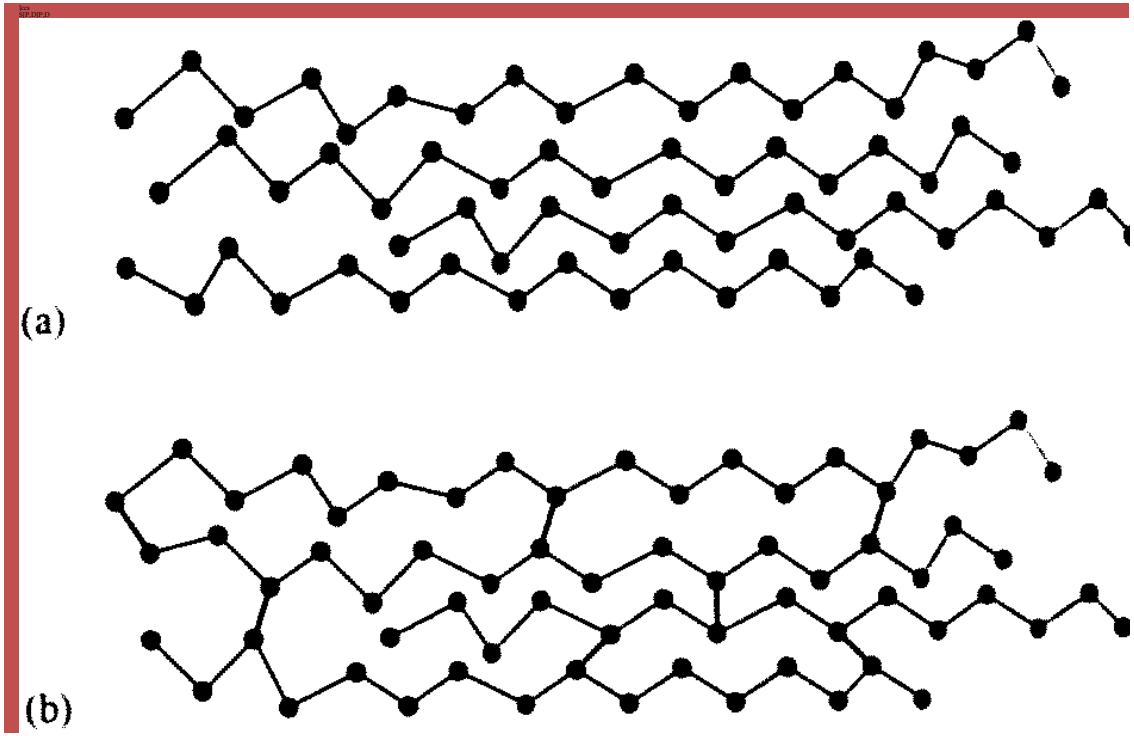
ENGINEERING SURVEY

PHYSICS

11-12

POLYMER MATERIALS



YOUNG'S MODULUS AND PDMS

Overview

This 4-day lesson will focus on the key components of engineering from inquiry, experimenting, experimental analysis, and reflection. This Lesson was developed in conjunction with The University of Akron, polymer science division.

Objectives

The Main overlying objectives are

- Students will use a hands on inquiry-based lesson to learn about the engineering process as it relates to polymer materials.
- Students will utilize the scientific method in answering questions about physical properties of polymer materials.

Activities-Daily.

Day 1: Students will gain pre-requisite knowledge about polymer materials and choose a specific variable to investigate.
Day 2: Students will create the Polymer to be used in the investigation. Student will also create a testing procedure they come up with.
Day 3: Students will perform their testing procedure, discuss problems they encounter, re-develop the testing method, and perform the re-developed procedure.
Day 4: Students will analyze data and prepare graphs to present to the class. Students will present to the class. Students will receive a reflection lesson packet for homework.

Adaptations

Students will be given extra-time if needed either after school or during my intervention period.

Evaluation

Students will be evaluated the following ways:
Participation, Completion Deadlines, Quizzes, Rubrics.

Student Materials Required

-Writing Utensil
PENCIL!!!!
-Calculator
-Lab Notebook

MAKING PDMS LAB

OBJECTIVES

1. Students will make PDMS to specifications depending on their choice of variable to investigate.
2. Students will exercise the use of proper safety procedures and equipment while making the PDMS.
3. Students will work as a team to accomplish their goal in a timely fashion.
4. Students will employ the use of Density to assist in proper measurement of materials.

ACTIVITY—Put all necessary information in your lab notebook to refer to later. (methods, measurements, calculations, data).

1. Measure and Record the radius of your Petri Dish.
2. Use the density formula to calculate the proper amount of mass you will need for the total PDMS solution.

   Remember: **If you chose thickness then this mass will change for each petri dish sample. Then you can split up your mass into **silicone base parts** needed and **curing agent parts** needed. (10:1 Ratio)

3. Once you obtain the mass, calculate the various cross-link ratios needed.

   Remember: **If you chose cross-link ratio then your mass values will change for the ratio of **silicone base** to **curing agent**. (30:1, 20:1, and 10:1)…overall mass is consistent with a 1mm thick sample.
4. Put on gloves and goggles.
5. Obtain Petri Dishes for samples
6. Label your Petri dishes!!!
7. Measure out curing agent first then add the base in a plastic solo cup.
8. Stir for 5 minutes.
9. Pour PDMS mixture into petri dish.
10. Smooth out using popsicle sticks…we want it to be as even as possible.
11. Place in the back of the room in your designated sample drop-off area. Are your samples Labeled?!!!
12. Throw away all materials, clean your area!!

TESTING PLAN

Begin working on a testing plan with the materials at your desk to test Young's Modulus.
Record this in your lab notebook.

MATERIALS SHEET

- Gloves
- Goggles
- Test-Tube Clamp
- C-clamp
- Ruler
- Hanging Masses
- Hanging Mass Hook
- Ring Stand
- Scissors
- Binder Clips
- Paper Clips
- String

**LIMITS: All these materials may be used in creating your testing procedure plan. Remember, you can only use three samples during this testing time, so think your plan out carefully as time is also a factor.

**RATIONALE: In many research settings, amount of materials and time are both critical factors in creating an experiment. This means that a plan must be well thought out before performing it! (Materials and Time mean $$$$$$$$)

Testing Procedure Plan—Trial #1

Directions: Below explain procedure plan for testing the PDMS material, stress vs. strain.

- **This plan will be used to test 3 of 6 samples.**

Testing Procedure Plan Modifications—Trial # 2

Directions: Below write out a proper procedure plan with modifications that you have made from Trial 1 above.

- **Underline the modifications that you added or changed.**
- **This plan will be used to test the remaining three samples**

Testing Data Collection Sheet—Testing plan #1

CROSS-LINK RATIO						
	Sample 1 20:1		**Sample 2** 10:1		**Sample 3** 8:1	
Length Initial (mm)=						
Mass Initial (grams)=						
	Mass Added	Length Increase	Mass Added	Length Increase	Mass Added	Length Increase
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
THICKNESS						
	Sample 1 1mm		**Sample 2** 2mm		**Sample 3** 4mm	
Length Initial (mm)=						
Mass Initial (grams)=						
	Mass Added	Length Increase	Mass added	Length Increase	Mass added	Length Increase
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

Testing Data Collection Sheet—Testing plan #2

CROSS-LINK RATIO

	Sample 1 20:1		Sample 2 10:1		Sample 3 8:1	
Length Initial (mm)=						
Mass Initial (grams)=						
	Mass Added	Length Increase	Mass Added	Length Increase	Mass Added	Length Increase
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

THICKNESS

	Sample 1 1mm		Sample 2 2mm		Sample 3 4mm	
Length Initial (mm)=						
Mass Initial (grams)=						
	Mass Added	Length Increase	Mass added	Length Increase	Mass added	Length Increase
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

GRAPHING YOUR DATA

PURPOSE: Graphing data is important in any scientific experiment. It is a way of displaying your data in a concise and organized method while also visually representing the relationships at play.

1.What type of graph are you going to use? Explain below using sound reasoning and rationale.

2.Sketch what your graph might look like before plotting points. BE VERY NEAT and ORGANIZED!

3.What is the main goal of this graph?

THE GRAPH

GRAPH IT!

Peer Evaluation Form for Group Work

Your name _____

Write the name of each of your group members in a separate column. For each person, indicate the extent to which you agree with the statement on the left, using a scale of 1-4 (1=strongly disagree; 2=disagree; 3=agree; 4=strongly agree). Total the numbers in each column.

Evaluation Criteria	Group Member	Group Member	Group Member	Group Member	Group Member	Group Member
Attends Group Meeting on Time						
Contributes During Group Discussion						
Completes Group Assignments on Time.						
Prepares Work in a Quality Manner						
Demonstrates a Cooperative and Supportive Manner						
Contributes Significantly to the Success of the Project.						
TOTALS						

Feedback on team dynamics

1. How effectively did your group work?

2. Were the behaviors of any of your team members particularly valuable or detrimental to the team? Explain.

What did you learn about working in a group from this project that you will carry into your next group experience?

Teacher Evaluation By Students

1=rarely 2= once in a while 3=sometimes 4= all of the time

1	Teacher is prepared	1	2	3	4	
2	Teacher knows content	1	2	3	4	
3	Teacher is organized	1	2	3	4	
4	Teacher uses meaningful activities	1	2	3	4	
5	Teacher manages time well	1	2	3	4	
6	Teacher grades fairly	1	2	3	4	
7	Teacher is creative	1	2	3	4	
8	Teacher encourages questions	1	2	3	4	
9	Teacher respects students opinions	1	2	3	4	
10	Teacher is sensitive to students needs	1	2	3	4	
11	Teacher words and actions match	1	2	3	4	
12	I trust this teacher	1	2	3	4	
13	Teacher is fair	1	2	3	4	
14	Teacher is fun to be with	1	2	3	4	
15	Teacher helps when you ask for help	1	2	3	4	
16	Teacher is firm but not overly strict	1	2	3	4	

Teacher Information Page-ASSESSMENT

Below is a description of how I will assess the students for this project. You can modify this to meet your curriculum needs.

Testing Procedure Plans-10 points a piece

- Do they have a step by step method?
- Is it chronologically sound?
- Is it detailed and well thought out?
- Do they include measurements and numerical amounts?
- Is there brainstorming notes prior to creation of plan (lab notebook)?
- Are there corrections underlined?
- Is there rationale to their corrections (lab notebook)?

Data Collection Sheets-20 points a piece

- Is it neat and legible?
- Did they include units?
- Is it completed?

Graphing your data sheet-10 points

- Did they select the proper graph?
- Do they have solid rationale as to why they chose that graph?
- Is it complete?
- Is their sketch neat and organized that includes labeled axis, title, etc?

The Graph itself-20 points

- Is the graph neat?
- Does the graph have all its necessary parts?
- Is the Graph to scale?

Peer Evaluation- up to 24points

- Is it completed
- Add the points up then divide by the number of group mates.…that's the allotted value of points earned.
- (EX. Sam gets 4 scores…23, 24, 24, 23, Avg. these scores)

Teacher Evaluation-10 points completion

Scientific Method Essay-___ Refer to rubric