8.5

FIRST CALCULATE N_o

$$N_o = \frac{3.0\,g}{L} \times \frac{L}{1000\,cm^3} \times \frac{mol}{200{,}000\,g} \times \frac{6.02\times10^{23}\ mlcs}{mol}$$

$$N_o = 9.03\times10^{15} = 9{,}030{,}000\times10^{9}\ mlcs/cm^3$$

★ A PLOT OF $\frac{N_o}{N}$ VERSUS TIME WILL SHOW A LINEAR RELATIONSHIP DURING DIFFUSION-LIMITED GROWTH AND AN EXPONENTIAL RELATIONSHIP DURING FLUID-MOTION LIMITED GROWTH.

A) SO, WE MUST PLOT N_o/N VS. TIME AND DETERMINE WHERE DIFFUSION LIMITED GROWTH OCCURS.

FROM THE PLOTS, $\frac{N_o}{N}$ VS. TIME IS

LINEAR FROM $\underline{\underline{0 \rightarrow 180s}}$ (3.0 MIN)

AT 3.0 MIN $N = 6.19\times10^{8}$ part./cm^3

$$\frac{N_o}{N} = \frac{M}{M_o} = \frac{9.03\times10^{15}}{6.19\times10^{8}} = 1.46\times10^{7}\ mlcs/PARTICLE$$

$$1.46\times10^{7}\ \frac{mlcs}{part.} \times \frac{mol}{6.02\times10^{23}\ mlcs} \times \frac{200{,}000\,g}{mol} = 4.85\times10^{-12}\ \frac{g}{part.}$$

$$\frac{4.85 \times 10^{-12}\, g}{part.} \times \frac{cm^3}{1.3 g} = 3.73 \times 10^{-12}\, cm^3/particle$$

$$V = \frac{4}{3}\pi r^3 = 3.73 \times 10^{-12}\ cm^3/particle$$

$$r = 9.62 \times 10^{-5}\, cm$$

$$d = 1.92 \times 10^{-4}\, cm$$

$$\underline{\underline{d = 1.9\ \mu m}}$$

b)

$$\frac{N_o}{N} = 1 + N_o K_A t \approx N_o K_A t$$

$$SLOPE = 81056 = N_o K_A$$

$$81056 = 9.03 \times 10^{15}\, K_A$$

$$\underline{\underline{K_A = 8.98 \times 10^{-12}\, cm^3/s}}$$

c) FOR FLUID MOTION – LIMITED GROWTH

$N_{F0} = 6.19 \times 10^8$ part./cm^3

HERE WE PLOT $\ln\left(\frac{N}{N_{F0}}\right)$ VS. TIME

$$\ln\left(\frac{N}{N_{F0}}\right) = -\frac{4}{\pi}\alpha\phi\left(\frac{P/V}{\rho\nu}\right)^{1/2} t$$

FROM PLOT

$$\text{SLOPE} = -0.0331 = -\frac{4}{\pi}\alpha\phi\left(\frac{P/V}{\rho\nu}\right)^{1/2}$$

$$\phi = \frac{3.0\times10^{-3}\,g/cm^3\ \text{SOLN}}{1.3\,g/cm^3\ \text{precip.}} = 0.00231$$

$$P/V = 1500\times10^7/1{,}000{,}000 = 15000$$

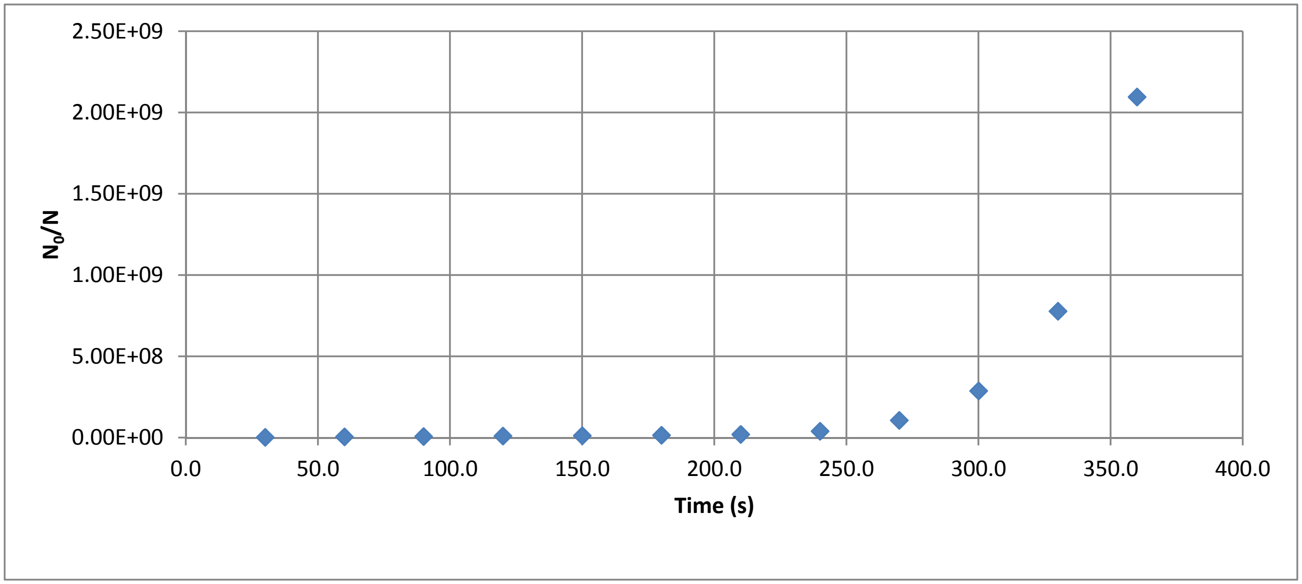
$$\rho\nu = \mu = 0.012\,g/cm\,s$$

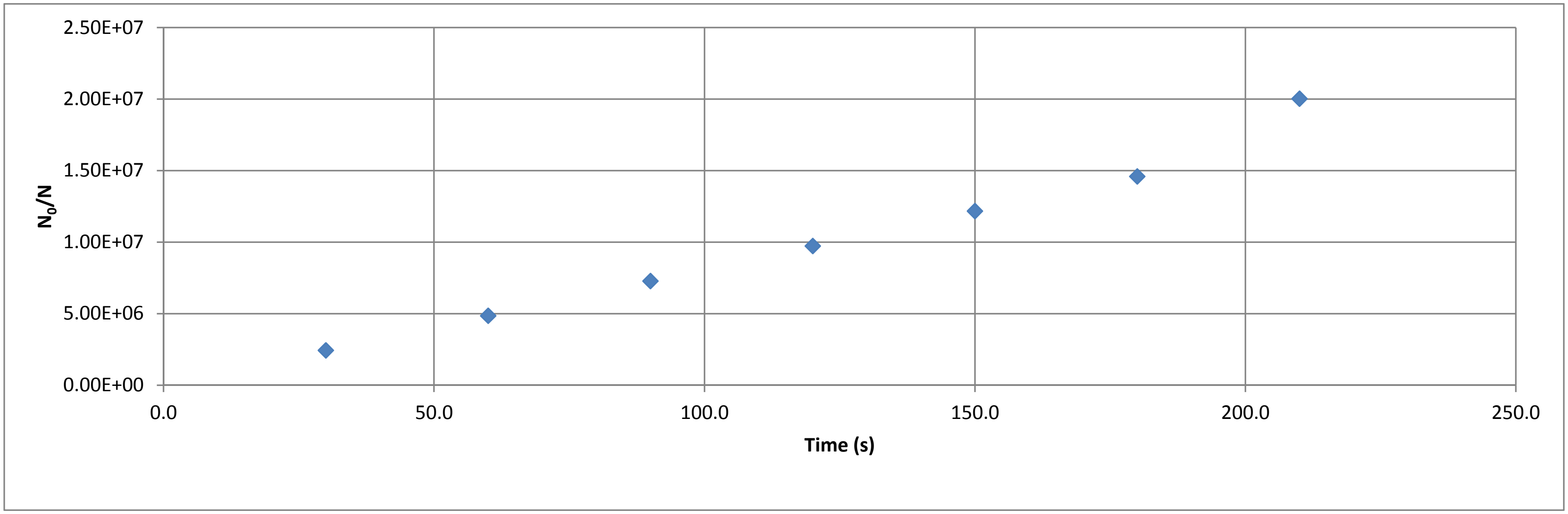
$$-0.0331 = -\frac{4}{\pi}\alpha(0.00231)\left(\frac{15000}{0.012}\right)^{1/2}$$

$$\underline{\underline{\alpha = 0.010\ s^{-1}}}$$

Problem 8.5(a)

t (min)	t (s)	N (10^9)	N_0/N
0.0	0.0	9030000	
0.5	30.0	3.72	2.43E+06
1.0	60.0	1.86	4.85E+06
1.5	90.0	1.24	7.28E+06
2.0	120.0	0.928	9.73E+06
2.5	150.0	0.742	1.22E+07
3.0	180.0	0.619	1.46E+07
3.5	210.0	0.451	2.00E+07
4.0	240.0	0.229	3.94E+07
4.5	270.0	0.0849	1.06E+08
5.0	300.0	0.0314	2.88E+08
5.5	330.0	0.0116	7.78E+08
6.0	360.0	0.00431	2.10E+09





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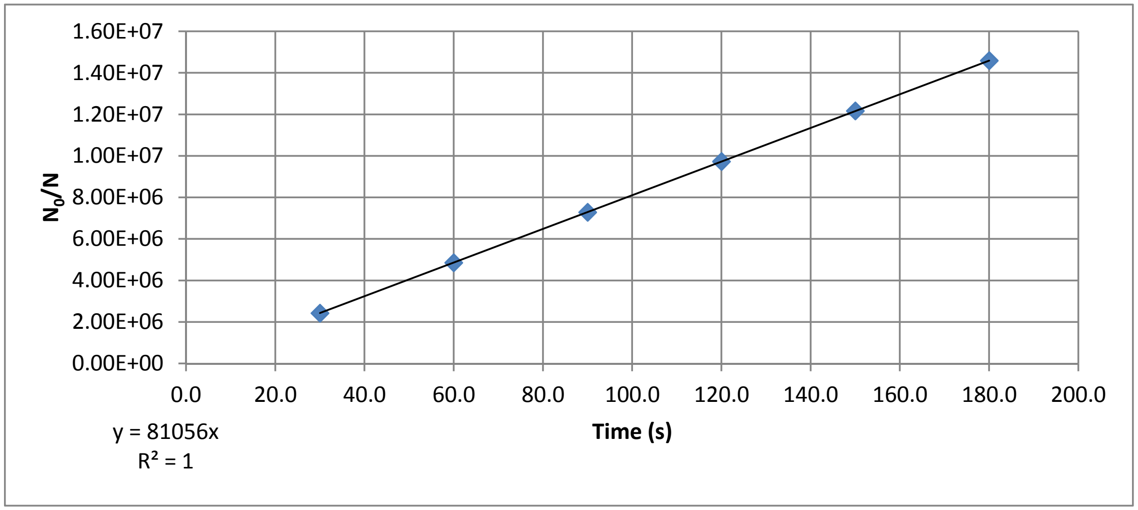

Problem 8.5(b)

t	t (after diffusion)	t (s)	N	N/N_{FO}	$\ln(N/N_{FO})$
3.5	0.5	30.0	0.4510	0.7286	-0.3166
4.0	1.0	60.0	0.2290	0.3700	-0.9944
4.5	1.5	90.0	0.0849	0.1372	-1.9866
5.0	2.0	120.0	0.0314	0.0507	-2.9813
5.5	2.5	150.0	0.0116	0.0187	-3.9771
6.0	3.0	180.0	0.0043	0.0070	-4.9672