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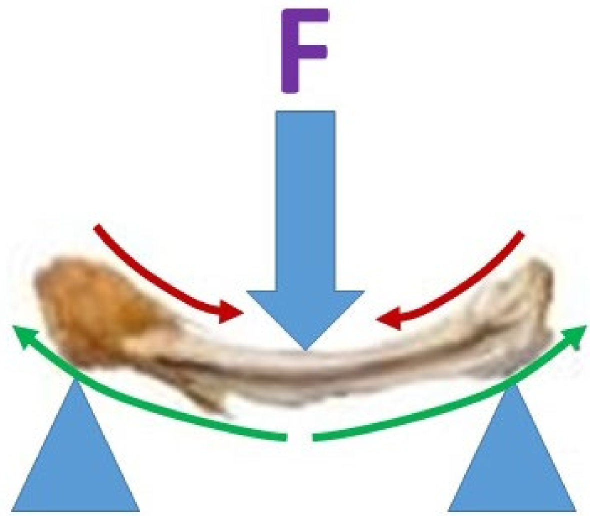
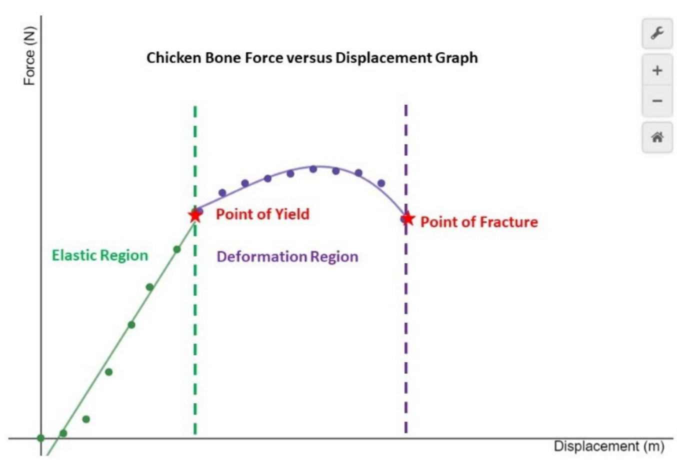
I Don't Wanna Be Chicken Worksheet

Fracture Data Analysis of 3-Point Bending on a Chicken Bone

In a three-point bend test, a beam (in this case a brittle chicken bone) is supported on both ends while a concentrated load, or force, is applied at the center. This test requires stronger equipment than is available in the classroom. The applied force results in compression on the top of the bone and tension on the bottom of the bone as shown. You will be given a table of information which represents force versus displacement data from a 3-point bend test collected in a lab with appropriate equipment. (Your teacher will assign your group Specimen A, B, or C.)



1. Use Desmos to create a scatterplot of the data. Use the wrench tool to adjust the window appropriately so all data points are visible.
2. From previous learning we know that the stress-strain graph can be divided into different regions. The same is true for the force-displacement graph. The three regions are:
   the elastic region, the deformation region, and the point of fracture as shown by the sample graph. (Your graph will look different.)
3. Using your scatterplot as a reference, circle the points on the data table that best represent the different regions. Label the corresponding sections in the table.
4. From your data and graph, what is the force at the YIELD point? _________ Be sure to include units.
5. From your data and graph, what is the force at the FRACTURE point? _____ Be sure to include units.
6. Just like we practiced in class, break the data into two different tables in Desmos. The first table hold the linear data and the second the non-linear data in the ductile region. Make sure the tables have different colors.



7. Insert an expression underneath the data table and run a linear regression on the first data set. Be sure to restrict the domain appropriately and to match the color of the line to the data set.

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8. Write the slope-intercept equation along with the restricted domain using interval notation:

   ____

9. What is the stiffness of your chicken bone sample? Be sure to include units.

   ____

10. Ask the other groups for their stiffness calculations and then average all of them. Complete the table below and include units. You may have to wait a day for all groups to rotate through this station.

Group	**Stiffness**
1	
2	
3	
4	
5	
6	
Average	

11. Look at the data table and find the Young's Modulus given for your data set keeping in mind the average age of a chicken at slaughter is 6 weeks. Six-week old chicken YM = _______________________________________
    How does this value compare to the Young's Modulus of a two-month old female mouse from the following scholarly article: Two-month old mouse YM = ____
    http://www.musculoskeletalcore.wustl.edu/mm/files/Understanding%203pt%20Bending%20outcomes.pdf
    Does this make sense? Explain why or why not?

    ____

    ____

12. How does the Young's Modulus in this activity compare with the Young's Modulus of a 20-month old female mouse from the article referenced in the previous question?
    Twenty-month old mouse YM = ____
    Note that in the wild, mice tend to live only five or six months; however, in ideal indoor conditions they can live up to two years. Does this make sense? Explain.

    ____

    ____

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13. Use Desmos to run a higher-order polynomial regression on the second data set representing the ductile region. You will have to experiment with regression functions to determine if the function is best modeled by a quadratic, cubic, or quartic. Notice the R^2 value; however, if the value does not change much, there is no point in adding complexity using a higher-ordered function. Which model did you choose?_____________

14. Write the deformation region's best-fit polynomial along with the restricted domain, using interval notation. Note: Since the domain starts with where you left off the linear restriction, one should be closed and the other open in the interval notation. (You may have to use closed notation in Desmos in order for the graph to show.)

____

15. Write a complete piece-wise defined function for the entire data set:

Sample A		**Sample B**		**Sample C**	
Displacement (m)	**Force (N)**	**Displacement (m)**	**Force (N)**	**Displacement (m)**	**Force (N)**
0	0	0	0	0	0
.00025	5	.00025	5	.00025	5
.0005	10	.0005	20	.0005	20
.00075	40	.00075	70	.00075	70
.001	75	.001	85	.001	120
.0012	110	.0012	145	.0012	160
.0015	150	.0015	200	.0015	180
.00175	185	.00175	240	.00175	220
.0020	220	.0020	265	.0020	240
.00225	245	.00225	310	.00225	235
.0025	275	.0025	330	.0025	237
.00275	295	.00275	350	.00275	245
.003	310	.003	360	.003	252
.00325	320	.00325	365	.00325	244
.0035	330	.0035	370	.0035	237
.00375	325	.00375	362	.00375	233
.004	315	.004	360	.004	232
.00425	300	.00425	355	.00425	231
.0045	280	.0045	350	.0045	227
Young's Modulus		**Young's Modulus**		**Young's Modulus**	
3.77E+08 N/m^2		4.34E+08 N/m^2		3.63+08 N/m^2	

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Specimen A	
Displacement (m)	**Force (N)**
0	0
.00025	5
.0005	10
.00075	40
.001	75
.0012	110
.0015	150
.00175	185
.0020	220
.00225	245
.0025	275
.00275	295
.003	310
.00325	320
.0035	330
.00375	325
.004	315
.00425	300
.0045	280
Young's Modulus	
3.77E+08 N/m^2	

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Specimen B	
Displacement (m)	**Force (N)**
0	0
.00025	5
.0005	20
.00075	70
.001	85
.0012	145
.0015	200
.00175	240
.0020	265
.00225	310
.0025	330
.00275	350
.003	360
.00325	365
.0035	370
.00375	362
.004	360
.00425	355
.0045	350
Young's Modulus	
4.34E+08 N/m^2	

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Specimen C	
Displacement (m)	**Force (N)**
0	0
.00025	5
.0005	20
.00075	70
.001	120
.0012	160
.0015	180
.00175	220
.0020	240
.00225	235
.0025	237
.00275	245
.003	252
.00325	244
.0035	237
.00375	233
.004	232
.00425	231
.0045	227
Young's Modulus	
3.63+08 N/m^2	