Determine the maximum reaction velocity, V_m (mg/ml-min · unit of enzyme) and the saturation constant, K_M (mg/ml).

b. The same authors studied the effect of temperature on the maximum rate of the hydrolysis of corn starch by glucoamylase. The results are tabulated next. Determine the activation energy (ΔE cal/g mole) for the soluble and immobilized enzyme reaction.

	V_{max} (m mol/min 10^6)	
T, °C	Soluble	Azo-immobilized
25	0.62	0.80
35	1.42	1.40
45	3.60	3.00
55	8.0	6.2
65	16.0	11.0

c. Using these results, determine if immobilized enzyme is diffusion limited.

[Courtesy of A. E. Humphrey from "Collected Coursework Problems in Biochemical Engineering" compiled by H. W. Blanch for 1977 Am. Soc. Eng. Educ. Summer School.]

3.11. Michaelis–Menten kinetics are used to describe intracellular reactions. Yet $[E_0] \approx [S_0]$. In in vitro batch reactors, the quasi-steady-state hypothesis does not hold for $[E_0] \approx [S_0]$. The rapid equilibrium assumption also will not hold. Explain why Michaelis–Menten kinetics and the quasi-steady-state approximation are still reasonable descriptions of intracellular enzyme reactions.

3.12. You are working for company A and you join a research group working on immobilized enzymes. Harry, the head of the lab, claims that immobilization improves the stability of the enzyme. His proof is that the enzyme has a half-life of 10 days in free solution, but under identical conditions of temperature, pH, and medium composition, the measured half-life of a packed column is 30 days. The enzyme is immobilized in a porous sphere 5 mm in diameter. Is Harry's reasoning right? Do you agree with him? Why or why not?

3.13. The following data were obtained from enzymatic oxidation of phenol by phenol oxidase at different phenol concentrations.

S (mg/l)	10	20	30	50	60	80	90	110	130	140	150
v (mg/l-h)	5	7.5	10	12.5	13.7	15	15	12.5	9.5	7.5	5.7

a. What type of inhibition is this ?

b. Determine the constants V_m, $K_{m,}$ and K_{si}.

c. Determine the oxidation rate at [S] = 70 mg/l.

3.14. Uric acid is degraded by uricase enzyme immobilized in porous Ca-alginate beads. Experiments conducted with different bead sizes result in the following rate data:

Bead Diameter, Dp (cm)	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8
Rate, v (mg/l.h)	200	198	180	140	100	70	50	30

a. Determine the effectiveness factor for particle sizes Dp = 0.5 cm and Dp = 0.7 cm.

b. The following data were obtained for Dp = 0.5 cm at different bulk uric acid concentrations. Assuming negligible liquid film resistance, calculate V_m and K_s for the enzyme. Assume no substrate or product inhibition.

S_0 (mg UA/l)	10	25	50	100	200	250
v (mg UA/l.h)	10	20	30	40	45	46