Physical Properties of Polymers

Objective: The objective of this experiment is to test and compare the physical properties of thermoplastic polymers.

Review of Scientific Principles:

Plastics are long chain molecules. Depending upon the monomers, the plastic will have different physical and chemical properties. Chemical properties are difficult to test for and usually call for the destruction of the plastic through incineration. Burning plastics can give off toxic fumes. This is one of the reasons firemen wear a self contained breathing apparatus when entering a burning building.

It is easier and safer to check the physical properties. Different plastics look, feel, and behave differently. Some are clear and colorless, while others are opaque. Some feel soft, while others feel slimy, slippery, or tacky. Some are more rigid than others. Each plastic has a unique density. Each plastic has a temperature at which it softens and/or melts.

The densities of the seven polymers are somewhat variable. The table below gives the expected normal range of variation for each:

Abbreviation	Common name	Chemical name for polymer	Density range/g cm-3	recycling symbol
EPS	expanded polystyrene	poly(phenylethene)	0.02 – 0.06	
PP	polypropylene	poly(propene)	0.89 – 0.91	
LDPE	low density polyethylene	poly(ethene)	0.91 – 0.93	
HDPE	high density polyethylene	poly(ethene)	0.94 – 0.96	
PS	polystyrene	poly(phenylethene)	1.04 – 1.11	
PVC	polyvinyl chloride	poly(chloroethene)	1.20 – 1.55	
PET	polyethylene terephthalate	poly(ethenediyl-1,4-benzenedicarboxylate)	1.38 – 1.40	

Procedure:

The melting or softening point we discussed in the last investigation is important when recycling, because when a plastic is softened or melted, it will adhere (stick) to itself. Generally when two or more plastics are softened or melted, the plastics will not adhere to one another. This is one of the reasons why recycled plastics must be sorted. This is an expensive process that adds to the costs of recycling.

General Safety Guidelines:

- Care should be taken in minimizing contact with the solutions used in the buoyancy portion of this experiment.
- Aprons and goggles should be worn during the experiment.
- The ethanol solutions and calcium chloride solutions are to be returned to the container provided by your instructor.
- Hands should be washed after the experiment has been completed.

Materials and Supplies:

Samples of the following plastics:

HDPE (high density polyethylene),

LDPE (low density polyethylene),

PET (polyethylene terephthalate),

PP (polypropylene),

PS [in solid form] (polystyrene),

PS [in foam form], and

PVC (polyvinyl chloride);

- ethanol/water solutions of various concentrations:

52% ethanol (density = 0.911),

38% ethanol (density = 0.9408), and

24% ethanol (density = 0.9549)

- calcium chloride/water solutions of various concentrations:

6% $CaCl_2$ (density = 1.0505),

32% $CaCl_2$ (density = 1.3059), and

40% $CaCl_2$ (density = 1.3982)

- Cyclohexane (density = 0.7),
- Butanol (density = 0.8),

- 250 ml beaker

Procedure:

1. Obtain a sample of each type of plastic, noting the letter on each piece. The letters are used to reference each sample.

2. Examine each sample and write a visual description in the proper location in the data table.

   a) Is the sample clear? Is the sample opaque? Does it have color?

   b) In the data table describe how the sample feels. Is the sample smooth or rough? Does it have a pattern?

   c) Flex each sample through an angle of 10^{o} to 30^{o}. Note in the data table how easy it was to flex the sample. Is it flexible or rigid? You might want to compare the various samples.

3. Pour 50 ml of the 40% $CaCl_2$ solution into a 150 ml beaker. Place each of the plastic samples in the solution. Note which samples sink (S) or float (F) in the DATA TABLE.

4. Return the solution to the appropriate container and dry out the beaker.

5. Dry off your samples.

6. Repeat Step #3-5 with:

   32% calcium chloride,

   6% calcium chloride,

   24% ethanol,

   38% ethanol, and

   52% ethanol

7. Return all plastics to the recycling box after usage.

Data Table:

Test	**A**	**B**	**C**	**D**	**E**	**F**	**G**
Visual Description							
Surface Appearance							
Rigidity							
Float/Sink Ethanol mix 52%							
38%							
24%							
Float/Sink $CaCl_2$ mix 6%							
32%							
40%							
Float/Sink cyclohexane							
Float/Sink butanol							

Questions:

1. From the data given in the REVIEW OF SCIENTIFIC PRINCIPLES section identify each of the plastics by proper recycling number and proper name.

Sample A

Sample B

Sample C

Sample D

Sample E

Sample F

Sample G

2. When testing for the density of the plastic samples, why did some of the samples stick out of the solution more than other samples?

3. If you were given two plastic samples, how would you identify them?

4. Which of the polymer (plastics) would be used as a material in making each of the following?

   Use letters and names to identify each polymer.

   i) A covering to go around a sandwich?

   ii) A replacement for a picture window ?

   iii) As a covering for a plastic bowl?

   iv) As a replacement for the lead sinkers used in fishing?

   v) As a clip board to write on?

5. Which polymer was most flexible?

6. Which polymer was most transparent?