	•Car parts •Trays •Carpets •Geo-textile fibres
 PS	Polystyrene	•Allows for the production of foam	•Protective packaging •Insulated packaging •Compact disc cases	•Office accessories •Trays •Video cassettes •Insulation panels
 Others	•Objects made from a mix of different kinds of plastics. •Other plastics like nylon and acrylic		Various applications depending on the combinations used. •Various containers, nylon stockings…	

Identification stages



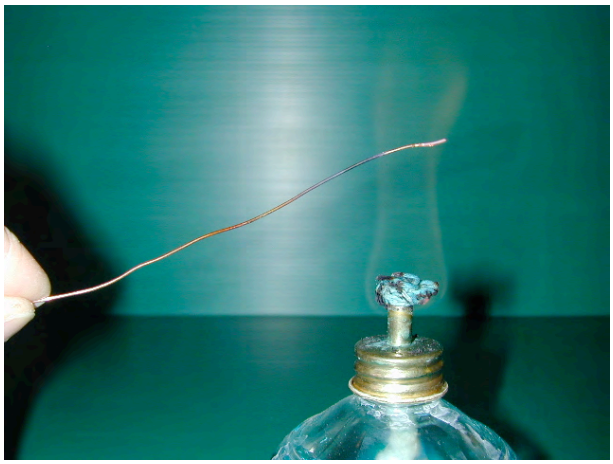
Heat test	
Material	Manipulations
• 1 plastic sample • 1 burner • 1 fuel bottle • 1 glass rod • 1 package of matches	 • Be careful of the flame and beware of loose clothing • Long hair must be tied back in order not to get burned • You must wear safety glasses 1) Heat the glass rod at the top of the flame. 2) Apply the heated tip of the rod to the plastic sample. 3) Observe and note your observations.



Density test 1 (Floats on water?)	
Material	Manipulations
• 1 plastic sample • 1 beaker • 1 bottle of water at room temperature	1) Place the sample of plastic in the water (Ensure that there are no air bubbles on the sample) 3) Observe and note your observations.

Beilstein test

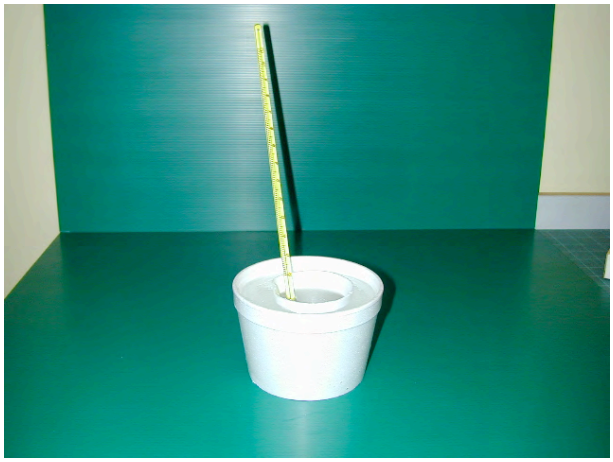
Material	Manipulations
• 1 plastic sample • 1 burner • 1 fuel bottle • 1 copper wire (a calibre between AWG#20 and AWG#28 will do) • 1 package of matches	 • Be careful of the flame and beware of loose clothing • Long hair must be tied back in order not to get burned. • Do not breathe in the emanations produced while the plastic is heating. While the quantities manipulated here are infinitesimal, we still recommend manipulation under a hood. • You must wear safety glasses. 1) Heat the copper wire at the top of the flame until it becomes incandescent. 2) Apply the red hot wire to the plastic sample in such a way as to coat the wire with plastic. 3) Replace the coated wire in the flame. 4) Observe and note your observations

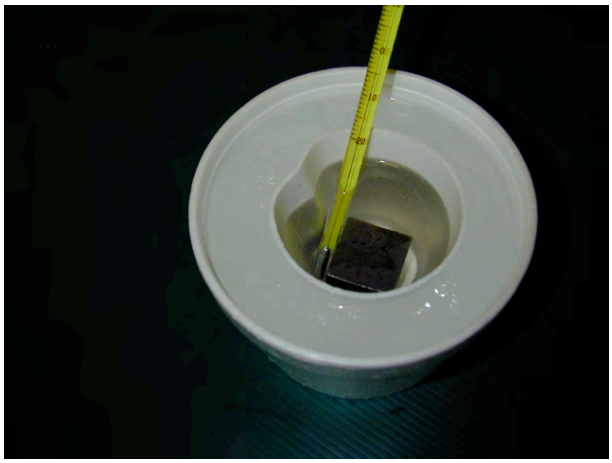


Solvent test	
Material	Manipulations
• 2 plastic samples • 1 beaker watch glass • 1 eye dropper • 5 millilitres acetone	 • Do not breathe in the acetone vapours. While the quantities manipulated here are infinitesimal, we still recommend manipulation under a hood. • Do not ingest the acetone, it is poisonous. • Keep acetone far from the flame, for it is flammable. • You must wear safety glasses. 1) Place a drop of acetone on the sample. 2) Observe the presence of discoloration or softening and note your observations.

Mechanical resistance test below -5°C

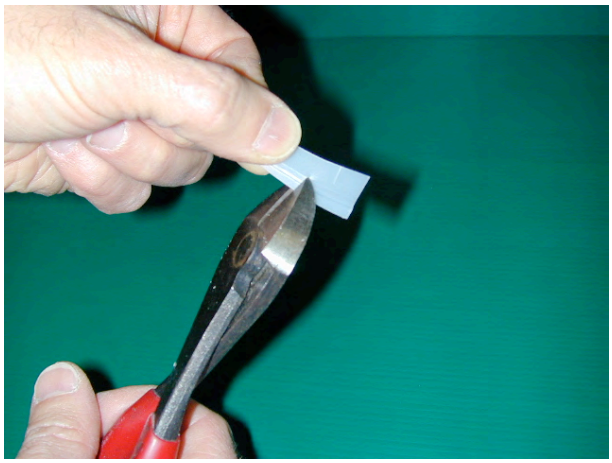
Material	Manipulations
• 1 sample of plastic of even thickness • 1 stapler • 1 freezer N.B. A home made thermos can be made using two expanded polystyrene containers of different sizes. One can easily attain and maintain a temperature of -15°C for longer than 30 minutes (see photos and comments below).	1) Cool the sample by immersing it in alcohol refrigerated at about -15°C for approximately 60 seconds. 2) Immediately after cooling, partially (not entirely) cut the sample with a pair of pliers or partially staple the sample. (N.B. The extremity of the tested sample must not touch your fingers in order not to heat the sample). 3) Observe the cut. 4) Note your observations.



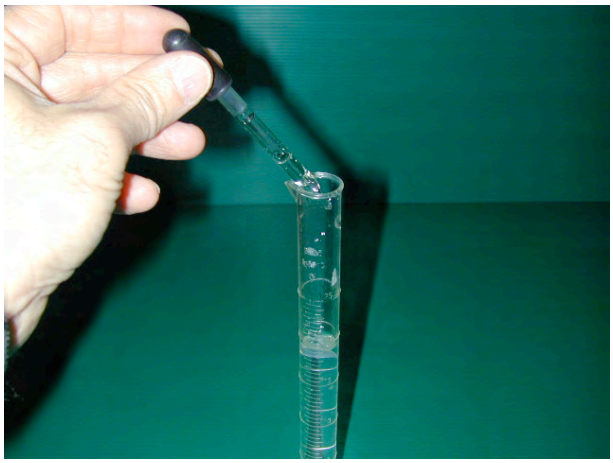


Making the thermos

- Put a weight on the bottom of a slightly shortened coffee cup so as to increase its density.
- Fill the cup with alcohol (ethyl or other).
- Place the cup in the center of a larger container.
- Add water all around the cup.
- Add a cover to the entire arrangement (the larger container's cover)
- Place the whole thing in a freezer adjusted to approximately -15°C.
- Take the whole thing out the next day just before the test.



Density Test 2 (Floats in an alcohol solution?)	
Material	Manipulations
• 25 mm^2 sample of plastic • 1 control sample of PEHD • 1 eye dropper • 2 - 25 ml graduated cylinders • Room temperature water • 70 % ethyl alcohol at room temperature.	 • Do not ingest this alcohol, it is poisonous. • Keep far from flame, because alcohol is flammable. 1) Pour 5 ml of alcohol into each graduated cylinder. 2) Place the control sample in one of the graduated cylinders. 3) Plastic the plastic sample in the other graduated cylinder. (Ensure that there are no air bubbles on the samples.) 4) Using the eye dropper, add water, 0.5 ml at a time to each of the graduated cylinders. (The samples should move away from the bottom during the process). 5) Observe and note your observations



Alternative suggestion to this test to study the uncertainty of the measurement:

Archimedes and density