**Problem 1 (50 points)**

In the production of acetominophen (Tylenol), para-aminophenol is reacted with an excess of acetic acid (see rxn below).

1. (24 points) Given the following data on p-aminophenol concentration vs. time, develop **nth order polynomial models (n=1 to 6) for the concentration as a function of time**. **Please provide appropriate plots of models vs. data points.**
2. (12 points) Using your models from part A, **develop models for the** **rate of reaction, dC/dt, as a function of time**. **Please provide appropriate plots of the models vs. data points.**
3. (14 points) **Which model would you select** for the chemical reaction, based on what you know about chemical reactions and the numerical models derived from parts A and B? **Clearly explain your reasoning/justification** of your selection of the model order.

t (sec) C (mol/L)

1. 19.015
2. 12.835
3. 9.368
4. 5.648
5. 4.903
6. 3.173
7. 2.057
8. 1.465
9. 1.388
10. 0.925

OH

OH

O

||

CH3-C-NH

O

||

+ CH3-C-OH

NH2

acetominophen

para-aminophenol

**Problem 2 (50 points)**

A liquid flowing in a channel has the following velocity profile:







Where z=0 is the wall of the channel (v=0) and 0.10 m is the center of the channel (v=4.5 m/min). (Note that this profile is only for ½ of the channel width, so it is symmetrical around the channel center.)

The shear stress of the fluid (kg/m-min2) has also been measured as a function of the position in the channel and is given below.







1. (15 points) Using a cubic spline, **model the velocity as a function of position** in the channel. **Provide an appropriate plot showing your model and the data**.
2. (10 points) Using your model from part A, provide a **model for the shear rate, dVz/dz, as a function of position** in the channel. **Provide an appropriate plot of model of shear rate vs. z**.
3. (15 points) Using a cubic spline, model the **shear stress as a function of position in the channel**. **Provide an appropriate plot showing your model and the data.**

From your fluid mechanics background, fluids that obey the model, tau = -  dV/dz, are classified as Newtonian fluids if  is a constant.

1. (10 points) Using your models, **prove/demonstrate that this fluid does not behave as a Newtonian fluid**. **Clearly explain/justify your solution using your models** (provide plots, graphs, etc.) **Explain the type of rheological/physical behavior shown by this fluid** and if possible, give examples from food/biological products.