Question 2 Part 1

Q =	65	gpm	0.1448	ft^3/s
D=	0.1558	ft	Appendix G	
L =	1500	ft		
g =	32.2	ft/s^2		
Flow area =	1.91E-02	ft^2	Appendix G	
Viscosity =	1.05E-05	ft^2/s	Table A.2	
$\varepsilon =$	1.50E-05	ft	Table 8.2	
f =	0.017		moody chart	
$\gamma =$	62.3	lb/ft^3	70°F	
V = Q/A	7.593	ft/s		
Re = VD/v	1.13E+05			
D/ε =	1.04E+04		9.63E-05	
hL pipe =	f(L/D)(V^2/2*g)			
hL pipe =	146.5	ft		
$\Delta P = \gamma h_L$	**9129**	**lbf/ft^2**	**63.396**	**psig**

Question 2 Part 2

L2 =	1500	ft			
L3 =	900	ft			
D2 =	0.1558	ft	Appendix G		
D 3 =	0.1142	ft	Appendix G		
Flow area of 2 =	1.91E-02	ft^2	Appendix G		
Flow area of 3 =	1.02E-02	ft^2	Appendix G		
$\varepsilon =$	1.50E-04	ft	Table 8.2		
Viscosity =	1.05E-05	ft^2/s	Table A.2		
$\gamma =$	62.3	lb/ft^3			
D2/ε =	1038.67				
D3/ε =	761.33				
D2/D3 =	1.36		diameter ratio		
ΔP =	**9129**	**lbf/ft^2**	**63.396**	**psig**	
standard tee =	Le/D =		60		
L/D 2 =	9627.727856				
L/D 3 =	7880.910683				
fT tube 2 =	0.019	moody chart	Table 10.5		
fT tee =	0.022	moody chart	60	fT	
fT elbow =	0.022	moody chart	30	fT	
K reduction=	0.045	Figure 10.11			
K expansion =	0.36	Figure 10.11			

Q2 formula including energy loss

RHS1	RHS2	RHS3
√ (2(g)(A2)*ΔP	1/f2(L/D)+ 2(	2*g*A^2

0.02349376

f = 0.25/log(1/3.7(D2/e)+5.74/Re^0.9))^2

% diff = f2 old - f2 new/f2 old

V = Q/A Re = VD/v

Iteration	f 2 assume	Q2 (ft^3/s)	V2 (ft/s)	Re 2	new f 2	% diff
1	0.01	0.18835388	9.86145983	1.46E+05	2.15E-02	-115%
2	0.02	0.13344786	6.98679876	1.04E+05	0.02213657	-11%
3	0.03	0.10903118	5.7084389	8.47E+04	0.02258575	25%
4	0.026	0.11709464	6.13060951	9.10E+04	0.02242021	14%
5	0.023	0.12447269	6.51689456	9.67E+04	0.02228454	3%
6	0.0222	0.12668778	6.63286812	9.84E+04	0.0222464	0%

Q2 = 56.82 gpm

energy losses for Q3

Pipe	Tee	Reduction	elbow	expansion
f3(L/D)	2(60)(fT)	0.045	2(30)(fT)	0.36
	2.64		1.32	

4.365

2gA3 = 0.00670018

f3*l/D+losses

Q3 Forumla = $\sqrt{(2gA3*\Delta P/\gamma)}*(1/f3*(L/D)+losses$

f = 0.25/log(1/3.7(D3/e)+5.74/Re^0.9))^2 % diff = f3 old - f3 new/f3 old

V = Q/A Re = VD/v

Iteration	f 3 assume	Q3 (ft^3/s)	V3 (ft/s)	Re 3	new f 3	% diff
1	0.01	0.10864672	10.651639	1.16E+05	0.02311014	-131%
2	0.0113	0.10251618	10.0506056	1.09E+05	0.02321095	-105%
3	0.011	0.10383858	10.180253	1.11E+05	0.02318833	-111%
4	0.02	0.07785306	7.63265282	8.30E+04	0.02375018	-19%
5	0.022	0.07432107	7.28637929	7.92E+04	0.02385192	-8%
6	0.024	0.07122993	6.9833263	7.60E+04	0.02394792	0%

Q3 = 31.97 gpm

Q1=Q2+Q3 88.79 gpm

increase: 23.79 gpm