Name: _____ Group Members: _____

Exploration 3-7a: Rubber-Band Chain Rule Problem

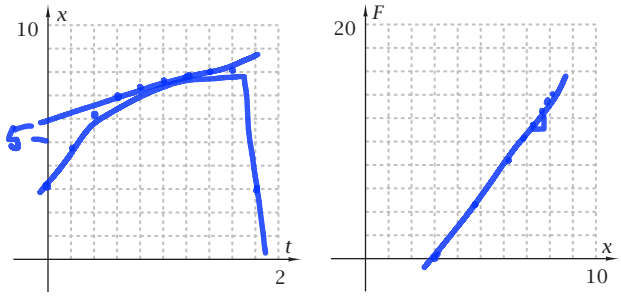
Date: _____

Objective: Given data for a composite function, demonstrate that the chain rule gives correct answers.

Calvin pulls back a rubber band and shoots it at Phoebe. He figures that the force, F, with which he pulls is a function of x, the length of the rubber band, and x is a function of t, the number of seconds since he started pulling. The following are corresponding values of t, x, and F, with x measured in inches, and F in ounces.

t s	x in.	F oz
0	3.0	0
0.2	4.8	4.4
0.4	6.1	8.2
0.6	6.9	11.2
0.8	7.3	13.7
1.0	7.7	14.4
1.2	7.9	15.6
1.4	8.0	16.0
1.6	8.0	16.0
1.8	3.0	0

1. Plot the graphs of F versus x and x versus t. Connect the dots with smooth curves.



2. Estimate dx/dt at $t = 0.8$. What are the units of dx/dt?

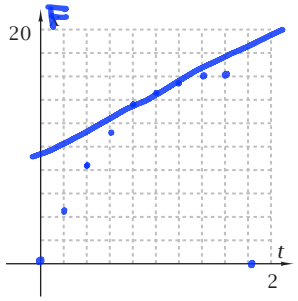
7.3 → 7.7 $\frac{7.7-7.3}{0.2} = 2$ $\frac{\text{in}}{\text{s}}$

3. Estimate dF/dx at $x = 7.3$ (that is, when $t = 0.8$). What are the units of dF/dx?

$\frac{0.7}{0.4} = \frac{7}{4}$ $\frac{\text{oz}}{\text{in}}$

4. Draw lines on the two graphs in Problem 1 to show graphically that the answers to Problems 2 and 3 are correct. Observe the different scales on the axes.

5. Plot the graph of F versus t.



6. The **chain rule** states that $\frac{dF}{dt} = \frac{dF}{dx} \cdot \frac{dx}{dt}$.

Find an estimate of dF/dt at $t = 0.8$ using the answers to Problems 2 and 3. Show how the units of dF/dx and dx/dt combine to give the units of dF/dt.

$2\left(\frac{7}{4}\right) = \frac{7}{2}$

7. Find dF/dt at $t = 0.8$ directly from t and F data in the table. How does the answer compare with the one you got using the chain rule?

$\frac{0.7}{0.2} = \frac{7}{2}$ yay!

8. How can you show graphically that your answers to Problems 6 and 7 are correct?

not sure... slope matches?

9. What did you learn as a result of doing this Exploration that you did not know before?

didn't know the chain rule