1. We will derive the equivalent of the Michaelis-Menten equation for the reversible enzymatic reaction:

$$\mathrm{E} + \mathrm{S} \underset{b}{\overset{f}{\rightleftharpoons}} \mathrm{C} \underset{f'}{\overset{k}{\rightleftharpoons}} \mathrm{P} + \mathrm{E}$$

Show that the quasi-steady state approximation implies that

$$C = \frac{(fS + f'P)E_{\text{tot}}}{b + k + fS + f'P}$$

and by simplifying the rate equation for P that

$$\frac{dP}{dt} = E_{\text{tot}} \cdot \frac{k\frac{S}{K_m} - b\frac{P}{K'_m}}{1 + \frac{S}{K_m} + \frac{P}{K'_m}}$$

with

$$K_m = \tfrac{b+k}{f} \quad ; \quad K'_m = \tfrac{b+k}{f'}.$$

Confirm that the result recovers the standard Michaelis-Menten equation when f' is zero. Explain why this enzymatic reaction has ‘product inhibition’.