Comparing the Bounce in a Ball

Background
One way to change properties of a polymer is by crosslinking and using different monomers. Rubber is no exception. When synthetic rubber is created, different monomers and different amounts of crosslinking are used to alter the properties. A variety of properties are needed for various applications. Some applications for rubber include: soles of shoes, tires, bouncy balls, seals for connections and rubber bands.

Purpose
In this activity the Neoprene® and Norsorex® balls will be dropped from various heights to compare the elastic properties of the spheres.

Procedure:
1. Drop the two spheres from a variety of selected heights.
2. Record the height of the bounce at each height in a data table.
3. Place both spheres in cold water for the same amount of time (at least 10 minutes) and then drop them from the same height.
4. Record the height of the bounce in a data table.
5. Place both spheres in hot water for the same amount of time (at least 10 minutes) and then drop them from the same height.
6. Record the height of the bounce in a data table.

Analysis
1. What is the difference in behavior of the two balls when dropped?
2. Before the balls were dropped, how did their energies compare?
3. How did the energy compare after they hit the floor?
4. Which ball lost more energy?
5. Where did the energy go?
6. Explain how this effect would be different on the moon.
Polymer Engineering Shop

Company Name:

You work for a company that makes______________________. Your company has been sent out to find a new and improved product. To do so, each employee must synthesize, study, and report on several different polymers. As a group, the company must decide which polymer would be the best to use for new and improved product. Once the company decides which polymer to use, they must make a commercial promoting that polymer (explaining why that polymer is the best one to use to make the new and improved product).

Each member of the group is responsible for making the polymers, but everyone will have an additional title and responsibility. You will work together as a team, and ensure that each member is completing his or her part. Everything submitted will be graded. As a group, decide which group member should be assigned each role:

Company Divisions

• **President of the Board**: This will be the person in charge of the group. This person should be someone responsible, willing to investigate alternatives for future products and has proven ability to coordinate and complete a project. They will hold the meeting of the group and communicate with the North American Trade commission president (the teacher).

• **Public Relations Representative**: This person should be someone who enjoys working with people, talking in front of crowds and has proven ability to presenting new and fascinating information. This person will be one of the lead members in making the commercial and presenting the marketing aspect of the product. They will also be helping synthesizing the first time around in the lab.

• **Organic Chemist**: This person should be someone who enjoys experimenting with chemicals and researching new polymers. He or she should have a proven ability to work carefully and methodically. This person will be responsible for verifying that the final product report is in order and all of the information has been recorded. He or she will also be responsible for answering most of the questions about the properties and techniques of the actual polymer. They will be helping with the synthesizing in the lab at all times. If the group needs to recreate or come up with a different version of their product, the organic chemist will be the one that leads this effort in the lab.

• **Advertising Manager**: This person should be someone who is good at developing gimmicks and slogans. He or she should also have proven their ability to persuade and influence others. They will be the other person responsible for the commercial and the marketing of the product. They will also help synthesize during the first time in the lab.

Requirements

• As a group, list the properties that your final product should have. List as many as possible. Rank the properties in relative importance.
• Synthesis of various polymers: Each member of the group will be a designated
employee for this part of the project. Some polymers have variations which should be investigated if it is a potential option for their product.

- Employee 1: polymer A and B
- Employee 2: polymer C and D
- Employee 3: polymer E and F
- Employee 4: polymer G and H

- Report: Each employee must submit at least two reports, one on each polymer synthesized, to the company and to the North American Trade Commission President. These reports must be typed. The report should include, but not be limited to, the sample given below:

**REPORT ON POLYMER (letter)**

Employee's name

1. Material, quantity and cost (see price list below) needed for polymer (letter):
2. Description of the polymer:
   a) Describe the polymer and report if you recommend its use for the new product. If it cannot be used for that particular product, suggest one product that the sample could be used for.
   b) The descriptions should be concise, but should also have complete sentences. The description does not have to be limited to the questions below. Be sure to include and organize all the information in a way that is easy for others to understand.
   c) Things to consider when describing the polymer:
      o Does it have the desired properties for the new product?
      o Does it have the right texture? If not, is it too slimy, too stiff?
      o Can you pour it?
      o Can you knead it? What happens to it when you knead it?
      o Can you bounce it?
      o How does it respond to pressure (squeezing it)?
      o Does it retain its shape when placed on a table for several minutes?
      o Is it viscous?
      o What happens when it is pulled apart quickly? Slowly?
      o Does it pick up water-soluble ink, graphite, or newsprint?
      o Make an imprint in the polymer with a coin or small object. Does the imprint last? How long?
      o Compare the properties of the product to the properties of the reactants?
      o The synthesis of a polymer involves a chemical change. What evidence do you have that indicates you have actually made something new?
      o If you made several variations of a polymer, compare and contrast their properties. How do they differ?

- Company conference: As a company, discuss the polymers made by each member of the company. Together, chose a polymer for your product. Everyone should **verbally** present his or her ideas to the group before a decision is made.
- Final report of product (Patent Form): A complete analysis of the chosen polymer...
needs to be prepared by the group. It should include a thorough description of the polymer, including if it has straight chains, branched, or is crosslinked (networked. Make sure your group includes what evidence you have to support your claims about the type of polymer and why it should be used for your particular product. Also include a description of any additional information you would need to confirm this. Make a drawing of the possible structural formula or model for this polymer. (Look at the chemicals used to synthesize the polymer.) The report should be typed.

- Commercial: The television time slot for the commercial is only one minute. In that time, you are to use whatever means necessary to convince the audience that a particular polymer is the best for a certain product. You can show the real thing, the data, the chemistry, and/or compare it to poor alternatives (clinical trials show...). Be sure to convey the message that your product is the best option for the product. Creativity counts!

- Questions and answers: Be prepared to defend your logic to critical buyers (your classmates and the head of the organization (the teacher)), who are interested in marketing your Product and to the North American Trade Commission. Remember your company thoroughly investigated and tested many types of polymers, so use your knowledge and experience to answer questions and to defend your polymer.
Polymer Engineering Shop

Price List
Refer to the following price list for each material that could be used in your newly engineered car part.

<table>
<thead>
<tr>
<th>Material</th>
<th>Unit</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyvinyl Acetate – White Glue (PVAc)</td>
<td>20 mL</td>
<td>$0.25</td>
</tr>
<tr>
<td>Polyvinyl Acetate – Wood Glue (PVAc – wood)</td>
<td>20 mL</td>
<td>$0.30</td>
</tr>
<tr>
<td>Sodium Polyacrylate Powder (SPA)</td>
<td>1 gram</td>
<td>$0.20</td>
</tr>
<tr>
<td>Saturated Sodium Borate Aqueous Solution</td>
<td>10 mL</td>
<td>$0.25</td>
</tr>
<tr>
<td>Solid Sodium Borate Powder Form</td>
<td>1 gram</td>
<td>$0.25</td>
</tr>
<tr>
<td>Talcum Powder</td>
<td>1 gram</td>
<td>$0.05</td>
</tr>
<tr>
<td>Hand Lotion</td>
<td>1 “pump”</td>
<td>$0.05</td>
</tr>
<tr>
<td>Food Dye</td>
<td>1 drop</td>
<td>$0.05</td>
</tr>
<tr>
<td>Mixing Cup</td>
<td>1 cup</td>
<td>$0.10</td>
</tr>
<tr>
<td>Wood Stirring Stick</td>
<td>1 stick</td>
<td>$0.10</td>
</tr>
<tr>
<td>Ziploc Bag</td>
<td>1 bag</td>
<td>$0.10</td>
</tr>
<tr>
<td>Deionized Water</td>
<td>100 mL</td>
<td>$0.10</td>
</tr>
<tr>
<td>Cornstarch</td>
<td>1 gram</td>
<td>$0.10</td>
</tr>
<tr>
<td>Mortar and Pestle use</td>
<td>1 day</td>
<td>$0.30</td>
</tr>
<tr>
<td>Oil</td>
<td>1 teaspoon</td>
<td>$0.15</td>
</tr>
<tr>
<td>Cream of tartar</td>
<td>1 teaspoon</td>
<td>$0.15</td>
</tr>
<tr>
<td>Flour</td>
<td>10 gram</td>
<td>$0.15</td>
</tr>
<tr>
<td>Vinegar</td>
<td>5mL</td>
<td>$0.10</td>
</tr>
<tr>
<td>Citric Acid</td>
<td>1 gram</td>
<td>$0.15</td>
</tr>
<tr>
<td>Latex</td>
<td>10 mL</td>
<td>$0.10</td>
</tr>
<tr>
<td>Epsom Salt</td>
<td>1 gram</td>
<td>$0.15</td>
</tr>
<tr>
<td>Sodium Polyacrylamide</td>
<td>1 gram</td>
<td>$0.15</td>
</tr>
<tr>
<td>Chalk</td>
<td>1 gram</td>
<td>$0.10</td>
</tr>
<tr>
<td>Kosher Salt</td>
<td>1 gram</td>
<td>$0.10</td>
</tr>
<tr>
<td>Calcium Chloride</td>
<td>1 gram</td>
<td>$0.05</td>
</tr>
<tr>
<td>Sodium alginate</td>
<td>10 mL</td>
<td>$0.30</td>
</tr>
<tr>
<td>Plaster of Paris</td>
<td>1 gram</td>
<td>$0.10</td>
</tr>
<tr>
<td>Guar Gum</td>
<td>1 gram</td>
<td>$0.15</td>
</tr>
<tr>
<td>Salt</td>
<td>1 gram</td>
<td>$0.05</td>
</tr>
<tr>
<td>Liquid Starch</td>
<td>5 mL</td>
<td>$0.15</td>
</tr>
</tbody>
</table>
Instructions for Synthesis of Polymers and their variations

Safety
- Always wear safety goggles when handling chemicals in the lab.
- Wash your hands thoroughly before leaving the lab.
- Follow the teacher’s instructions for cleanup of materials and disposal of chemicals.

Polymer A
1. Pour 100 mL of warm water into a beaker
2. VERY slowly add 1.05 g of guar gum while constantly stirring.
3. Observe the result of the mixture.
4. Add one or two drops of food coloring, if desired.
5. Add 5 mL of 4% borax solution while rapidly stirring.
6. Stir for about 2 minutes.

Polymer B (Variation #1)
1. Place 14 mL of cornstarch in a paper cup.
2. Add two drops of corn oil to the cornstarch.
3. Add 14 mL of water to the corn oil and cornstarch.
4. Stir the mixture.
5. Add one or two drops of food coloring, if desired.
6. What properties do you observe?
7. Place the substance in the microwave for 20-30 seconds.

Polymer B (Variation #2)
1. Place 14 mL of water in a paper cup.
2. Add two drops of corn oil to the water.
3. Slowly add 30 mL of cornstarch to the water and mix.
4. One may add more cornstarch to the mixture until one can form it into a ball.

Polymer C (Variation #1)
1. Combine 60 mL flour and 15 mL salt into a large cup.
2. Add 30 mL of water.
3. Add one drop of food coloring to water mixture, if desired.
4. Mix.

Polymer C (Variation #2)
1. Add 60 mL of flour and 30 mL of salt into a large cup.
2. Add 5 mL of oil to the salt and flour.
3. Mix.
4. Add a little water slowly and stirring until the mixture is like a dough.

Polymer C (Variation #3)
1. Mix all of the ingredients in a saucepan or beaker.
2. Add one cup of flour and cup of salt into the saucepan or beaker.
3. While mixing, add 1 cup of water and 2T of vegetable cooking oil to the flour mixture.
4. Add 1 T of cream of tartar to the mixture.
5. Mix.
6. Heat over a medium heat, stirring constantly until it thickens.
7. Let it cool.

**Polymer D (Variation #1)**
1. Combine 30 mL Elmer's glue with 15 mL Purex Sta-Flo liquid starch.
2. Stir mixture until it begins to stick together.
3. Remove mixture and knead in hands (about 10 minutes).

**Polymer D (Variation #2)**
1. Combine 30 mL Elmer's glue with 15 mL 4% borax solution.
2. Stir mixture until it begins to stick together.
3. Remove mixture and knead in hands.

**Polymer D (Variation #3)**
1. Mix about 25 mL of glue and 25 mL of warm water in a cup or beaker.
2. Add one or two drops of food coloring, if desired.
3. Mix in about 50 mL of 4% borax solution.
4. Mix thoroughly and knead if necessary.

**Polymer D (Variation #4)**
1. Combine equal parts of borax powder and white glue. (Start with 30 mL).
2. Stir well.
3. Observe what happens as more glue is added.

**Polymer D (Variation #5)**
1. Place in a cup, 10 mL of Epsom salt and 10 mL of water.
2. Stir to dissolve the Epsom salt.
3. Add 60 mL of Elmer's glue to the cup and stir.
4. Knead the mixture, then place the mixture onto a paper towel and soak up the excess water.

**Polymer E (Variation #1)**
1. Add 15 mL Sta-Flo liquid starch to 30 mL of glue and STIR.
2. Add powdered chalk.
3. Stir until the powder is completely dispersed.

**Polymer E (Variation #2)**
1. Add 15 mL 4% borax solution to 30 mL of glue and STIR.
2. Add 10 mL powdered chalk.
3. Stir until the powder is completely dispersed.

**Polymer F (Variation #1)**
1. Add 15 mL Sta-Flo liquid starch to 30 mL of glue and STIR.
2. Add 20 mL (14g) Plaster of Paris.
3. Stir until the powder is completely dispersed.
4. Knead if needed in hand.

**Polymer F (Variation #2)**
1. Add 15 mL 4% borax solution to 30 mL of glue and STIR.
2. Add 20 mL (14g) Plaster of Paris
3. Stir until the powder is completely dispersed.
4. Knead if needed in hand.

**Polymer G**
1. COMPLETELY mix 20 mL glue with 20 mL water.
2. Place 5 mL talcum powder into a SECOND cup.
3. Add diluted glue TO the talcum powder.
4. Stir COMPLETELY.
5. Add 5 mL of 4% borax solution and stir CONTINUOUSLY.

**Polymer H (Variation #1)**
1. In a cup, stir 3 mL of latex into 10 mL water.
2. Slowly pour 10 mL citric acid solution into the latex mixture, and stir.
3. Put the substance into a cup of water to wash it.
4. Roll into a ball.
5. Dry with a paper towel.

**Polymer H (Variation #2)**
1. In a cup, stir 3 mL of latex into 10 mL water.
2. Slowly pour 10 mL vinegar into the latex mixture, and stir.
3. Put the substance into a cup of water to wash it.
4. Roll into a ball.
5. Dry with a paper towel.

**Polymer H (Variation #3)**
1. In a cup, stir 3 mL of latex into 10 mL water.
2. In a second cup place ½ gram of sodium polyacrylamide (ghost crystals) and 10 mL of vinegar. Let this sit for at least 5 minutes.
3. Pour 10 mL vinegar/ ghost crystal mixture into the latex mixture, and stir.
4. Put the substance into a cup of water to wash it.
5. Roll into a ball.
6. Dry with a paper towel.

**Polymer I**
1. Dissolve 1 gram of Calcium Chloride into a cup of water.
2. Squeeze the sodium alginate solution into the cup.
3. Pull out the crosslinked polymer and either place in a cup of water or just let sit out.

**Polymer J**
1. Squeeze 10mL of gorilla glue into a cup.
2. Add 10mL of 4% borax solution into the cup and stir.
3. Set aside and wait.
EVALUATION SHEET

Employee Name:

Polymer letter (A, B, C, etc):

Brief description of the polymer:

Cost of polymer the way it was made:

Use it for the product? Yes No Maybe

Reasons for or against using the product:
Patent Application Form 1A602101023C
Persons Applying for Patent: Name of Invention:

Intended Use of Invention and why:

Patented Formula: (What are specific ingredients/directions for manufacture?)

Science Concepts Involved in Material (Applicants should write or draw information in the space below):