F01 8.01X

Experiment Flow: Solutions

1. Here is my data for the Experiment FL

I: $L = 131$ mm, $T = 17°C$

	Head cm	t1 (s)	t2 (s)	t3 (s)	tav (s)	SD(s)
0	8	0.1	0.1	0.1	0.1	0.1
1	7	7	6	7	6.7	0.5
2	6	14	14	14	14.0	0.0
3	5	22	23	23	22.7	0.5
4	4	34	33	33	33.3	0.5
5	3	46	45	46	45.7	0.5
6	1					
7	0					

II $L = 261$ mm $T = 17°C$

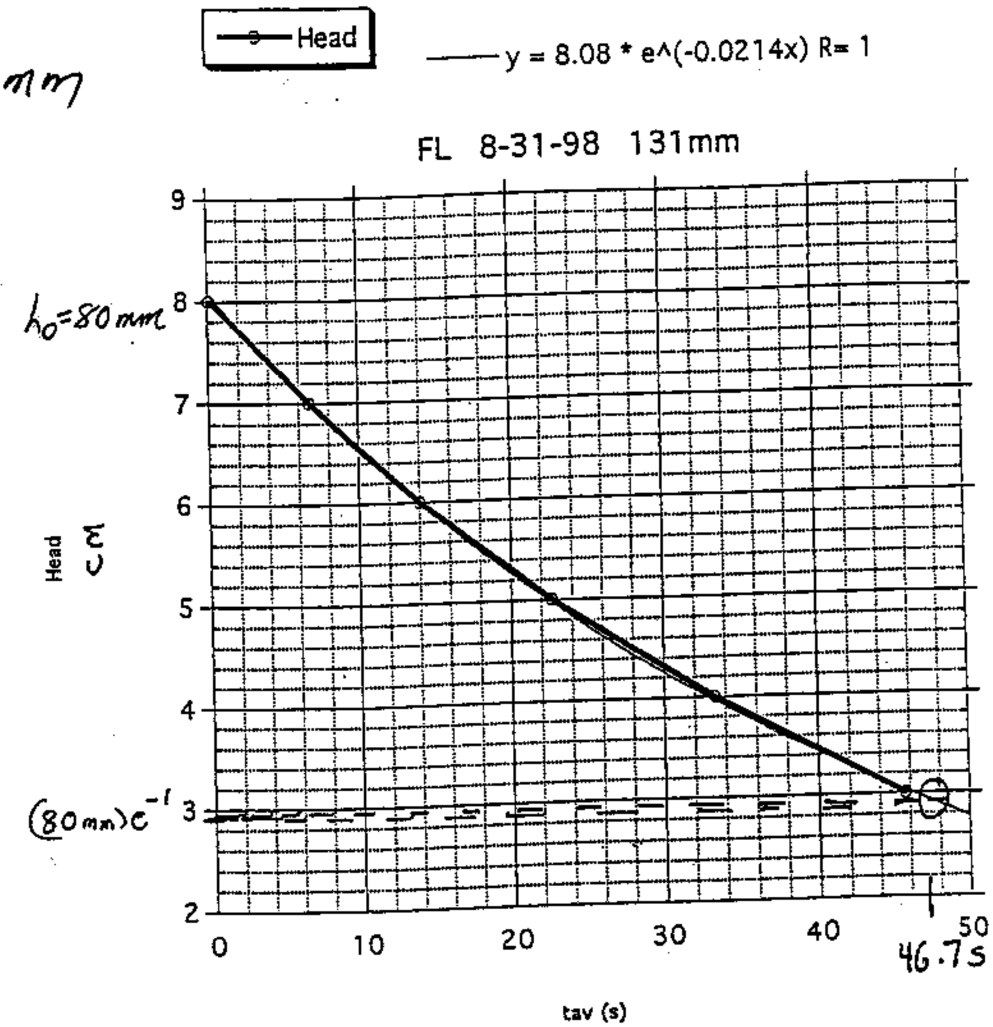
	Head cm	t1 (s)	t2 (s)	t3 (s)	tav (s)	SD(s)
0	8	0	0	0	0.0	0.0
1	7	15	17	18	16.7	1.2
2	6	30	35	41	35.3	4.5
3	5	47	58	68	57.7	8.6
4	4	70	83	99	84.0	11.9
5	3	97	120	140	119.0	17.6
6	2	138	166	196	166.7	23.7
7	1					
8	0					

III $L = 390$ mm $T = 17°C$

	Head cm	t1 (s)	t2 (s)	t3 (s)	tav (s)	SD(s)
0	8	0	0.1	0.1	0.1	0.1
1	7	17	22	23	20.7	2.6
2	6	38	45	48	43.7	4.2
3	5	61	69	75	68.3	5.7
4	4	90	100	108	99.3	7.4
5	3	123	137	147	135.7	9.8
6	1					
7	0					

2. Here are my graphs

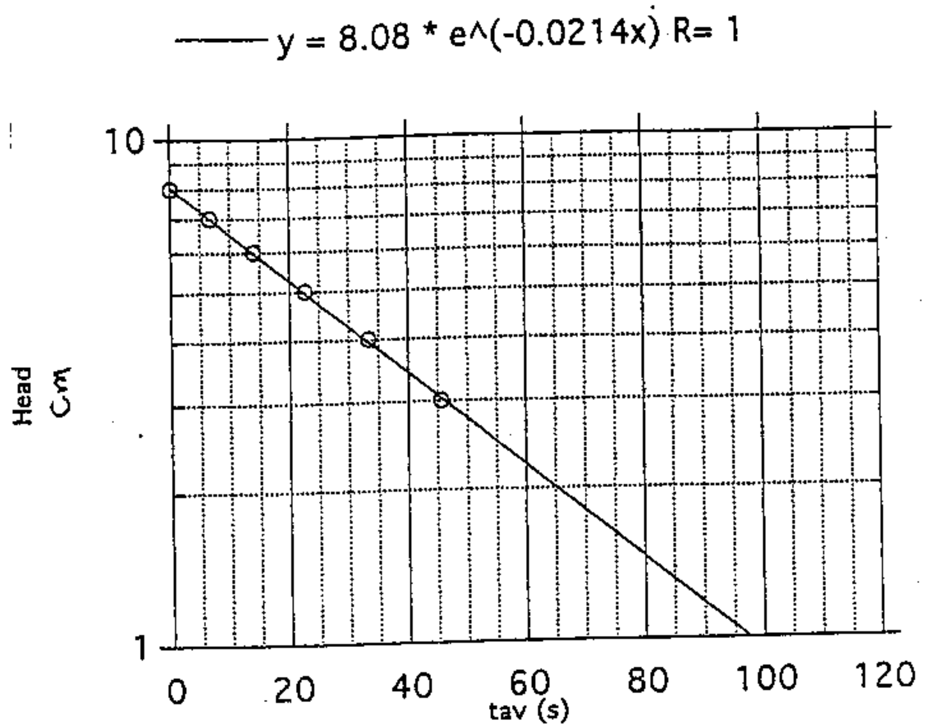
I. $L = 131\,mm$



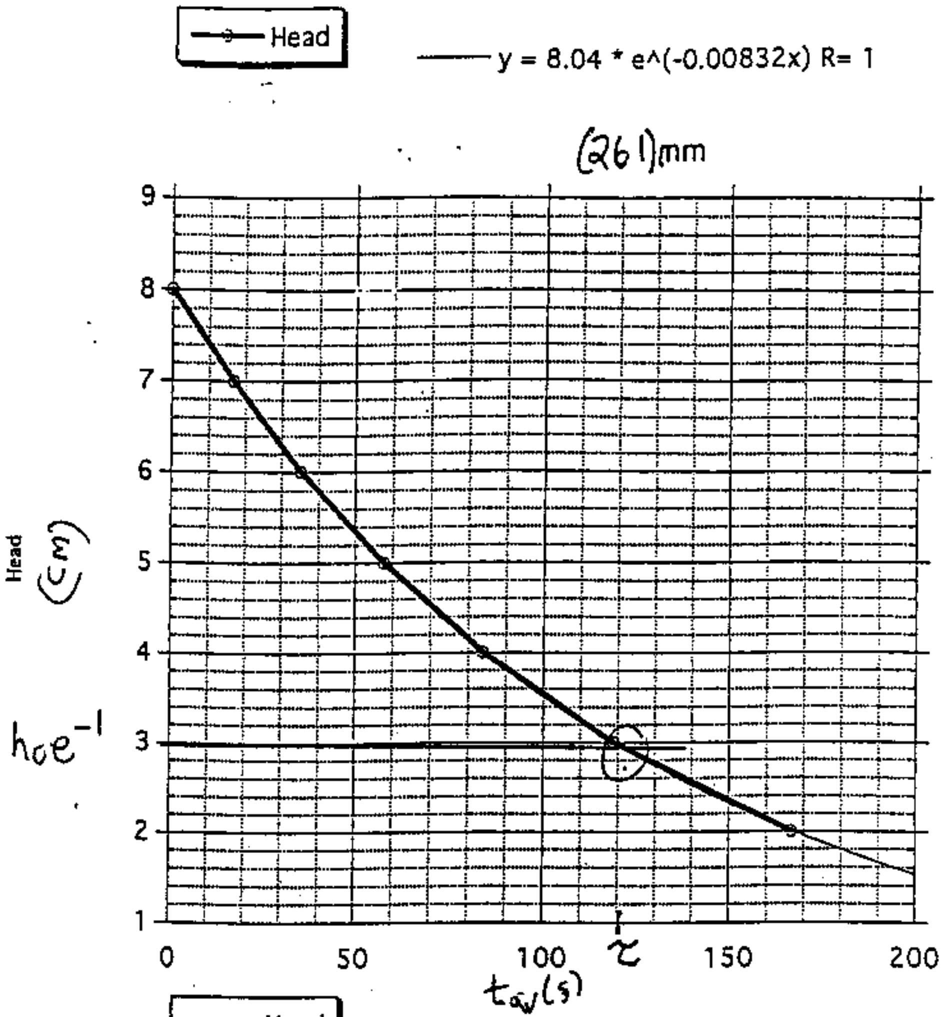
$$\text{Slope} = \frac{\text{rise}}{\text{run}}$$

$$= \frac{\ln(40) - \ln(81)}{(32.5s - 0s)}$$

$$= -.0217\ \frac{1}{s}$$



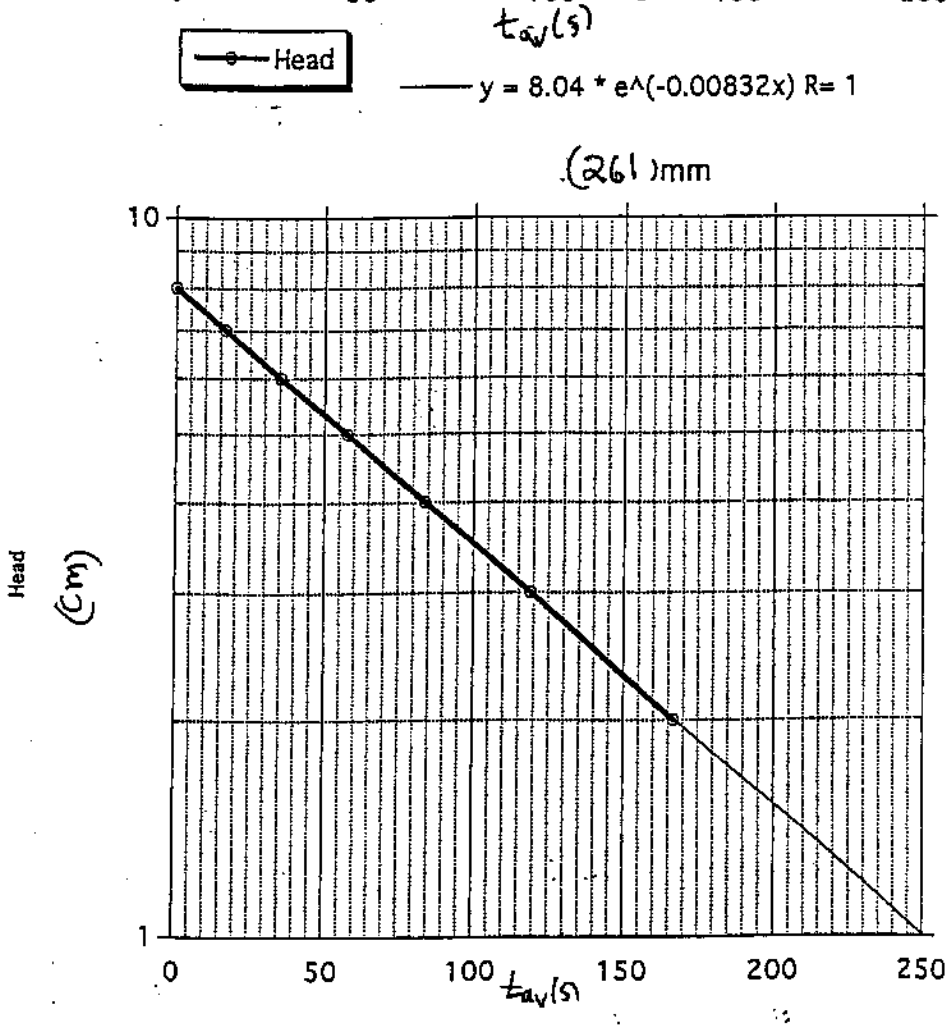
$L = 261\,mm$



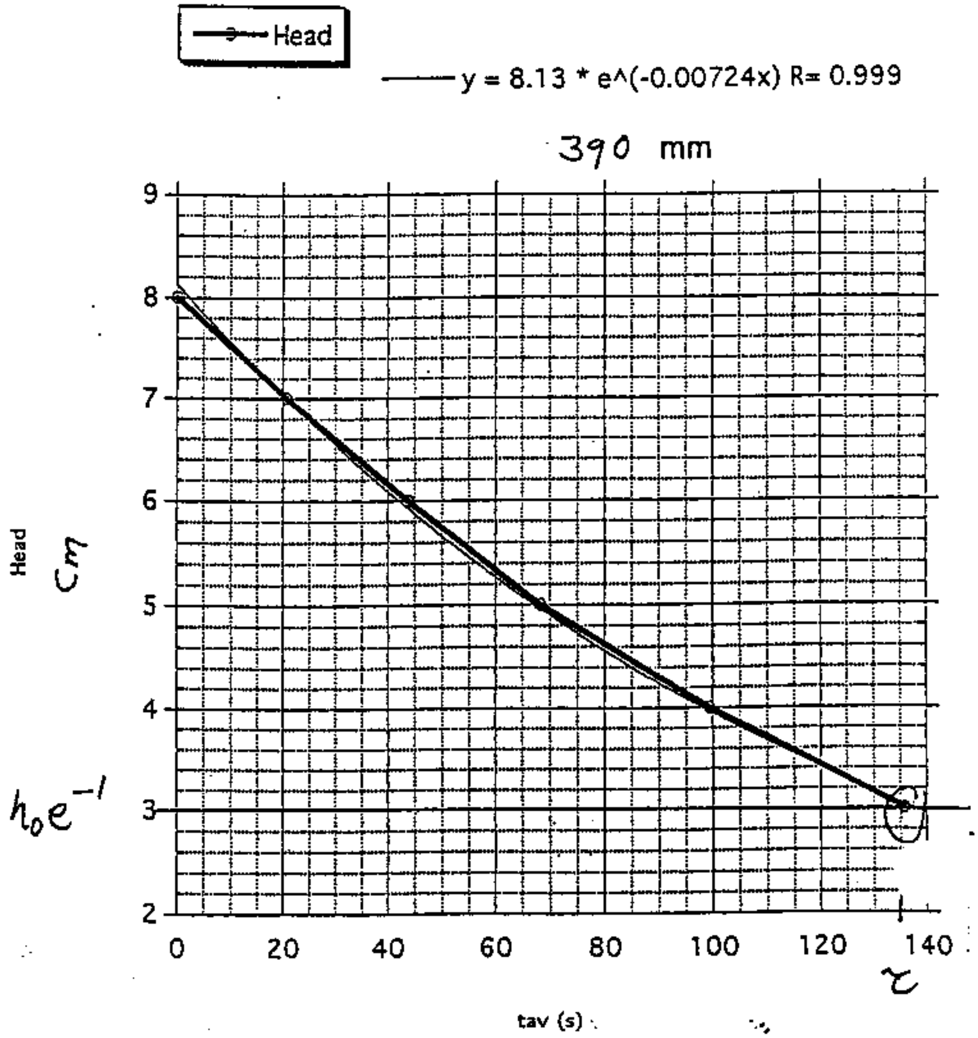
$$slope = \frac{rise}{run}$$

$$= \frac{\ln(50) - \ln(80.4)}{(57.5 - 0)\,s}$$

$$= -.00826\ \frac{1}{s}$$

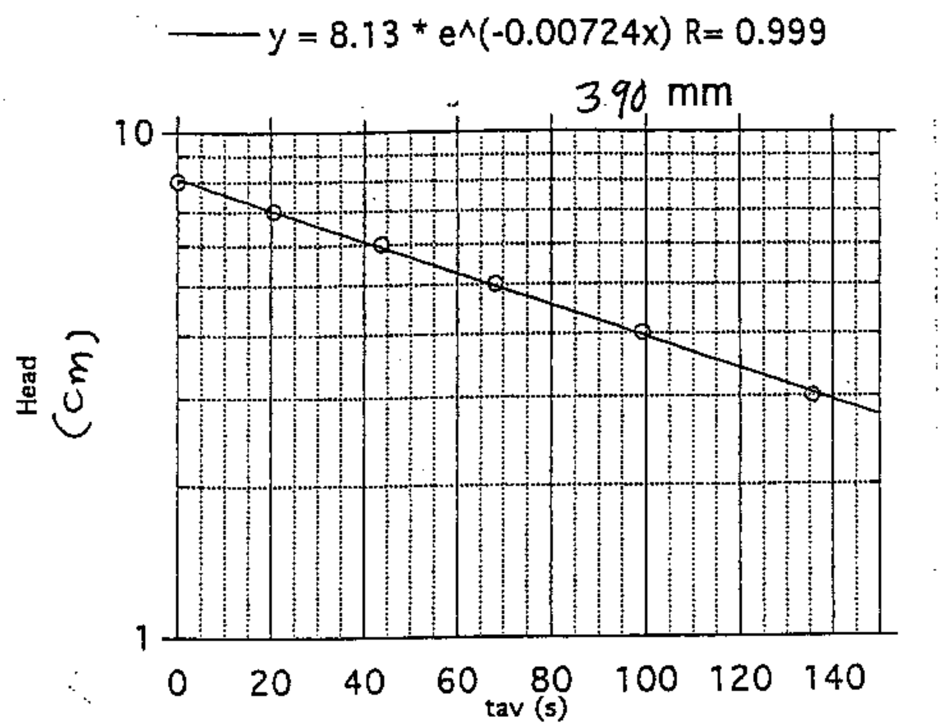


III. $L=391mm$



my best straight line fit has a slope

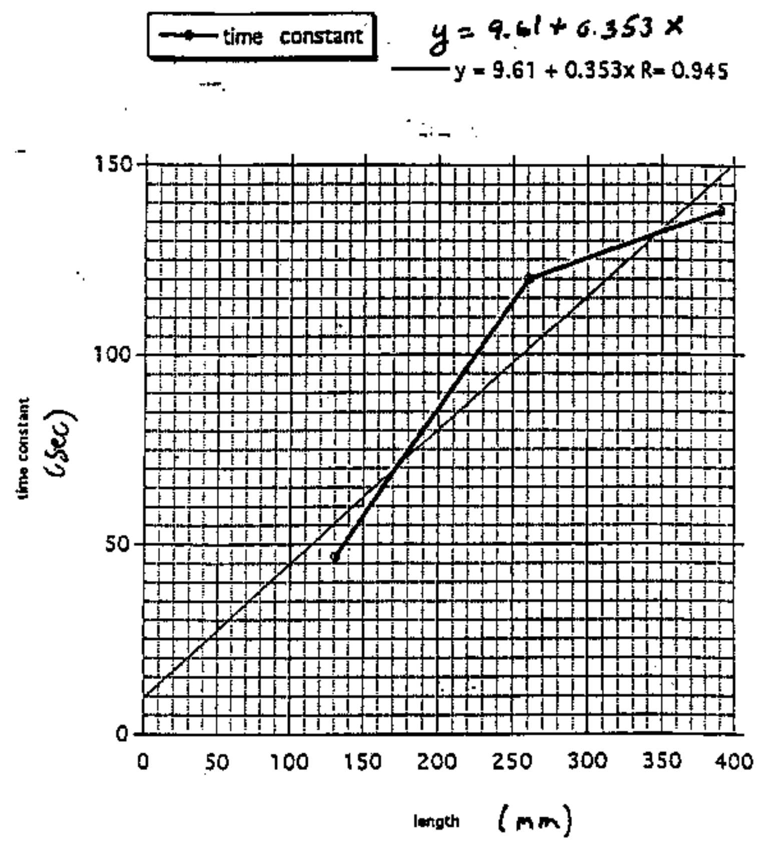
slope $= -7.24\times10^{-3}\frac{1}{s}$



3 My Calculations for the time constants are

	L	slope	time constant $\tau = -\frac{1}{\alpha}$
I	131 mm	$-.0214 \frac{1}{s}$	46.7 s
II	261 mm	$-.0832 \frac{1}{s}$	120 s $= 1.2 \times 10^{2}$ s
III	390 mm	$-7.24 \times 10^{-3} \frac{1}{s}$	138 s 1.38×10^{2} s

4. My plot of time constant vs length is



My data does not have a very good straight line fit. We expect that when $L = 0$, the time constant will not be zero because it takes a finite amount of time to empty the bottle.

As the length L decreases, the flow changes from a uniform 'laminar' flow to a complicated flow that depends on the geometry of the hole and is most likely 'turbulent'.