Designer Sneakers:
Student Pages
Short Version

Written By Three Polymer Ambassadors
For The Akron Global Polymer Academy

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Introduction to Athletic Shoes- Homework Activity

What has 26 bones, 33 joints, 19 muscles, and a bunch of ligaments? A human foot! These parts work together in perfect precision when a person is unaware of any of the parts. What a wonderful machine! A foot may strike the ground 10,000 times a day and cover more than 115,000 miles in a lifetime. An average athlete will generate up to 700 pounds of pressure on a foot in a single leap or stride.

There are three energy-storing mechanisms in a foot. As your Achilles tendon stretches when you step down, it is storing energy. The release of energy is when the tendon relaxes and you step off. The arch in your foot flattens when you step down thus storing energy. The arch releases its stored energy when you step off. The third mechanism is the cushion under the heel of the foot. This fatty cushion acts as a shock absorber or stores energy as it is compressed.

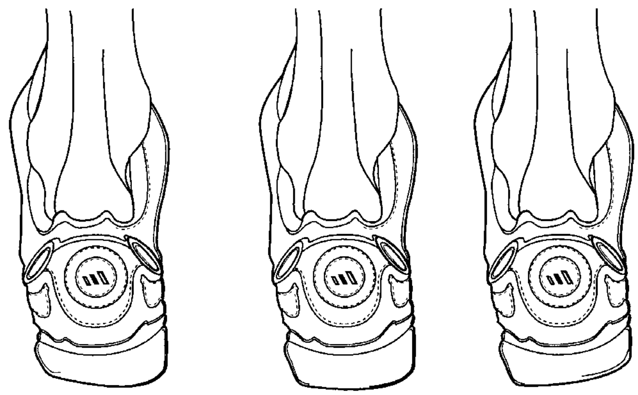
In running, the foot follows a series of steps: the outer edge of the heel strikes the ground, then it rolls inward so that the weight is shifted to the inside edge of the forefoot, and the arch flattens during this roll to absorb the shock of the foot strike. In walking, the foot follows a different series of steps: the outer edge of the heel strikes the ground, then the foot rolls slowly onto the toes as the foot flattens since it is more relaxed and finally the sole also helps to rock the foot forward toward the toes.

How do your feet compare to the feet of your best friend? Have you ever done a comparison? Here are some simple experiments:

- Wet your foot in a tub of water and then stand on a piece of colored paper. Look at the wet print and notice the band that connects the forefoot with the heel. Draw a line around your footprint while the print is still damp. If the band is narrow, you have a high-arch. If the band is wide, you have a "flat foot". Label your footprint with your name and kind of print.

- "Normal" feet will land on the outside of the heel and roll inward to absorb shock as you walk. Flat feet land on the outside of the heel and roll inward excessively as you walk. High arch feel don't roll inward enough as you walk. High arch feet do not have a built-in shock absorber.
- Examine the soles of a well-used pair of sneakers. If there is heavy wear around the heel and arch, you may overpronate or roll your foot inward too much as you walk. The inner side of the foot hits the ground first and the foot appears to roll outward. Heavy wear along the

outside of the shoe indicates supination or rolling your foot to the outside as you walk. The outer side of the foot hits the ground first and the foot appears to roll inward. Patterns that are not symmetrical may reflect other problems such as an imbalance in muscle strength.



- Place the well-used shoes on a level surface and look at them from behind. If the shoes tilt forward with the heel bulges to the inside, this is evidence that you pronate. An outward tilt is evidence that you underpronate. Try to diagnose your walking or wear on shoes. Write your diagnosis on the "foot print paper" which will be turned in to your teacher.

History:

The modern athletic shoe did not come into existence until the 1970's. Before that consumers wore "sneakers" or rubber-soled shoes with canvas tops. Keds® were introduced in 1917. In 1925, Adolph and Rudolph Dassler (Germans) founded a company to make athletic shoes. Olympians were attracted to their products. Adolph later founded Adidas and Rudolph founded Puma. In 1951 Shigeki Tanaka won the Boston Marathon wearing a shoe called, Tiger, where the big toe was separated from the other toes. Credit is due to Phil Knight and Bill Bowerman from Oregon for the science and fashion found in current athletic shoes today. They formed a company in 1964 to market a lighter and more comfortable running shoe. In 1968 it became Nike, Inc. named after the Greek goddess of Victory. The invention of waffle soles in 1972, cushioned mid-sole and nylon uppers were unique for the time. The layer of padding in the midsole became a "marketing war zone". At first the midsole was made out of rubber but later engineers introduced a lighter material called ethylene vinyl acetate or EVA. EVA is a polymer material filled with gas bubbles and it makes a great shock absorber. Nike's advertisements in the 1980's and 1990's have elevated sales around the world.

The New Balance Shoe Company was founded in the 1960's too and they developed an orthopedic running shoe with a rippled sole and wedge heel. The wedge was made out of rubber and it helped absorb shock during running and this new design quickly became standard in running shoes in the 1960's.

An article in the *Wall Street Journal* (March 3, 1998, page B1 and B12) "Tripped Up by Too Many Shoes, Nike Regroups" by Bill Richards discusses the problem Nike Inc. is having in 1998. Nike Inc. has a team of 15 research staff members who introduce 350 new athletic shoe models each year. The head of the team, Mr. Mario Lafortune, says "But it is getting harder to come up with innovations that people can easily see." Since Nike lost sales in 1997, the new marketing strategy will be to market apparel, sporting goods and athletic shoes as one giant package. The program is called "Alpha" and is will be hitting the public the end of 1998. "Alpha Athletes" will include Tiger Woods and other top name professionals. According to Athlete's Foot director of research, Nike's last improvement in shoes was in 1978 with the concept of air bags in the soles. Athletic shoes have become lighter and more flexible over the years due to new polymeric materials.

Reebok's pump sneaker was introduced in the late 1980's but disappeared about 1993. Reebok followed the lead of Nike by inserting see-through windows in the heels of shoes. Reebok is introducing the 3D Ultra-Lite foam shoe in 1998 with air cushions in the sole as well as see-through windows. Not to be out done, Nike has the Visible Zoom Air shoe for 1998 which has a nylon pillow in the air pocket.

Study Guide Questions:

1. How many times will an average person's foot strike the ground in a week?

2. What are the three energy-storing mechanisms in a foot?

3. Would running or walking have the foot roll toward the toes after the heel strikes the ground?

4. Before 1970, describe the typical athletic shoe.

5. What unique shoe design was developed in 1972?

6. Of the hundreds of new models of athletic shoes introduced each year, are the changes due to innovation and engineering or are they more due to color and gimmicks?

Engagement Phase of the Learning Cycle

What Are The Parts Of An Athletic Shoe? 

Purpose: To discover the parts of an athletic shoe by dissecting an old one.

Materials: a selection of old athletic shoes (at least two different brands), these are cut lengthwise with a power saw (laces removed), metric rulers

Procedure:
1. Take one "cut" athletic shoe and find the various parts of the shoe mentioned in the diagram on the next page.
2. Since you are most interested in the insole, midsole and outersole of the shoe, measure the thickness of these parts and record the dimensions in the tables below:

Data Table: (Write "na" for not applicable.)

Shoe Brand: ____________	Thickness in mm at the toe	Thickness in mm at the ball of the foot	Thickness in mm at the arch	Thickness in mm at the heel
Insole				
Midsole				
Outersole				

3. Take another brand of shoe and repeat the measurements.

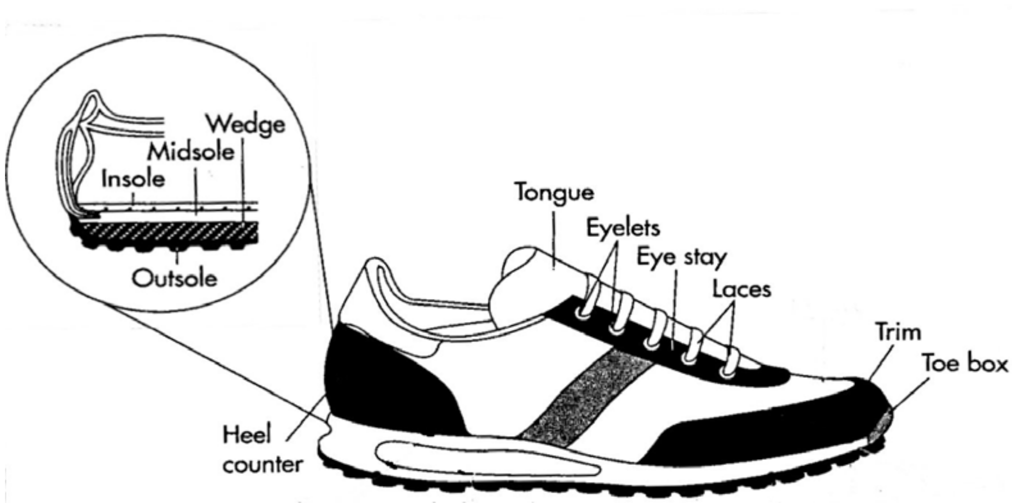
Data Table: (Write "na" for not applicable.)

Shoe Brand: ____________	Thickness in mm at the toe	Thickness in mm at the ball of the foot	Thickness in mm at the arch	Thickness in mm at the heel
Insole				
Midsole				
Outersole				

Conclusions:
1. Comparing the two brands:
   a. Which insole is in better condition?
   b. Which midsole is in better condition?
   c. Do you think one shoe has seen more miles than the other? Explain.
2. Does the thickness of the insole change depending upon where it is located in the shoe? Where is it the thickest? Thinnest?
3. Does the thickness of the midsole change depending upon where it is located in the shoe? Where is it the thickest? Thinnest?

4. Are there any "air pockets" present? What would be a reason for putting air pockets in shoes?
5. Does one brand have a special feature that the other does not have? What is it? What purpose does it serve in the wearing of the shoe?
6. Based on the construction of each shoe, classify each by the following categories:
   a. Running
   b. Walking
   c. Tennis
   d. Basketball
   e. Cross training
   f. Other

Parts of an Athletic Shoe



Heel counter - This stiffens the back of the shoe for stability. It is molded to encase the heal and surrounds the Achilles tendon.
Insole – or sock liner – It cushions and is an arch support that should be removable. The foot rests upon the insole of the shoe.
Last – The mold or form around which the shoe is shaped during manufacture. The shape of the shoe can be straight for low arches, semi-curved, or curved for high arches. Last construction comes in three basic designs: Board Last has a flat light-weight fiberboard glued to the midsole and provides a very supportive base, Combination Last has a cloth lining in the forefoot and a fiberboard in the rear foot for stability and support, and Slip Last has the upper and midsole stitched together and is the most flexible of the three constructions.
Midsole – The cushioning material – (usually ethyl vinyl acetate (EVA) or polyurethane) – often surrounded by air cells or gel cells for shock-absorbing quality is the make-up of the midsole. This is found between the insole and the outsole. With long use, the EVA will compress and lose its ability to absorb shock. Polyurethane is firmer and more durable than EVA.
Outsole – This part touches the ground and is made of durable carbon rubber or polyurethane. The carbon rubber has better traction.
Toe box – The area for the toes of the foot.
Ankle Collar – The padded area around the top of the shoe for added fit and comfort.
Heel Tab – The area of the ankle collar that is usually notched and located above the heel. It reduces stress on the Achilles tendon.

Exploration and Explanation of the Learning Cycle

Part A. Compounding Glue Polymers for the Midsole of Designer Sneaker

Introduction:
One type of additive is called a crosslinker. When a crosslinker is added to the strands in liquid solutions and suspensions, the mixtures begin to thicken and form slimes and putties. Borax is a crosslinker for slimes or Gak®. It chemically "ties" chains together which limits their flow. In this activity, students will investigate the effects of compounding on the polymer poly(vinyl acetate) or more commonly known as Elmer's® Glue-All. Students will crosslink two glue/water mixtures with the cross linking agent, sodium tetraborate decahydrate (laundry borax dissolved in water). After determining the effects of crosslinking and the additives on the two dilutions of the glue with water, students will have a detailed data table to use for the assessment activity.
Note: Water is not a compounding agent used in industry. It does noticeably alter the properties of the resulting glue-polymer.

Purpose: To investigate the physical properties of two formulations of Elmer's® Glue-All with water.

Materials: Elmer's® Glue-All, talc or talcum powder, calcium carbonate (powdered chalk (not dustless)), food coloring, 4% borax solution, small plastic cups (can be reused), stirring craft sticks or spoons (can be reused), sandwich-size zipper-type bags (10/team), graduated cylinders or marked plastic cups, felt-tip markers, 1 liter or 2 liter plastic bottles, pump-type nozzle to fit the bottle, goggles, aprons are optional

Safety: Goggles must be worn at all times. Borax may cause allergic reactions in some students and those should avoid handling the chemical. Wash with soap and water to relieve the redness and itching.

Time: Five laboratory days for Part A and two days for Part B.

Procedure: Days 1&2&3
1. Students should be in teams of four.
2. Using a 75% glue and 25% water putty that is colored green, pour 30 mL of the mixture into a cup.
3. Add 10 mL of 4% borax solution while stirring. Stir with a stick or spoon until the mass of glue putty forms on the stick.
4. Take the mass of putty in your hands and form it into a ball. Continue to press it in your hands until it forms a ball of even consistency.

5. Take a new zipper-type bag and label it with your names and “75/25 putty”. Place the glue putty in the labeled bag.
6. Make another sample of this same glue putty but this time add an additive to the mixture of glue and water BEFORE adding 10 mL of 4% borax solution. Prepare a labeled plastic bag with your names and the additive used. Add1 teaspoon of talc or talcum powder to the 30 mL of glue putty, stir to mix well and then add the 10 ml of borax solution. Take the mass of putty in your hand and form it into a ball. Continue to press it in your hands until it forms a ball of even consistency.
7. Place this ball in the newly labeled plastic bag.
8. Repeat steps 6 and 7 with one of the other additives. When you finish, you will have five bags of labeled glue putties which are all the same color. The other additives are:
   a. 1 teaspoon of calcium carbonate or powdered chalk
   b. 1 teaspoon of vegetable oil
   c. 1 teaspoon of talcum powder and 1 teaspoon of vegetable oil
9. Begin your tests of the five putties. Record all results in the data tables.

Procedure: Days 4&5

1. Students should be in teams of four.
2. Using a 50% glue and 50% water putty that is colored red, pour 30 mL of the mixture into a cup.
3. Add 10 mL of 4% borax solution <u>while stirring</u>. Stir with a stick or spoon until the mass of glue putty forms on the stick.
4. Take the mass of putty in your hand and form it into a ball. Continue to press it in your hands until it forms a ball of even consistency.
5. Take a new zipper-type bag and label it with your names and “50% putty”. Place the glue putty in the labeled bag.
6. Make another sample of this same glue putty but this time add an additive to the mixture of glue and water BEFORE adding 10 mL of 4% borax solution. Prepare a labeled plastic bag with your names and the additive used. Add1 teaspoon of talc or talcum powder to the 30 mL of glue putty, stir to mix well and then add the 10 ml of borax solution. Take the mass of putty in your hand and form it into a ball. Continue to press it in your hands until it forms a ball of even consistency.
7. Place this ball in the newly labeled plastic bag.
8. Repeat steps 6 and 7 with one of the other additives. When you finish, you will have five bags of labeled glue putties which are all the same color. The other additives are:
   d. 1 teaspoon of calcium carbonate or powdered chalk
   e. 1 teaspoon of vegetable oil
   f. 1 teaspoon of talcum powder and 1 teaspoon of vegetable oil
9. Begin your tests of the five putties. Record all results in the data tables.

Testing Procedures:

Background:

Industry conducts a variety of tests on plastics and rubber materials as a form of quality control. Testing for various properties yields information on the differences between compounds in terms of toughness, stiffness, and strength. Testing also is useful for screening to determine whether a particular material meets customer specifications. Since sales to the customer ultimately determine the financial success of a company, test must be performed that simulate the way a product will be used.

The following tests mimic the way industrial processes test various polymer products. However, the tests have been designed to deal with the flowing or non-Newtonian glue putties used in this investigation. The tests yield information which will be helpful to students in the assessment phase.

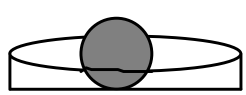
Fluidity – Test #1

All of the glue putties produced can be classified as non-Newtonian fluids since they show both characteristics of solids and liquids. For example, they stretch and flow when pulled slowly. They break when pulled apart rapidly. Testing the fluidity of the putties can be correlated with surface recovery time as well as durability of the shoe components.

Materials: (for each team) four plastic Petri dishes (60x15 mm) either the lid or bottom or the bottom of a yogurt cups (cut off the top leaving a 2 cm edge), samples of each glue putty, second hand on a wall clock or wrist watch

Procedure:

1. Use a putty sample you made earlier.
2. Shape the sample into a ball. Place the ball in the center of a Petri dish (top or bottom of the dish)or cut-off yogurt cup. Measure from the edge of the ball to the edge of the dish in mm. Record.



3. Allow the putty to flow to the edges of the dish. Using a clock or watch, time (in seconds and minutes) how long it takes for the putty to come in contact with the side of the dish at all points. Record the time in the data table. After 5 minutes, if the sample has not reached the edge of the dish, sketch the outline shape of the putty in the circles provided in the data table. This will only serve as a general source of information on the fluidity of the sample.
4. Repeat the above procedure for each putty sample.

Data Table:

Polymer Tested	**Distance From Edge of Ball to Edge of Dish (mm)**	**Time to Flow to the Edges of the Dish (sec. and min.) Time exceeds 5 min, see sketches below**	**Distance from edge of putty to edge of dish at 5 min (mm)**	**Rate in mm/min. or mm/sec.**
75% glue/water				
Talc added				
Calcium carbonate added				
Oil added				
Oil and talc added				
50% glue/water				
Talc added				
Calcium carbonate added				
Oil added				
Oil and talc added				

Sketches for those putties that exceeded 5 minutes. Label each sketch with the kind of putty observed.

Questions:
1. Which putty had the fastest flow rate? Which had the slowest rate? What were the rates in mm/min or mm/sec?
2. What influence, if any, do your feel the compounding has on fluidity?
3. ANSWER IN A PARAGRAPH: The results of this test can be used to help you make decisions about the placement of a polymer in the midsole or insole of a shoe. Where would you want a polymer with the greatest/slowest flow rate?

Texture and Consistency – Test #2

The texture or "feel" of a given material can influence a customer's response to a given product. The following test is a very subjective test. An effort has been made to make this evaluation as consistent as possible by using data tables with specific parameters.

Materials: samples of glue putty

Procedure:
Take a small sample of each polymer and knead it in your hands. Stretch it, bounce it, and squeeze it between two fingers. Describe its characteristics in the data tables below.

Data Table for Texture:

Polymer Tested	**Very Smooth**	**Smooth**	**Slightly Sandy**
75% glue/water			
Talc added			
Calcium carbonate added			
Oil added			
Oil and talc added			
50% Glue/water			
Talc added			
Calcium carbonated added			
Oil added			
Oil and talc added			

Data Table for Stretchiness:

Polymer Tested	**Stiff**	**Slightly Runny**	**Very Runny**
75% glue/water			
Talc added			
Calcium carbonate added			
Oil added			
Oil and talc added			
50% Glue/water			
Talc added			
Calcium carbonated added			
Oil added			
Oil and talc added			

Questions:

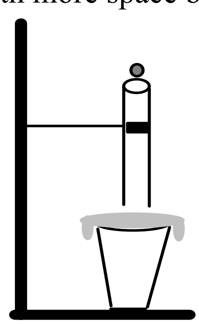
1. What is your favorite glue polymer recipe? Why have you chosen this product?
2. Will this glue putty you chose be suitable for any part of a shoe? Why or why not?
3. ANSWER IN A PARAGRAPH: After seeing and feeling the differences between the compounded glue polymers, how important do you feel compounding is in industry? Support your answers with specific data or examples.

Strength - Test #3 

The strength of a plastic determines its use in such products as bottles, bags, storage containers, and even toys. The polymers used in shoes must be strong enough to withstand the numerous indentations produced by sticks, pebbles, and other objects encountered on an irregular running surface. Polymers must also be able to stretch in applications where flexion and movement are common. This test is designed to judge the strength and elasticity of a thin sheet of the each glue polymer.

Materials: (for each team) glue putty samples, PVC tubing in 30 cm length (1.25 in ID), marble about 2.54 cm diameter or a glass cube, 6 or 8 oz plastic cup (yogurt cups work well), ring stand and clamp to fit the tube, meter stick

Procedure:
1. Mount a piece of 30 cm plastic tubing vertically using a ring stand and clamp. Adjust the height of the tubing so that its bottom end rests 1 cm above the open end of the plastic cup.
2. Place a sample of glue putty on the table protected with plastic wrap. Flatten the putty with your fingers. Make the size of the putty just larger than the diameter of the yogurt cup.
3. Carefully lift the putty sheet and place it over the opening of the cup. One person is in charge of holding the putty around the rim of the cup.
4. Slide the mounted tubing over the cup and putty film. The open end of the tubing should be above the center of the cup and film. (Hold the tubing by hand if a ring stand is unavailable.)
5. Drop a marble through the 30 cm tubing onto the surface of the putty. Record if the putty stretches or breaks when contacted by the marble. If the putty stretches, reform the putty sheet as in step 2. Once the putty breaks, the tests are done for that sample.
6. Adjust the 30 cm tube so that there are 6 cm of space between the top of the cup and the bottom of the tube. Use a meter stick for measuring. Clamp it securely in place. This is the 35 cm drop test.
7. Drop a marble through the tube onto the surface of the putty. Record your results.
8. Keep repeating the above steps with more space between the tube and the top of the



9. cup. Use these distances: 11 cm for a drop of 40 cm, 16 cm for a drop of 45 cm, 21 cm for a drop of 50 cm, 31 cm for a drop of 60 cm, and 41 cm for a drop of 70 cm (if needed) until the putty film breaks.
10. Test the remaining putty samples using the procedure described above.

Note: The polymer film will continue to stretch while placed across the mouth of the cup. To try and keep the tests consistent, conduct the marble test quickly after placing the film on the cup. If the film gets too thin, reform it before the next drop.

Data Table for Strength:

Drop Heights: S= Stretch and B=Break

Polymer	**30 cm**	**35 cm**	**40 cm**	**45 cm**	**50 cm**	**60 cm**	**70 cm**
75% glue/water							
Talc added							
Calcium carbonate added							
Oil added							
Oil and talc added							
50% glue/water							
Talc added							
Calcium carbonate added							
Oil added							
Oil and talc added							

Questions:

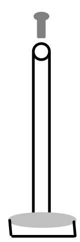
1. Which polymer(s) has/have the greatest ability to withstand impact force of the marble?
2. ANSWER IN A PARAGRAPH: What advantages would such a polymer(s) have in a shoe?

Impact and Elastic Recovery – Test #4 

The human foot repeatedly hits the ground during any running or walking activity. In order to provide comfort for the foot and relieve the joints of impact shock, the midsole of an athletic shoe must be able to take repeated "poundings". At the same time it must be able to restore itself to its original shape in between each foot strike. In the following test, a weight will be dropped on to the surface of each polymer. The amount of indentation (deformation) will be measured as well as the time it takes for the surface of the polymer to restore itself to its original flat (non-dented) surface.

Materials: (for each team) samples of each glue putty, four yogurt cups that have been cut down to 2 cm in height, PVC tube that is 60 cm in length with a ID of 1.25 in, bolt (1/2" diameter hexagonal head, 3" long), metric ruler, ring stand and clamp, clock or watch

Procedure:
1. Place the glue putty sample in the cup. The surface needs to be smooth.
2. Support the 60 cm tube vertically above the putty with your hand. Adjust the tubing so that the bottom of the tube sits directly above the surface of the putty in the cup.
3. Hold the bolt, thread side pointing downward. The top of the bolt should be even with the top of the tube when you hold the bolt ready for a drop test. Drop the bolt through the tube. Note the time at which the bolt is dropped.



4. Quickly remove the tube and bolt, measure the amount of indentation (in mm) produced by the bolt in the surface of the polymer. Record in the data table.
5. Measure the time (in min.) needed for the surface of the polymer to return to its level or flat surface. Record. If the surface has not recovered after 5 minutes, note the amount of recovery or indentation depth remaining.

Data Table for Impact and Elastic Recovery:

Polymer Tested	**Depth of initial indentation (mm)**	**Surface Recovery Time in min**	**Indentation remaining if any (mm)**	**Rate of Recovery in mm/min**
75% glue/water				
Talc added				
Calcium carbonate added				

Oil added				
Oil and talc added				
50% Glue/water				
Talc added				
Calcium carbonated added				
Oil added				
Oil and talc added				

Questions:

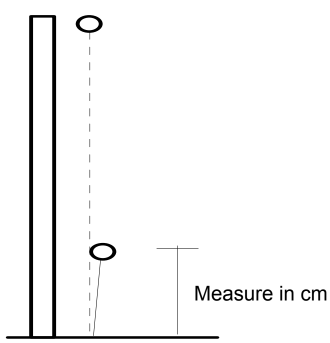
1. Which polymer seems to be the best at absorbing shock? On what data are you basing your decision?
2. Which polymer most rapidly returns to its “normal” flat state? (Shows the quickest elastic recovery.)
3. ANSWER IN A PARAGRAPH: Which of your polymers seems to be the best at both absorbing shock and returning to it pre-deformed shape? Explain why you picked this polymer. Where would you need they type of polymer in a shoe?

Elasticity/Bounce - Test #5 

In the final phase of a stride, the foot rolls forward, and the body weight is transferred to the metatarsal bones in the forefoot. A shoe must absorb the surge of power that propels the foot off the ground. One needs to pick a good shock absorber for the front of the sole of a shoe. However, one might also want to include a second polymer which will help the foot spring forward.

Materials: (for each team) samples of putty to be tested, meter stick, 3 surface materials such as classroom floor tile, asphalt or cement, grass

Procedure:
1. Move to the location of the chosen testing surface.
2. Hold a meter stick vertically so that one edge is in contact with the testing surface.
3. Roll the putty sample into a ball. Hold the bottom of the ball even with the upper edge of the meter stick.
4. Have a "measurer" squat or kneel down so that he/she can get at eye level with low bouncing balls.
5. Drop (do not push) the ball onto the surface and allow it to bounce.
6. Note the height of the top of the ball on its bounce. Record this distance (cm) in the data table. Test each sample twice.
7. Repeat the above steps of each sample to be tested.
8. Move to the second and third locations and measure the bouncing height for each putty sample.



Data Table for Elasticity:

Polymer Tested	**Height of Bounce (cm)**					
	Floor Tile		**Asphalt/Cement**		**Grass**	
	Trial 1	**Trial 2**	**Trial 1**	**Trial 2**	**Trial 1**	**Trial 2**
75% Glue/Water						
Talc added						
Calcium carbonate						

added		
Oil added	!	!
Oil and talc added	!	!
50% Glue/water	!	!
Talc added	!	!
Calcium carbonate added	! !	! !
Oil added	!	!
Oil and talc added	!	!

Questions:

1. Which type of putty bounced the highest on each surface type? Why do you think this happened?
2. Is a good bouncer necessarily a good shock absorber? Explain your reasoning.
3. ANSWER IN A PARAGRAPH: Where in a shoe would you place a material with good elastic or bouncing characteristics? Explain your answer.

Part B. Compounding Latex for the Insole of an Athletic Shoe

Purpose: To investigate the physical properties of latex bonded to a fabric.

Materials: liquid latex (25 mL per team), old tee-shirt fabric, vinegar in a spray bottle, talc or talcum powder, calcium carbonate (powdered chalk), vegetable oil, plastic cups, spoons, 5 yogurt cups, teaspoon, old newspapers

Safety: Goggles must be worn at all times. If you are allergic to latex, DO NOT participate in this activity.

Time: Two laboratory days. One for preparing four samples and one for testing. The second day may not take a whole laboratory period.

Procedure:

1. Cut an old tee shirt into a rectangle of cloth about 10 cm by 15 cm. Write your names on the edge of the cloth. Cover the table surface with old newspaper. Spray the back of the cloth with vinegar to moisten the cloth.
2. Pour about 5 mL (one teaspoon)of undiluted latex into a plastic cup. Using a spoon, smear some onto one rectangle of cloth. Spray the latex immediately with vinegar to cause the latex to solidify. The cloth should be moist with vinegar.
3. Add another layer of latex with the spoon and spray with vinegar.
4. Add a third layer of latex and spray with vinegar.
5. Place the cloth over a yogurt cup to let dry over night. (Air should be able to circulate under the cloth.)
7. Cut an old tee shirt into a rectangle of cloth about 10 cm by 15 cm. Write your names on the edge of the cloth. Spray the back of the cloth with vinegar to moisten the cloth.
8. Pour about 5 mL of undiluted latex into a paper cup. Add one-half to one teaspoon of talc to the latex. Stir with a spoon to make a homogeneous mixture. Using a spoon, smear some onto one rectangle of cloth. Spray the latex with vinegar immediately to cause the latex to solidify. The cloth should be moist with vinegar.
9. Add another layer of latex with the spoon and spray with vinegar.
10. Add a third layer of latex and spray with vinegar.
11. Place the cloth over a yogurt cup to let dry over night. (Air should be able to circulate under the cloth.)
12. Repeat steps 7-11 to prepare a third, fourth and fifth samples with different additives: calcium carbonate, oil, oil and talc.
13. Test your latex-coated fabric for physical properties. Each team of students has five samples to test. Record your observations in the data table.

Texture and Consistency Tests

The texture or "feel" of a given material can influence a customer's response to a given product. The following test is a very subjective test. An effort has been made to make this evaluation as consistent as possible by using data tables with specific parameters. Latex bonded to a fabric is similar to the insole of an athletic shoe. Think about the physical properties needed for an insole as you do your testing. The insole is the part of the shoe where the foot rests.

Materials: five samples of latex

Procedure:
Take each latex sample and knead it in your hands. Stretch it, pinch it, dent it with a coin pressing down on the surface, and run your hands over the surface of the polymer. Describe its characteristics in the data tables below.

Data Table for Texture:

Latex Tested	**Smooth**	**Slightly Sandy**	**Gritty**
100% Latex			
Latex with talc			
Latex with calcium carbonate			
Latex with oil			
Latex with oil and talc			

Data Table for Elasticity/Flexibility:

Latex Tested	**Stiff**	**Slightly Elastic**	**Very Elastic and Flexible**
100% Latex			
Latex with talc			
Latex with calcium carbonate			
Latex with oil			
Latex with oil and talc			

Data Table for Recovery Time:

Latex Tested	**Extremely Slow to Erase a Dent**	**Slow to Erase a Dent**	**Springs Back Quickly From a Dent**
100% Latex			
Latex with talc			
Latex with calcium carbonate			
Latex with oil			
Latex with oil and talc			

Question:
1. Which latex or latex with additive is the best suitable for the insole of an athletic shoe? Give reasons for you answer.

Elaboration of the Learning Cycle

Task:

Your group represents members of a product development team in a leading athletic shoe manufacturing corporation. You are to design a midsole and insole for one of the following types of athletic shoes: basketball, tennis, running, skateboard, or a cross trainer. Picking numbers or drawing straws in order to allow teams to choose a type of athletic shoe may be the best method to be fair to all.

Objectives:

Each team will form an "Athletic Shoe" company. All team members must contribute to the final written report in paragraph form. A rubric on the next page shows the team how grading will be accomplished. There are several tasks to be completed for this report:

- Select a name for your company that reflects your shoe design.
- Get organized and volunteer to do specific parts of the report.
- Grammar and spelling will be graded.
- Use of correct terminology is important.
- Choose three tests that best reflect the putties you want to use in the midsole of your designer sneaker for a particular sport. These putties will be placed in the diagram of the shoe sole on the following page. For example: Will the same putty be in the heel as under the arch? Your report must justify the choice of your putties.
- Graph these three tests by hand or use a computer.
- Choose a plain latex or latex with additive for the insole.
- Find two references (on the Internet or in the library) to help you to create an athletic shoe for your company. Quote specific text that supports the use of the qualities of putties you picked to use for the midsole.
- Calculate the cost of your new shoe based on the pricing structure given.

All data tables from the team work are available for study. These are secret files and only the team who created the work is to see this information. Remember, this is a very competitive business!

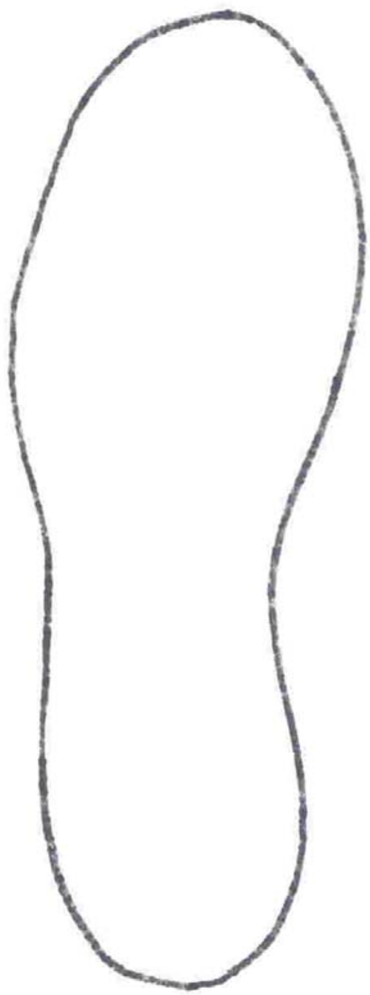
All shoe companies get their chemicals from the same source. Here are the "wholesale" prices for the following: (These prices are rather inflated!)
<u>To keep everyone using approximately the same amount of glue/water mixtures, all companies must use 4 times the amount you used for your samples. That will mean you use 4x 30 mL = 120 mL mixtures. Latex will be 3 times the sample or 3 x 5 mL = 15 mL.</u> Each team must decide on the additives they want to use.

White glue	$.50 per mL	Oil	$3.00 per teaspoon
Latex	$1.00 per mL	Borax solution	$.25 per mL
Talc	$2.00 per teaspoon	Water	$.05 per mL
Calcium carbonate	$1.00 per teaspoon		

Calculate the cost of the designer sneaker you are creating for your report and then double the price to get the retail price for a pair of shoes.

Outline of Shoe Sole
for placement of putties in the midsole
and latex in the insole.

Type of Shoe ________________
Name of Company ____________________



Midsole

Insole

Place in each outline of shoe soles, the putties and latex formulations you are using in your new designer sneaker.

Scoring Rubric for Evaluation Written Reports

Category	4	2	0
Corporation Grade			
Name of company reflects shoe design and originality	Accomplishes both	Accomplishes one	Accomplishes neither
Report Grade			
Organization	Organized	Partly organized	Not organized
Each team member contributed to the written report.	All team members contributed.	More than half of the team members but not all contributed.	Half or less of the team members contributed.
Use of grammar and spelling.	Grammar and spelling were excellent.	Several mistakes in grammar and spelling.	Many mistakes in grammar and spelling.
Use of correct terminology	All terms used were correct.	Some of the terms were incorrect.	Most of the terms were incorrect.
Explanation of putties selected based on test results and explanation for the insole. Use of shoe sole outline.	Explained three or more tests done on polymer properties used in final shoe design. Used shoe sole outline.	Explained two of the tests done and discussed insole. Used shoe sole outline.	Explained only one test done but did not discuss insole. Did not use shoe sole outline.
Graphs of test results.	Three graphs were displayed of the tests discussed above.	Only two graphs were displayed of the tests discussed above.	One or none graphs displayed.
References cited and quoted.	Two references were cited and quoted.	Only one reference was cited and quoted.	No references were cited.
Calculations for the retail price of the shoe.	Itemized costs of materials used to make the new shoe soles and final selling price to make a 50% profit. .	Provided only some of these costs.	Did not provide any costs.
Total of Points (36 Possible)			

A Short Reading Supplement on Buying Shoes

Manufacturers cover a range of foot shapes in their styles and models. The molds for a certain set of shoes are set to a certain arch, size of toe box, heel width and more. Therefore, no one shoe or brand of shoe is going to fit everyone. The consumer needs to have a little knowledge before he/she puts down a lot of money for an athletic shoe. If you know of a problem with your feet such as pronation, you can find shoes with antipronation devices such as "rollbars" (wedges inserted in the midsole) and shock absorption in the rearfoot of new shoes. A flat foot needs a motion-control shoe or one that is rigid, rugged and with deep heel counters. A high-arched foot needs cushion chambers under the heel and a spongy midsole. Here are some shopping tips:

- Check inside the shoe for a removable insole. Look for something more than a flat padding. Your foot needs an insole that can take a pounding with those 10,000 steps per day.
- Check for a stiff heel that will prevent your heel from twisting with each stride. Try to press down on the heel and you should not be able to compress it from the side so that the two sides meet.
- Width is very important is buying shoes. When shoes are too wide, one gets blisters and risks strains from a foot slipping inside the shoe. If they are too narrow, the foot gets numb or hurts. If shoes are too short, blacken toenails result. Before you go to the store, stand barefoot on an index card and mark the width where it is the widest. Cut the card to that width. Match this card width to the underside of each shoe at its widest point. The card should not extend beyond the shoe by more an one-eighth of an inch. If the soles extend beyond the body of the shoe (as in running shoes), match the width to the top of the shoe.
- Put the shoe on and tie it. If less than one inch of tongue is seen under the laces, the shoes are too wide. Wiggle your toes to see if you have room to do so. Do not buy shoes to grow into, this will lead to blisters!
- Focus on the feel. It should feel comfortable immediately. You do not have to break -in athletic shoes!
- Walk, jog and jump around. Let people stare at you! Ask yourself questions like: Are the heels snug? Is the arch supported? Does the shoe bend where your foot does at the toe joint?

The technology used in the manufacture of athletic shoes is amazing. A person buys shoes for the sport they intend to play. The following are guidelines for buying shoes for specific sports:

Tennis Shoes - wide stabilizer straps, deep heel cushions, midesole and forefoot cushioning, toe bumper with plenty of leather, foot frames, hard rubber outsoles
Running Shoes - midsole beds of air chambers or gels for cushioning, hourglass-shape outsoles, shock absorption insoles, durable overlay materials, support features, deep waffle tread for traction, breathable mesh sides, raised heel to ease the foot into forward movement, heel support but little side-to-side support, light in weight
Basketball or Court Shoes - ankle support, lots of eyelets for a custom fit, lots of cushioning and support in the arch and heel, herringbone or concentric circular tread patterns, sturdy foot frame, heel counter to cradle the heel
All-Around Appeal is the Cross-Trainer - stable heel and cushioned, rubber outsole, instep laces for a better fit, mesh sides for air circulation, sturdy toe box or forefoot cushioning.