Fabric That Works Just Like a Pine Cone

A textile developed in Britain has pores that open when it's wet, and sheaves that close up when it's dry.

We all hate wet clothes, but why are they so uncomfortable? A materials engineer would tell you: Not only is your skin getting wet, but the function of the material breaks down when it's soaked, because the wet fibers plump up with water. Porosity goes down, and thus, a really wet jacket takes exponentially longer to dry than a merely damp one—and it feels gross on your skin.

Dr. Veronika Kapsali, the founder of MMT and an expert on bio-mimetic fabrics, thinks she found a solution that's inspired by pine cones, which only open when the air is dry. (Pine cones do that because its easier for seeds to spread and germinate when its dry.) Unlike regular fabrics, Kapsali's invention becomes more porous when it's wet out, so that clothes might not feel as damp. When it's dry, the tiny sheaves in the fabric open up, reducing how permeable it is to air and improving the insulating properties.

Kapsali founded her company just this year, and is currently panning for investors and corporate partners to make her invention commercially available.

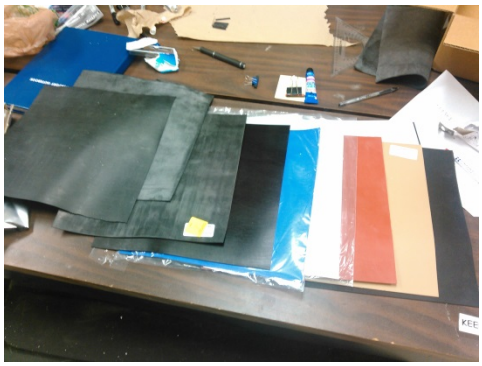
Biomimicry Lab

Name: _____

Today you will be conducting a laboratory experiment using thin rubber sheets. The rubber sheets have different densities and will react differently when placed in a solvent. Some rubber samples will swell up and others will not swell as much. We will be using Hexane as our solvent. Hexane should be used only in the fuming hood under teacher guidance. Rubber samples with high densities will not soak up and expand as much as the rubber strips with low densities. If we attach two rubber strips together with varying densities and place them in solvent, their expansion rates will be different. This difference in density will make the strips bend. These structural differences that cause the bending (or opening and closing) is very similar to a pine cone. The pine cone has a bilayer that consisting of varying densities which cause it to open when it is dry and close when it is wet. You will be recreating this and testing a variety of rubber samples to see which ones recreate this pine cone affect the best. Your job is to design an experiment that can clearly show (using data) which materials worked the best for you to do this. You will be assessed by your completed laboratory write up.

1. Begin by cutting out your flower template.

2. Next, use your template to outline and cut out two different types of rubber



3. Glue your samples together.
4. Place your sample pine cone/flower into solvent for 24 hours.
5. Check to see which samples have bent the most.

Laboratory rubric:

Design (D)	Identifies problem/ question	1	6
	Reasoned hypothesis with background information	1	
	Variables	1	
	Apparatus/Materials	1	
	Method that controls variables	1	
	Method that collects relevant data	1	

DCP	Records raw data, units, uncertainties	2	6
	Presents raw data clearly	2	
	Processes data correctly	2	

CEv	Valid conclusion	2	6
	Evaluates procedure	2	
	Suggestions for improvements	2	

MS	Safely uses appropriate lab techniques	1	3
	Follows lab instructions	1	
	Uses equipment appropriately	1	

PS	Works well with others	1	3
	Self-motivation & Perserverence	1	
	Ethical Work	1	

Writing Lab Reports

General Instructions:

1. **All labs must be written in pen, typed and be submitted stapled.**
2. **Always use third person (NO personal pronouns --- me, I, you, we, etc.) when writing all parts of a lab report. (USE HE, SHE, THEY, THEIR, THEM, ETC.**
3. **The following things should be written clearly in marker on the front cover --- "Subject" Lab Notebook, teacher name, student name, and period.**
4. **Number each page of the spiral notebook in the lower right hand corner.**
5. **On Page 1, write the subject, year, student name, class period, and teacher name.**
6. **Page 2 should have "Table of Contents" written at the top and two columns, one for "Page" and the other for "Lab Title".**
7. **Begin writing the first lab on page 3 of you notebook. DO NOT WRITE ON THE BACK OF YOUR PAPER!**
8. **SKIP A LINE BETWEEN EVERY SECTION!**
9. **TITLE and UNDERLINE each section & then begin writing on the NEXT LINE!**

Your lab report should be written using the following format: *(Be sure to left align & underline headings)*

Title (*center on top line; on the right of line 2, put date & lab #)*
The title should indicate clearly & concisely the subject and scope of the report.

Introduction - *20 points (PARAGRAPH FORM)*

- **The introduction should give *background information about the experiment*.**
- **It should also state the purpose of the investigation.**
- **This section will be two or more paragraphs in length.**

Hypothesis - *20 points (SINGLE SENTENCE)*

- **The hypothesis should be a *single statement telling the exact thing you are trying to prove in your experiment*.**
- **NEVER write this statement using "first person". Write the hypothesis in past tense (third person.)**

Materials - *5 points (SINGLE SENTENCE)*

- **This section should be written in sentence form and name all of the materials and equipment used.**
- **Be sure to include specific amounts and concentrations of chemicals used.**
- **Start the statement, "*The materials used include _____, _____, etc.*"**

Methods *(Procedure) - 5 points (STEPS; NUMBER)*

- **This section includes *the step-by-step procedures* used.**
- **The procedure should be so thorough that someone else could use your listed materials and procedures to conduct the same experiment and get the same results.**

Results (Data & Questions) - *20 points*

- **All data should be collected and organized in a logical order. Results should be illustrated as charts, tables, graphs, &/or diagrams. All graphs should include a title, the independent variable labeled on the horizontal axis, and the dependent variable labeled on the vertical axis.**
- ***All lab questions and answers should be included also with this section.* (NUMBER & UNDERLINE the questions & then write but DON'T UNDERLINE the answers)**
- *SKIP ONE LINE BETWEEN EACH QUESTION*

Error Analysis

Include any important factors that you think may have actually affected your results.

Discussion and Conclusion - *30 points*

Discussion is the most important part of your report, because here, you show that you understand the experiment beyond the simple level of completing it.!!

- **Your conclusion MUST CONTAIN YOUR SUPPORTING DATA!**
- **This is where you give a detailed account of what happened in the experiment.**
- **Explain all observations and results in your experiment.**
- **Analyze and interpret why these results were obtained.**
- **Be sure to tell the significance or meaning of the results.**
- **Restate the original hypothesis and explain whether the experiment succeeded. If the hypothesis was not correct, you should analyze why the results were not as predicted.**
- **Explain experimental errors that appear in the results.**

QUESTIONS MUST BE ANSWERED & CONCLUSION WRITTEN TO RECEIVE LAB CREDIT!