

Let's try to understand this model.

For simplicity take $k = 17$, $M = 256$.

$$\frac{dP}{dt} = 17P(256 - P)$$

Separate variables

$$\frac{dP}{P(256 - P)} = 17 dt$$

Integrate $\int 17 dt = 17t + C$

$$\begin{aligned} \int \frac{dP}{P(256 - P)} &= \int \frac{1}{256} \left(\frac{1}{P} + \frac{1}{256 - P} \right) dP = \\ &= \frac{1}{256} \left(\ln|P| - \ln|256 - P| \right) \end{aligned}$$

$$\text{So } \frac{1}{256} \left(\ln|P| - \ln|256 - P| \right) = 17t + C$$

$$\ln|P| - \ln|256 - P| = 17 \cdot 256 t + 256C$$

$$\ln \left| \frac{P}{256 - P} \right| = 17 \cdot 256 t + D$$

$$\left| \frac{P}{256 - P} \right| = e^D e^{(17 \cdot 256)t}$$

$$\frac{P}{256 - P} = \pm e^D e^{(17 \cdot 256)t}$$