1H)

$$E = \frac{0.66\,mg}{0.5\,L} = 1.32\,mg/L$$

$$k_{CAT} = 1550\,s^{-1} \times \frac{60\,s}{min} = 93000\,min^{-1}$$

$$K_m = 2.5\,mM$$

WITH THIS ENZYME CONC. V_{MAX} IS:

$$V_{MAX} = k_{CAT}[E_{ACT\ SITE}] \qquad [E] = [E_{ACT\ SITE}] \qquad \left(\begin{array}{c}\text{ONE ACTIVE SITE}\\ \text{PER ENZYME}\\ \text{MOLECULE}\end{array}\right)$$

$$V_{MAX} = \left(\frac{93000}{min}\right)\left(\frac{1.32\,mg}{L}\right)\left(\frac{mmol}{65000\,mg}\right)\left(\frac{mmol\,S}{mmol\,E}\right) = 1.889\,\frac{mmol}{L\,min}$$

SUCROSE $\longrightarrow$ GLUCOSE + FRUCTOSE

S $\longrightarrow$ G + F

i) $$-\left.\frac{dS}{dt}\right|_0 = \frac{V_{MAX}\,S_0}{K_m + S_0} = \frac{\left(1.889 \frac{mmol}{L\,min}\right)(20\,mM)}{2.5\,mM + 20\,mM} = 1.68 \frac{mmol}{L\,min}$$

NOTE: THIS IS THE **INITIAL** RATE; IT IS **NOT** A CONSTANT RATE WHICH PERSISTS OVER 5-10 MINUTES.

ii) THE INTEGRATED FORM OF THE MICHAELIS-MENTEN EQUATION IS USED TO RELATE S & t:

$$S_0 - S + K_m \ln(S_0/S) = V_{MAX}\,t$$

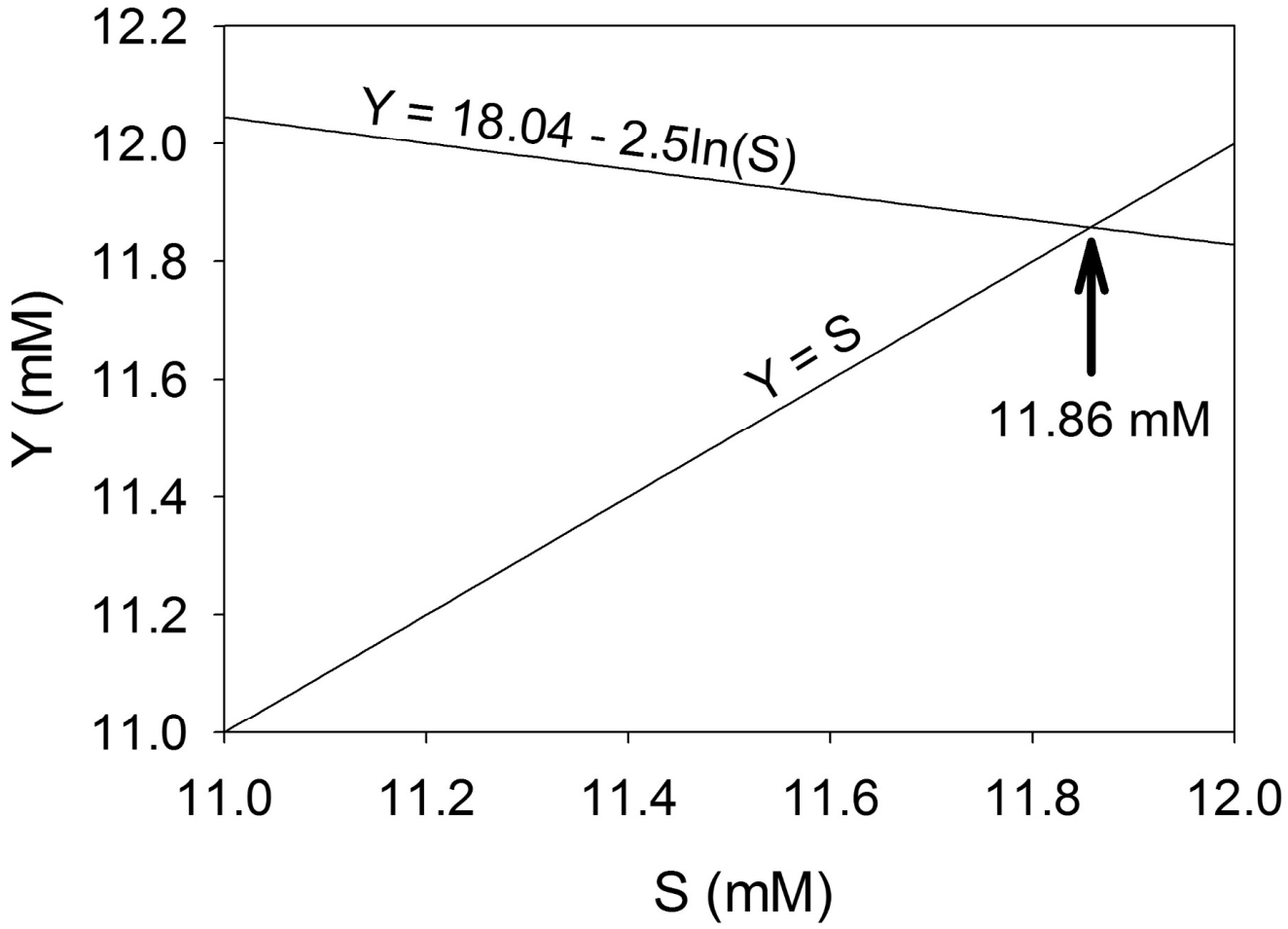
$$20 - S + 2.5 \ln(20/S) = (1.889)(5)$$

REARRANGE: $$20 - 9.445 + 2.5\ln(20) - 2.5\ln(S) = S$$

$$\underbrace{18.04 - 2.5\ln(S)}_{Y_1} = \underbrace{S}_{Y_2}$$

PLOT Y_1 & Y_2 VS. S

Problem 1H ii



$$S = 11.9 \text{ mM}$$

iii)

$$-\frac{dS}{dt} = \frac{V_{MAX}\,S}{K_m + S} = \frac{(1.889)(11.9)}{(2.5 + 11.9)} = 1.56 \text{ mmol/L min}$$

$$\% = \frac{1.68 - 1.56}{1.68} = 7.1\% \text{ DECREASE}$$

NOTE: THIS CALCULATION DEMONSTRATES THAT THE RATE CHANGES. THIS CALCULATION THEREFORE SHOWS THAT ASSUMING THE RATE TO BE CONSTANT IS INAPPROPRIATE.

iv) $S_0 - S + K_m \ln(S_0/S) = V_{MAX} t$ $\quad t = 10$ min?

$20 - S + 2.5 \ln(20/S) = (1.889)(10)$

$\underbrace{8.60 - 2.5 \ln(S)}_{Y_1} = \underbrace{S}_{Y_2}$

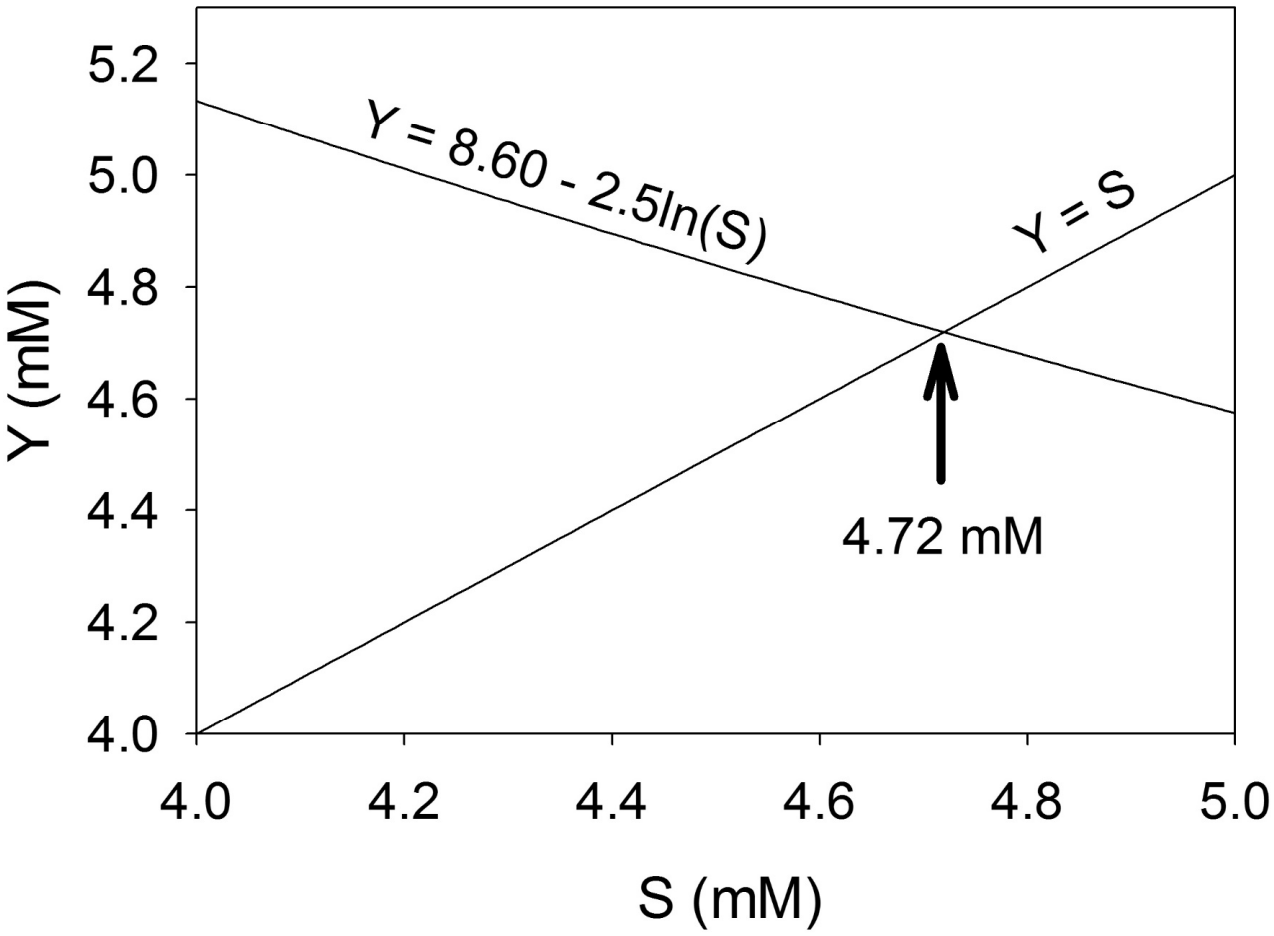
PLOT Y_1 & Y_2 VS. S

$S = 4.72$ mM

BY STOICHIOMETRY SUCROSE LOST = GLUCOSE GAINED

$20 - 4.72 = 15.28$ mM

Problem 1H iv



v) $$-\frac{dS}{dt} = \frac{V_{MAX}\,S}{K_m + S} = \frac{(1.889)(4.72)}{2.5 + 4.72} = 1.24 \ \frac{mmol}{L\,MIN}$$

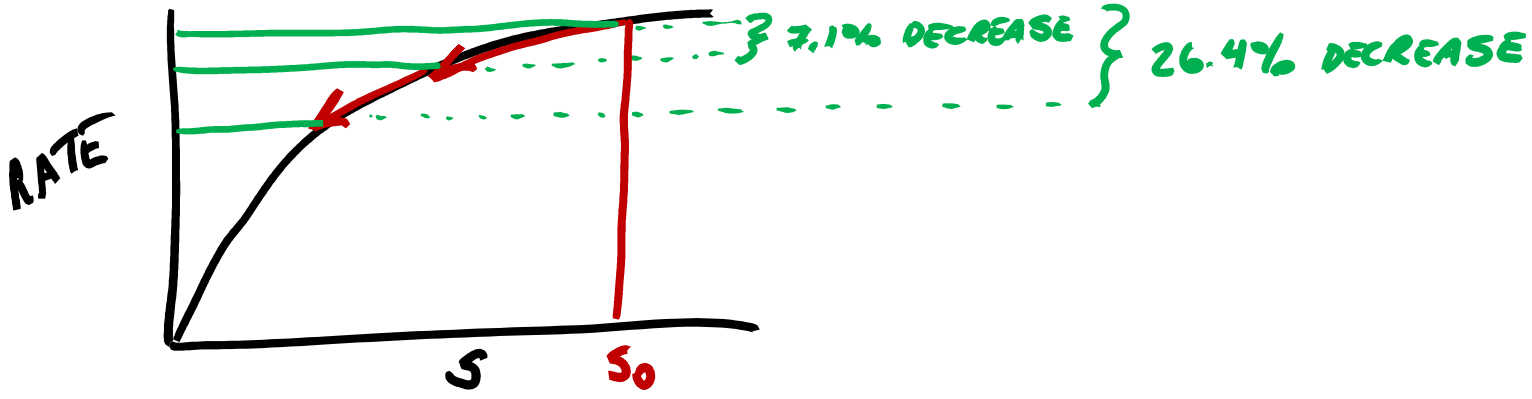
$$\% = \frac{1.679 - 1.235}{1.679} = 26.4\% \text{ DECREASE}$$

NOTE

AFTER 5 MIN, RATE DECREASED 7.1%

AFTER 10 MIN, RATE DECREASED 26.4%

SKETCH NOT TO SCALE!



vi) IF $[E] = \frac{1.32\,mg}{0.5L} = \frac{2.64\,mg}{L}$

THEN $V_{MAX} = k_{CAT}[E] = \left(\frac{93000}{min}\right)\left(\frac{mmol}{65000\,mg}\right)\left(\frac{2.64\,mg}{L}\right)\left(\frac{mmol\,S}{mmol\,E}\right)$

$V_{MAX} = 3.78\ mmol/L\,min$ (TWICE AS FAST)

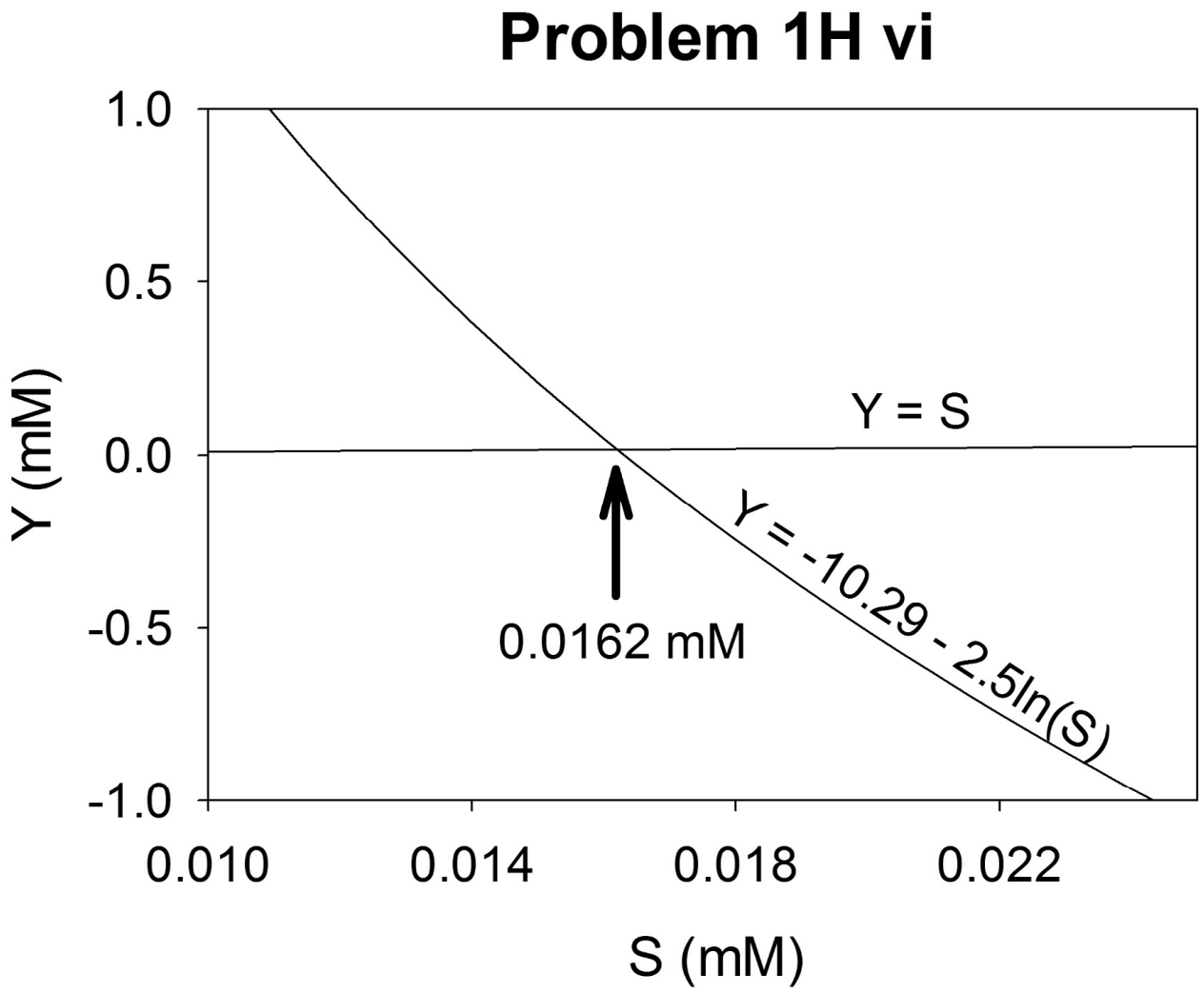
SO, $S_o - S + K_m \ln(S_o/S) = V_{MAX} t$

$20 - S + 2.5\ln(20) - 2.5\ln(S) = (3.78)(10)$

$\underbrace{-10.29 - 2.5\ln(S)}_{Y_1} = \underbrace{S}_{Y_2}$

PLOT Y_1 & Y_2 VS. S

$S = 0.016\,mM$


Problem 1H vi
1.0
0.5
0.0
-0.5
-1.0
Y (mM)
Y = S
Y = -10.29 - 2.5ln(S)
0.0162 mM
0.010
0.014
0.018
0.022
S (mM)

COMMENTS

1) MANY STUDENTS SHOWED (CORRECTLY) THE RATE DECREASED WHEN CONCENTRATION WAS LOWER, BUT THEN PROCEEDED TO USE A CONSTANT VALUE FOR THE RATE WHEN CALCULATING A FUTURE CONCENTRATION!!!!

2) IF YOU OBTAIN A NEGATIVE CONCENTRATION FROM YOUR MODEL, THEN STOP TO THINK ABOUT WHETHER THERE MIGHT BE SOMETHING WRONG WITH YOUR MODEL OR ITS ASSUMPTIONS!