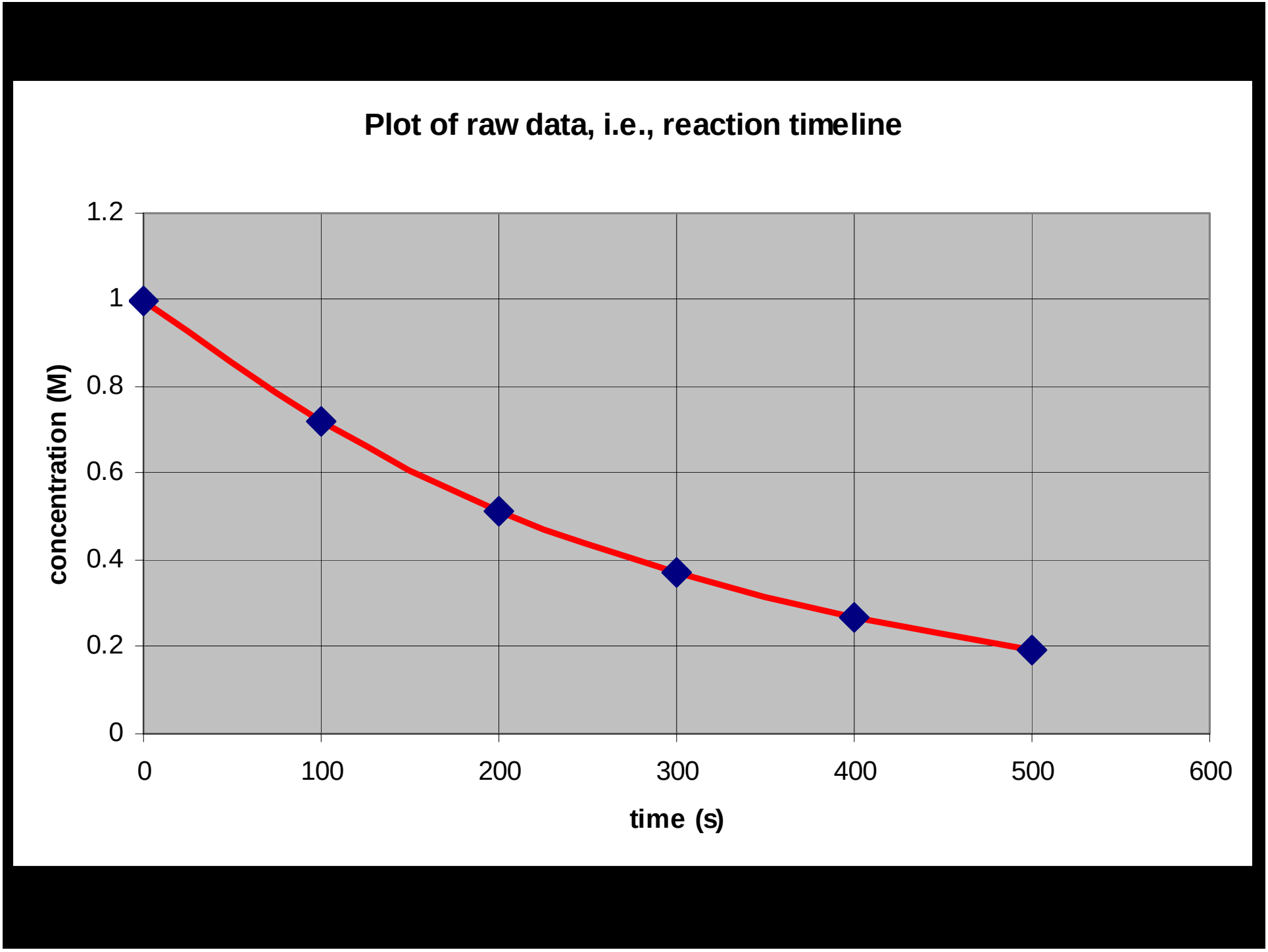
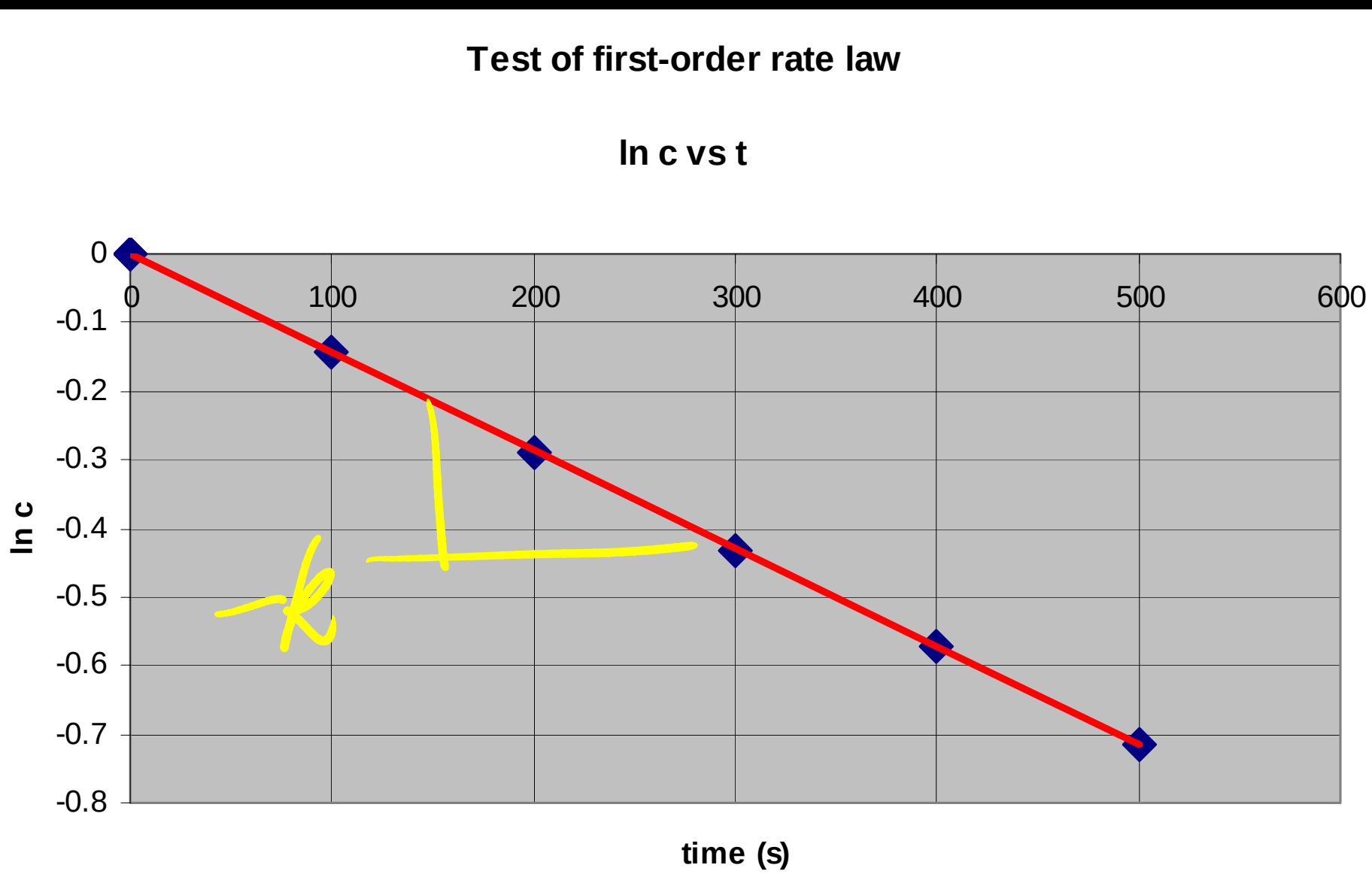
Welcome to 3.091

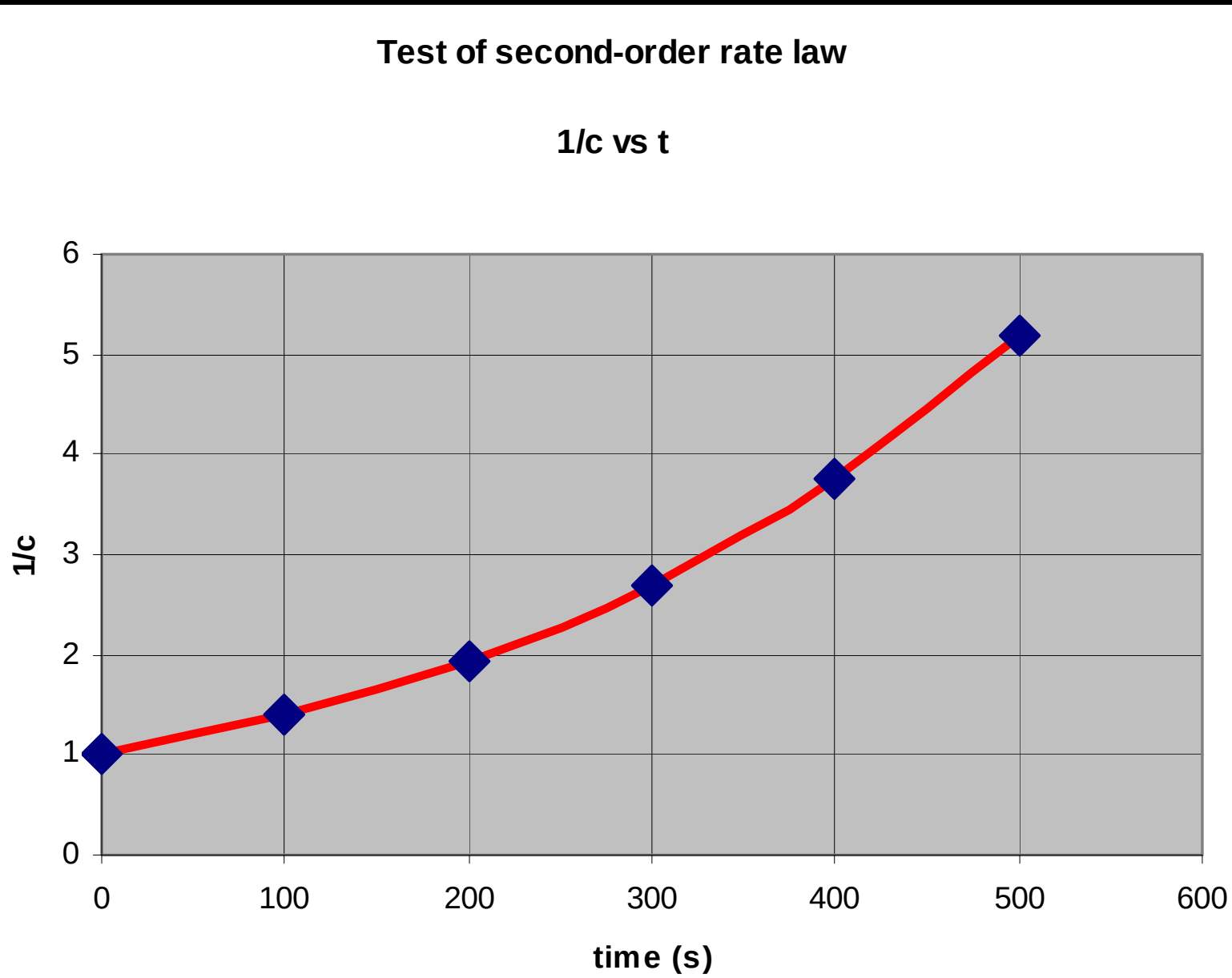
Lecture 22

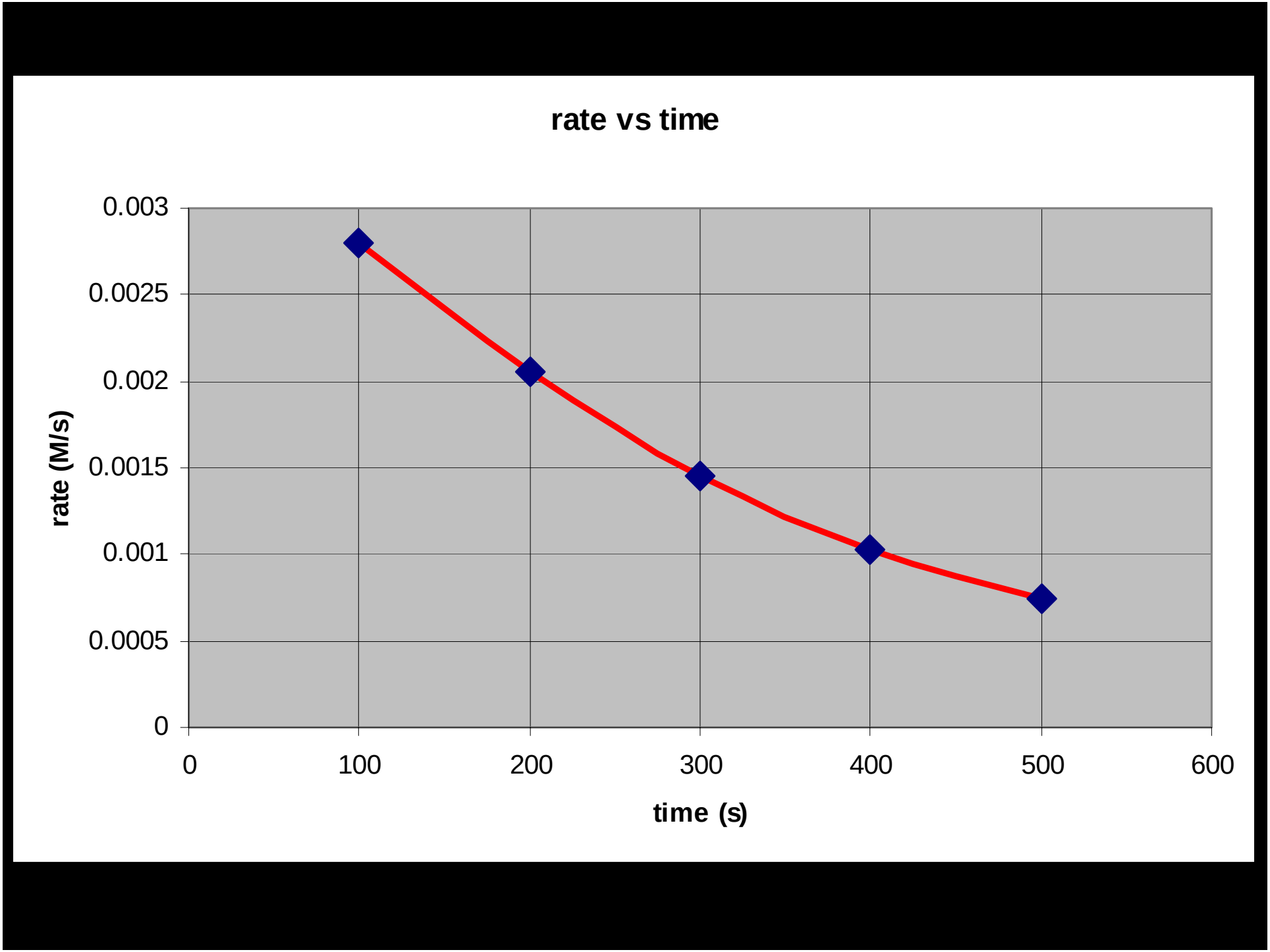
November 3, 2004

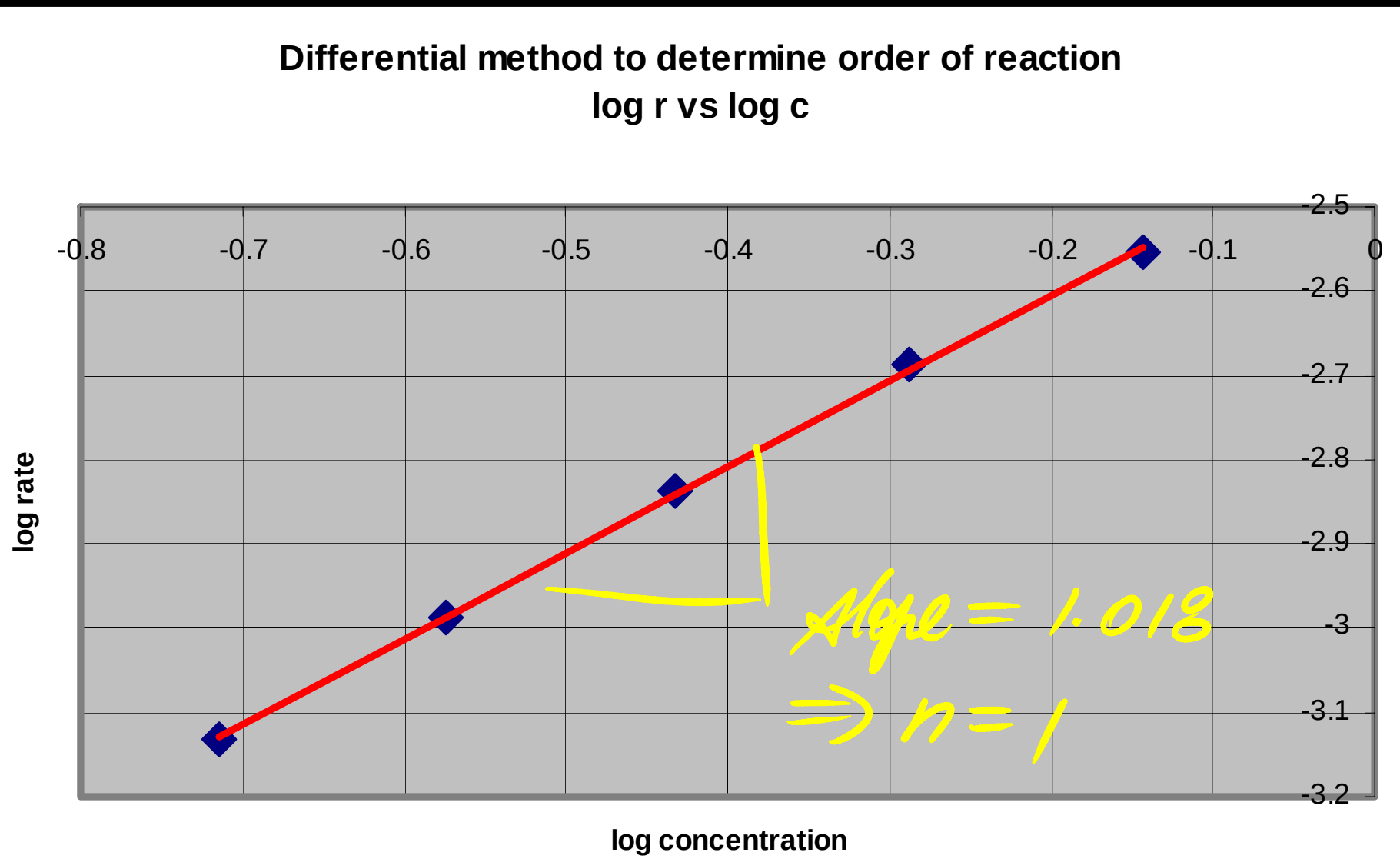
time (seconds)	concentration (moles/liter)	rate (moles/liter/s)
0	1.000	
100	0.720	0.00280
200	0.515	0.00205
300	0.370	0.00145
400	0.267	0.00103
500	0.193	0.00074


Plot of raw data, i.e., reaction timeline
concentration (M)
1.2
1
0.8
0.6
0.4
0.2
0
0
100
200
300
400
500
600
time (s)


Test of first-order rate law
ln c vs t
ln c
0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
-0.8
0
100
200
300
400
500
600
time (s)


Test of second-order rate law
1/c vs t
1/c
0
1
2
3
4
5
6
0
100
200
300
400
500
600
time (s)


rate vs time
0.003
0.0025
0.002
0.0015
0.001
0.0005
0
rate (M/s)
0
100
200
300
400
500
600
time (s)


Differential method to determine order of reaction
log r vs log c
log rate
log concentration
-0.8
-0.7
-0.6
-0.5
-0.4
-0.3
-0.2
-0.1
0
-2.5
-2.6
-2.7
-2.8
-2.9
-3
-3.1
-3.2
Slope = 1.018
⇒ n = 1

Radiocarbon Dating

Willard F. Libby: Nobel Prize 1960

* in the upper atmosphere, radioactive carbon is produced naturally by cosmic rays which generate neutrons:

$$ {}_{7}N^{14} + {}_{0}n^{1} \rightsquigarrow {}_{6}C^{14} + {}_{1}p^{1} $$

* ${}_{6}C^{14}$ enters the carbon cycle, $\therefore$ ratio of ${}_{6}C^{14}/{}_{6}C^{12}$ constant in all organisms (as is ${}_{6}C^{13}/{}_{6}C^{12}$)

* upon death, conc. of ${}_{6}C^{14}$ falls via ${}_{6}C^{14} \rightsquigarrow {}_{7}N^{14} + {}_{-1}\beta^{0-}$

* measure ${}_{6}C^{14}/{}_{6}C^{12}$ to determine age ($t_{½}$ = 5730 y)