

1.1. The Michaelis–Menten enzyme kinetics model (1913 *Biochem Z* 49: 333–369) is named after German biochemist Leonor Michaelis and Canadian physician Maud Menten. Yu and Rappaport (1997 *Environ Health Perspectives* 105 : 496–503) show that the Michaelis Menten model describes the clearance rate ( $k$ ) of insoluble dust particles from lungs as a function of the maximum rate ( $k_{max}$ ), the particulate burden ( $m$ ), and the particulate burden ( $m_{half}$ ) at which  $k$  is half of  $k_{max}$ .

$$k = \frac{k_{max} \cdot m_{half}}{m + m_{half}} \qquad k = k_{max} \left( \frac{m_{half}}{m + m_{half}} \right)$$

The parameter  $m_{half}$  and the variable  $m$  have units of milligrams (mg),  $k$  has units of %/day

a. Show units for the ratio in parentheses  $\frac{mg}{(mg+mg)}$  and for  $k_{max}$   $\% / day$  [1+1]

b. Explain your answer for units of  $k_{max}$  [2]

Same as  $k$  because no units for  $\left( \frac{m_{half}}{m+m_{half}} \right)$

c. Does the ratio in parentheses increase or decrease as lung burden  $m$  decreases?

Write your answer here it increases [no mark]

d. Given  $m_{half} = 0.97$  mg for photocopier toner dust (PTT) and  $k_{max} = 0.009/day$  for experimental rats, calculate the expected clearance rate at

$m = 5$  mg  $E(k) = \frac{0.001462}{1}$  [1]

$m = 0.5$  mg.  $E(k) = \frac{0.005939}{1}$  [1]

d. Show your calculations, with units, for 0.5 mg [2]

$$E(k) = (0.009) \left( \frac{0.97}{0.5 + 0.97} \right) = 0.005939$$

e. Does the expected clearance  $E(k)$  change in the direction you expected, with decrease in lung burden  $m$ ? [no mark]

2. Using the expected value  $E(k)$  at a burden of  $m = 0.5$  mg, complete a data equation for an observed value of  $k = 0.008$

$$k = E(k) + \text{residual}$$

$$0.008 = 0.005939 + 0.002061 \qquad [3]$$

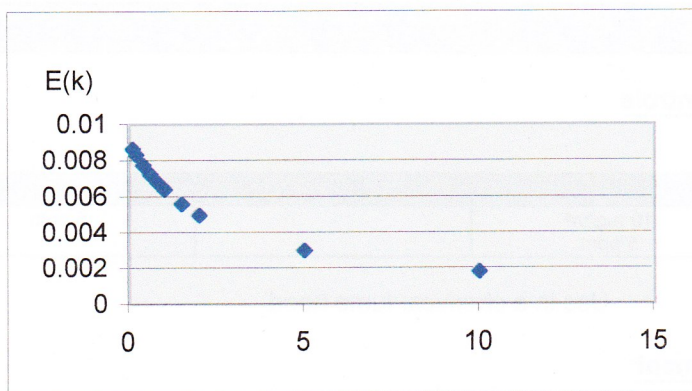
# Quiz 3

A Lung Retention Model Based on Michaelis-I  
 Rong Chun Yu and Stephen M. Rappaport  
 Yu and Rappaport (1997 Environ Health Pers

DEP = Deisel Exhaust particles

kmax	0.009	per day
m	0.5	mg
mhalf	2.49	mg
E(k)	0.007495	per day
k	0.008	per day
residuals	0.000505	per day

m	E(k)
0.1	0.008653
0.2	0.008331
0.4	0.007754
0.6	0.007252
0.8	0.006812
1	0.006421
1.5	0.005617
2	0.004991
5	0.002992
10	0.001794



PTT = Photocopy Test Toner

kmax	0.009	per day
m	0.5	mg
mhalf	0.97	mg
E(k)	0.005939	per day
k	0.008	per day
residuals	0.002061	per day

m	E(k)
0.1	0.008159
0.2	0.007462
0.4	0.006372
0.6	0.005561
0.8	0.004932
1	0.004431
1.5	0.003534
2	0.002939
5	0.001462
10	0.000796

