PETE 324
HW # 3. Solution.
February 20, 2004

Tubing length, L = 10500 ft
Tubing ID = 2.44 in

1) Wellbore Volume, Vw

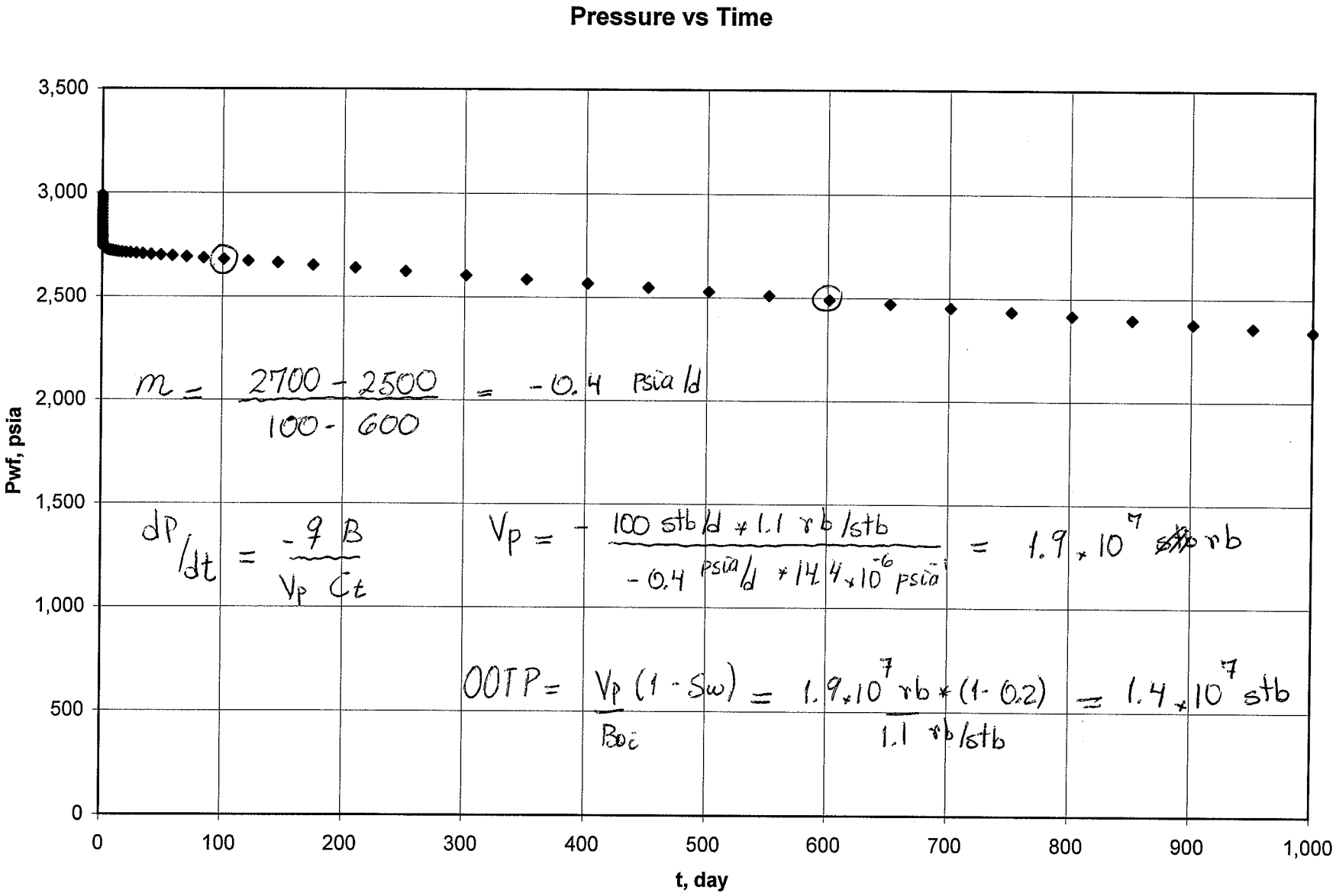
$$Vw = \pi * (ID/2)^2 * L = \pi * (2.44in/2*12\ in/ft)^2 * 10500\ ft$$
$$Vw = 340.78\ ft3$$

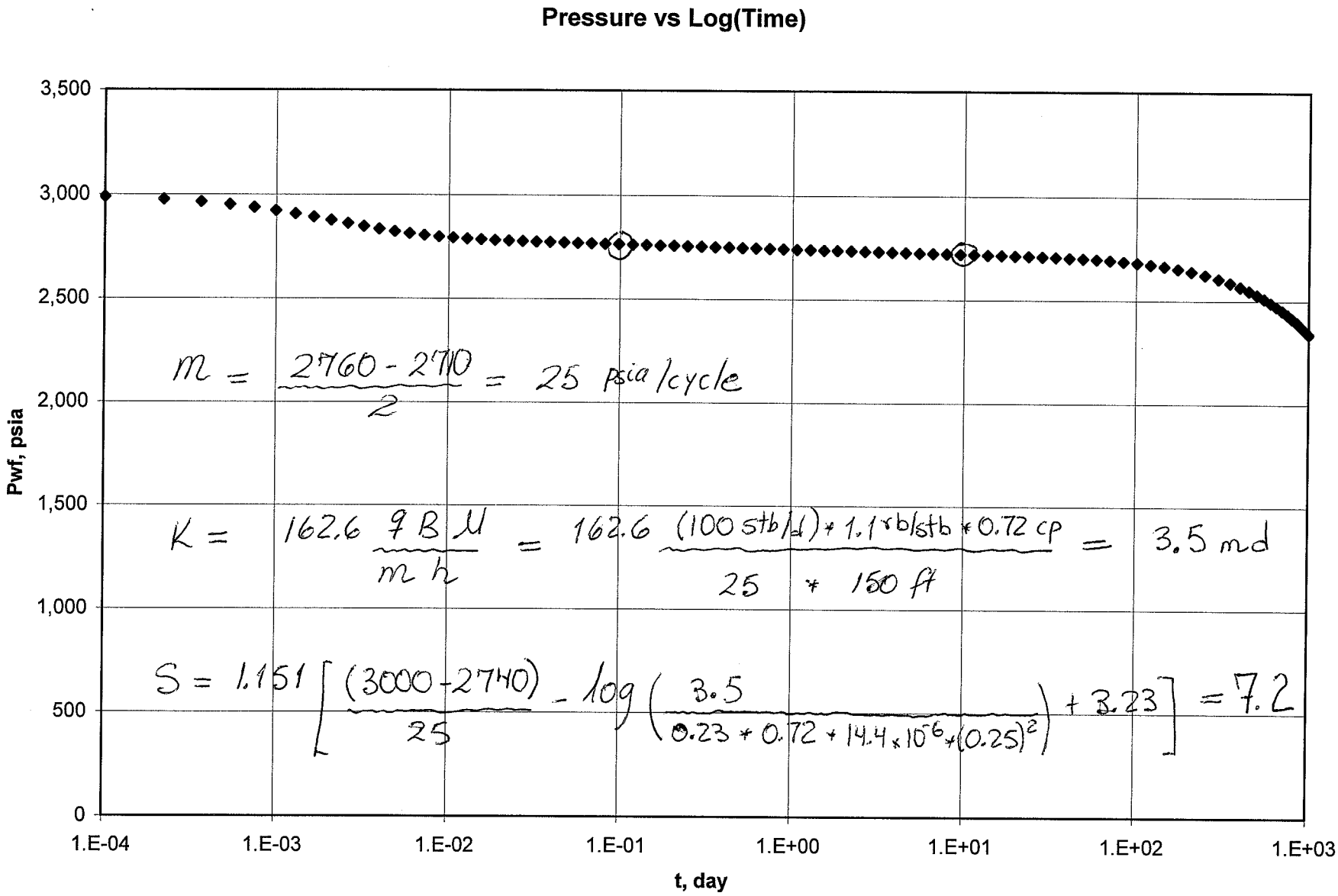
2) Porosity of wellbore cell with wellbore storage, PHIS

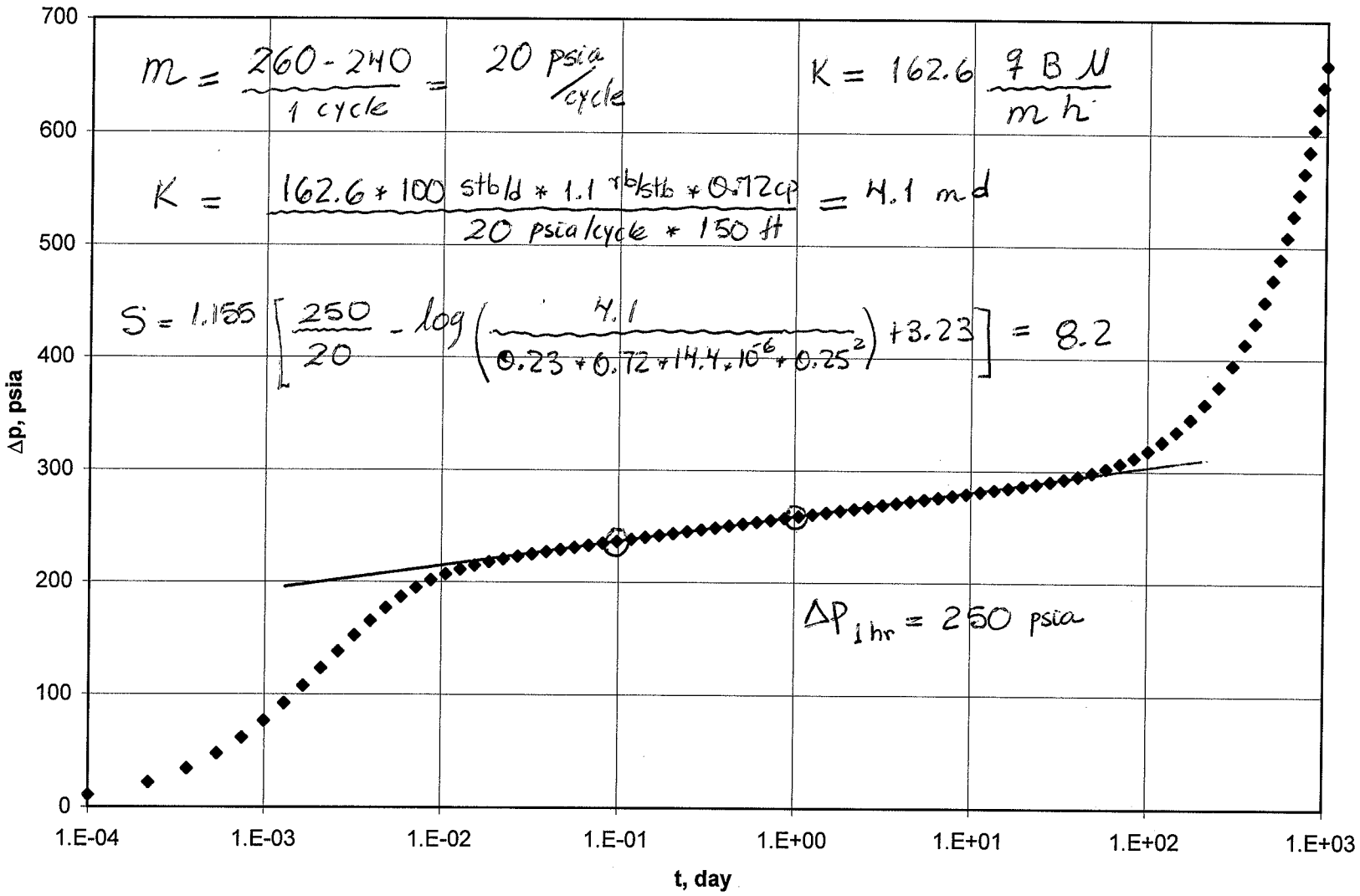
$$PHIS = Vw / [\pi * (RR^2 - RWEL^2) * DELY] = 340.78ft3 / [\pi * (0.25^2 - 0.001^2)*150ft]$$
$$PHIS = 11.57$$

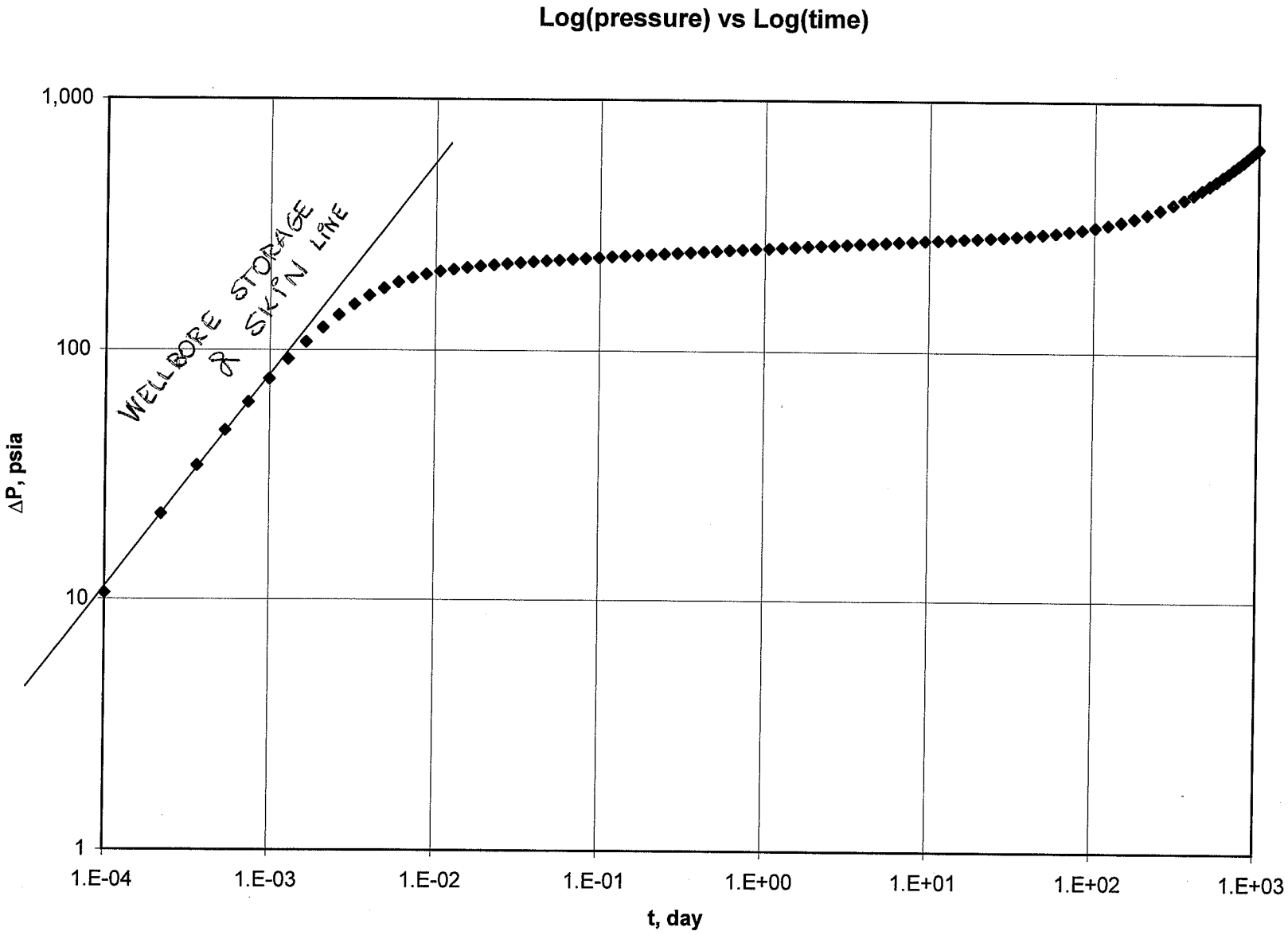
3) Permeability of cell on damaged zone, ks:

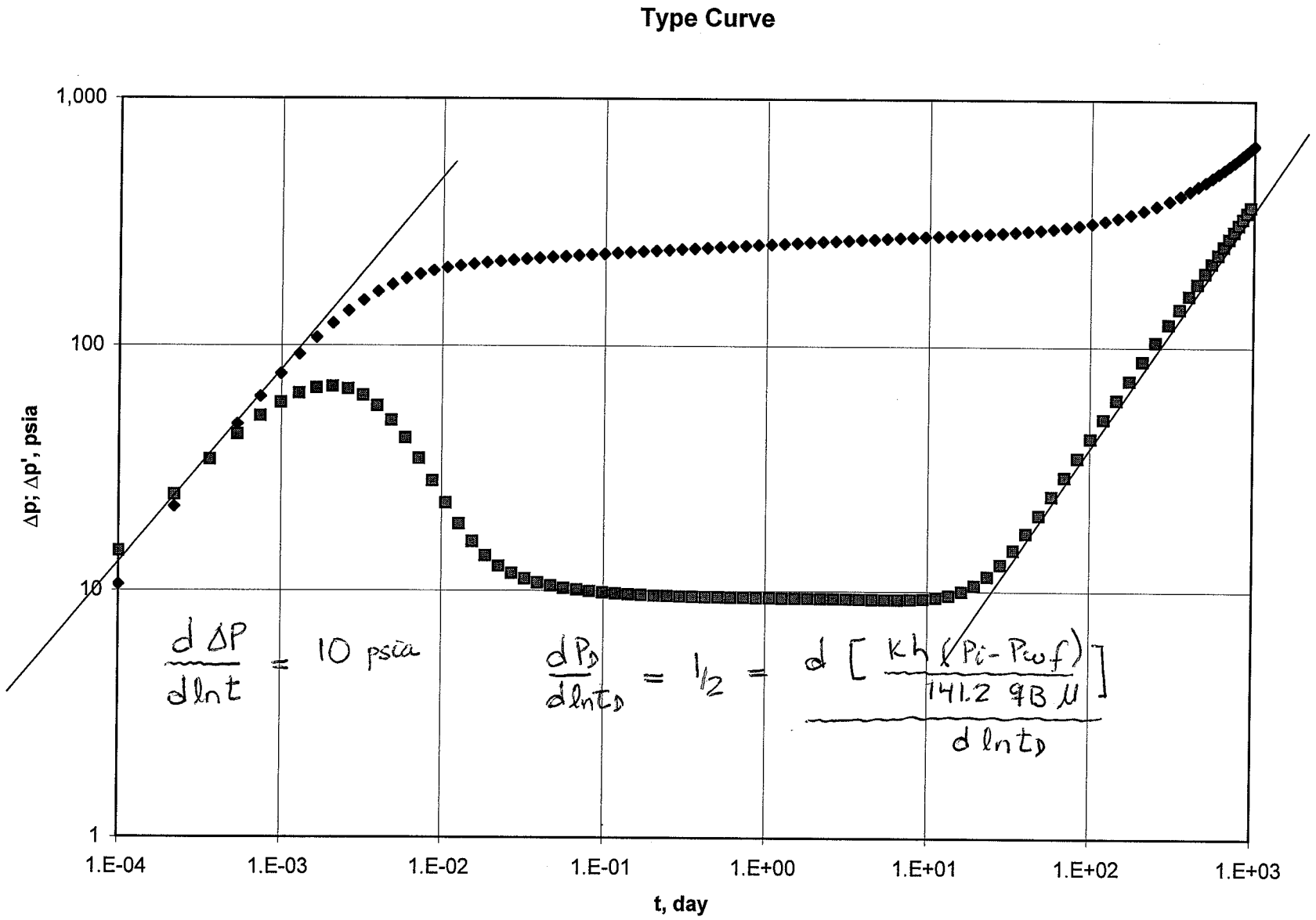
$$s = \left(\frac{k}{ks} - 1\right) \ln\left(\frac{rs}{rw}\right);$$
$$0.75 = \left(\frac{4}{ks} - 1\right) * \ln(2.756/0.25)$$
$$ks = 0.97\ md$$


Pressure vs Time
Pwf, psia
3,500
3,000
2,500
2,000
1,500
1,000
500
0
0
100
200
300
400
500
600
700
800
900
1,000
t, day
m = (2700 - 2500) / (100 - 600) = -0.4 psia/d
dP/dt = -q B / (Vp Ct)
Vp = - 100 stb/d * 1.1 rb/stb / (-0.4 psia/d * 14.4 * 10^-6 psia^-1) = 1.9 * 10^7 rb
OOIP = Vp (1 - Sw) / Boi = 1.9 * 10^7 rb * (1 - 0.2) / 1.1 rb/stb = 1.4 * 10^7 stb

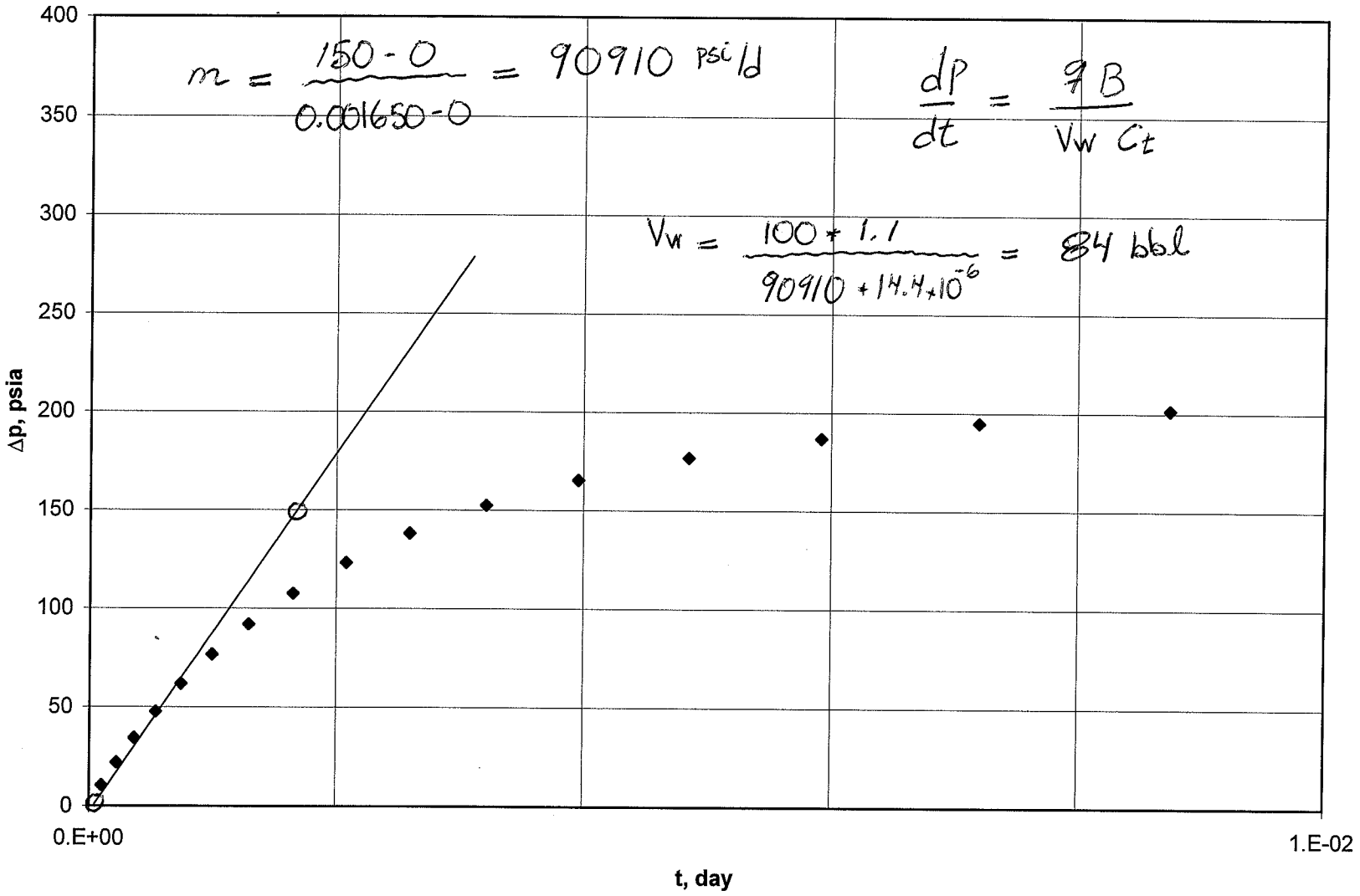

Pressure vs Log(Time)
Pwf, psia
3,500
3,000
2,500
2,000
1,500
1,000
500
0
1.E-04
1.E-03
1.E-02
1.E-01
1.E+00
1.E+01
1.E+02
1.E+03
t, day
m = (2760 - 2710) / 2 = 25 psia/cycle
K = 162.6 q B μ / m h = 162.6 (100 stb/d) * 1.1 rb/stb * 0.72 cp / 25 * 150 ft = 3.5 md
S = 1.151 [(3000 - 2740) / 25 - log (3.5 / (0.23 * 0.72 * 14.4 x 10^-6 * (0.25)^2)) + 3.23] = 7.2

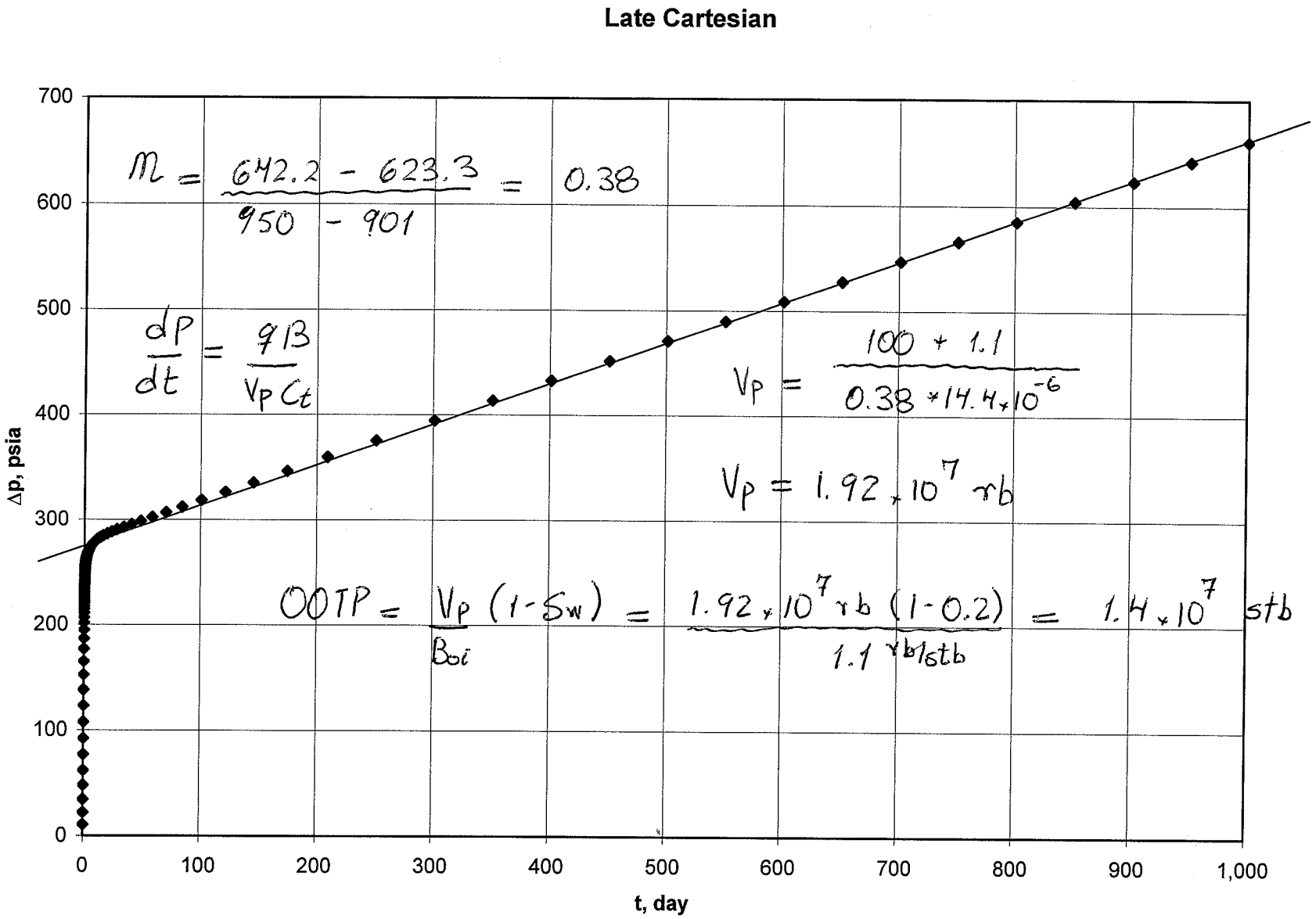

Drawdown vs Log(time)
$m = \frac{260-240}{1\ cycle} = 20\ \frac{psia}{cycle}$
$K = 162.6\ \frac{q B \mu}{m h}$
$K = \frac{162.6 * 100\ stb/d * 1.1\ rb/stb * 0.72 cp}{20\ psia/cycle * 150\ ft} = 4.1\ md$
$S = 1.155\left[\frac{250}{20} - \log\left(\frac{4.1}{0.23 * 0.72 * 14.4 * 10^{6} * 0.25^{2}}\right) + 3.23\right] = 8.2$
$\Delta P_{1\ hr} = 250\ psia$
Δp, psia
t, day
700
600
500
400
300
200
100
0
1.E-04
1.E-03
1.E-02
1.E-01
1.E+00
1.E+01
1.E+02
1.E+03

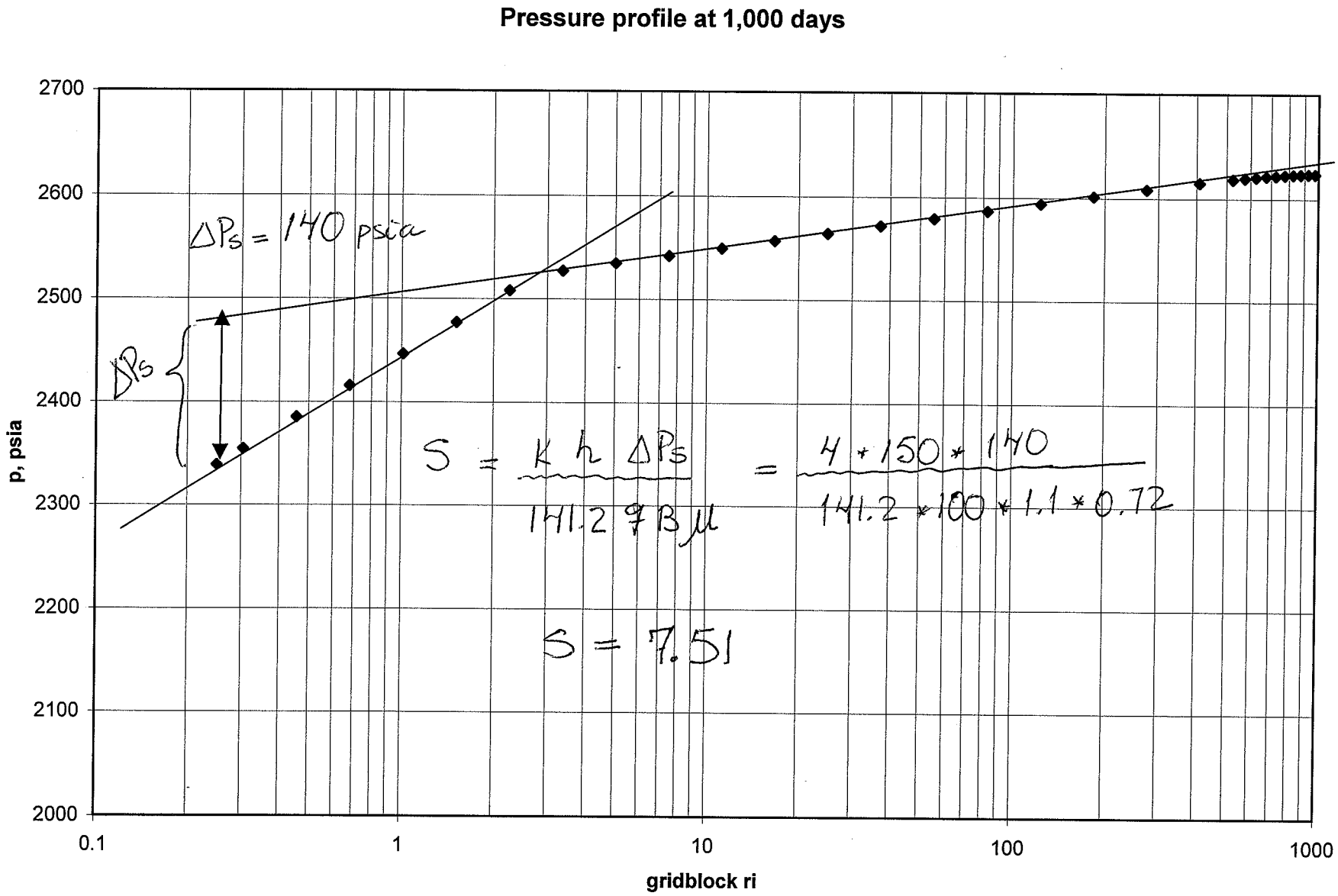

Log(pressure) vs Log(time)
1,000
100
10
1
ΔP, psia
WELLBORE STORAGE & SKIN LINE
1.E-04
1.E-03
1.E-02
1.E-01
1.E+00
1.E+01
1.E+02
1.E+03
t, day



$$\frac{kh\,\Delta P}{141.2\,qB\mu} = \frac{1}{2} = \frac{k(150)(10)}{141.2(100)(1.1)(0.72} \Rightarrow k = 3.7 \text{ md}$$


Early Cartesian
400
350
300
250
200
150
100
50
0
Δp, psia
0.E+00
1.E-02
t, day
$m = \frac{150-0}{0.001650-0} = 90910$ psi/d
$\frac{dp}{dt} = \frac{q B}{V_w C_t}$
$V_w = \frac{100 * 1.1}{90910 * 14.4 * 10^{-6}} = 84$ bbl


Late Cartesian
Δp, psia
t, day
0
100
200
300
400
500
600
700
800
900
1,000
m = (642.2 - 623.3) / (950 - 901) = 0.38
dP/dt = 913 / (Vp Ct)
Vp = (100 * 1.1) / (0.38 * 14.4 * 10^-6)
Vp = 1.92 * 10^7 rb
OOIP = Vp (1 - Sw) / Boi = 1.92 * 10^7 rb (1 - 0.2) / 1.1 rb/stb = 1.4 * 10^7 stb


Pressure profile at 1,000 days
2700
2600
2500
2400
2300
2200
2100
2000
p, psia
0.1
1
10
100
1000
gridblock ri
ΔPs = 140 psia
ΔPs
S = k h ΔPs / 141.2 q B μ = 4 * 150 * 140 / 141.2 * 100 * 1.1 * 0.72
S = 7.51