1) Formalkinetik

1.1) Vorbemerkungen – Grundbegriffe

Reaktionsgeschwindigkeit, -mechanismus

Reaktionslaufzahl, Elementarreaktionen (uni-,bi-,trimolekular)

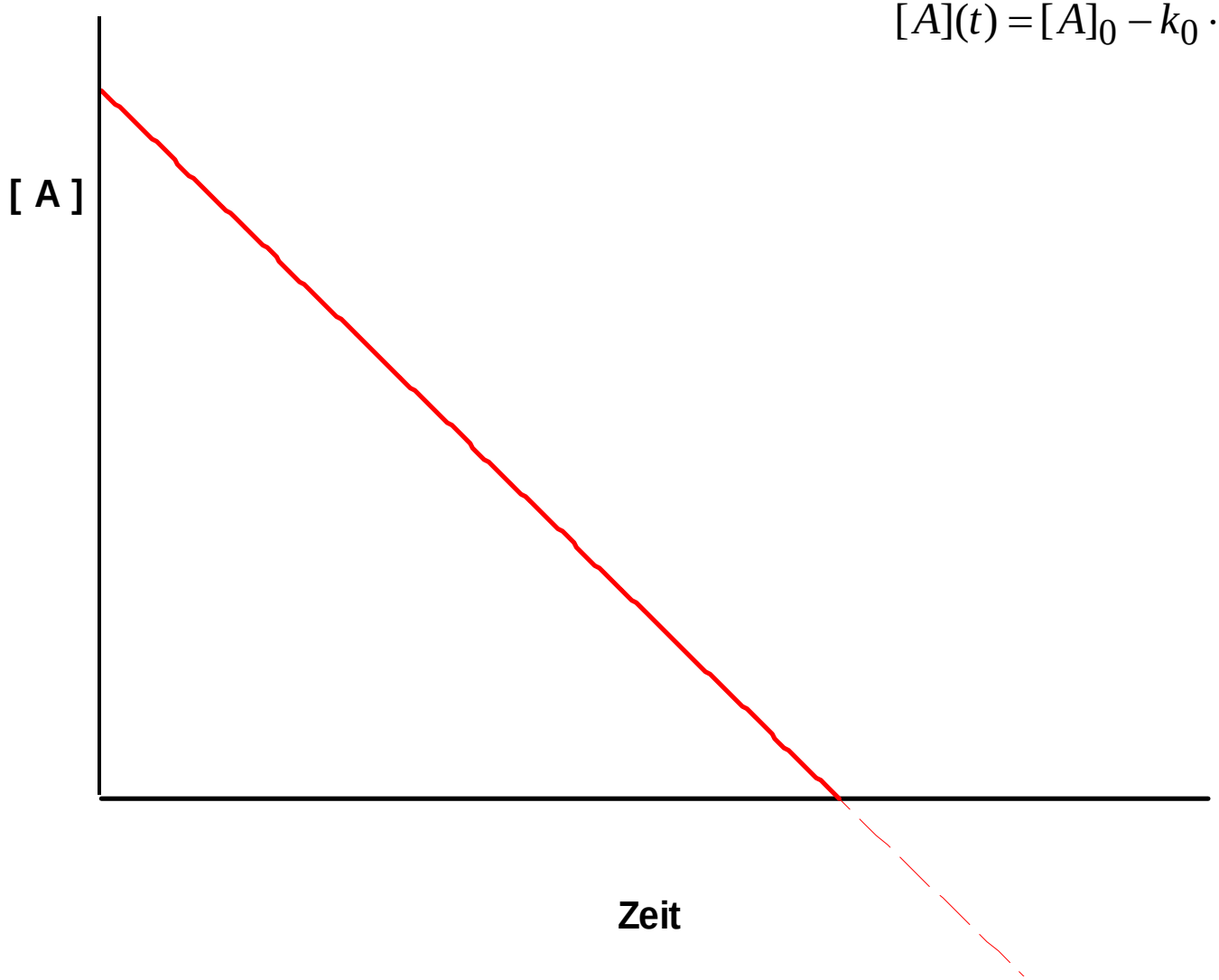
1.2) Einfache Kinetiken - Geschwindigkeitsgesetze und deren Integration

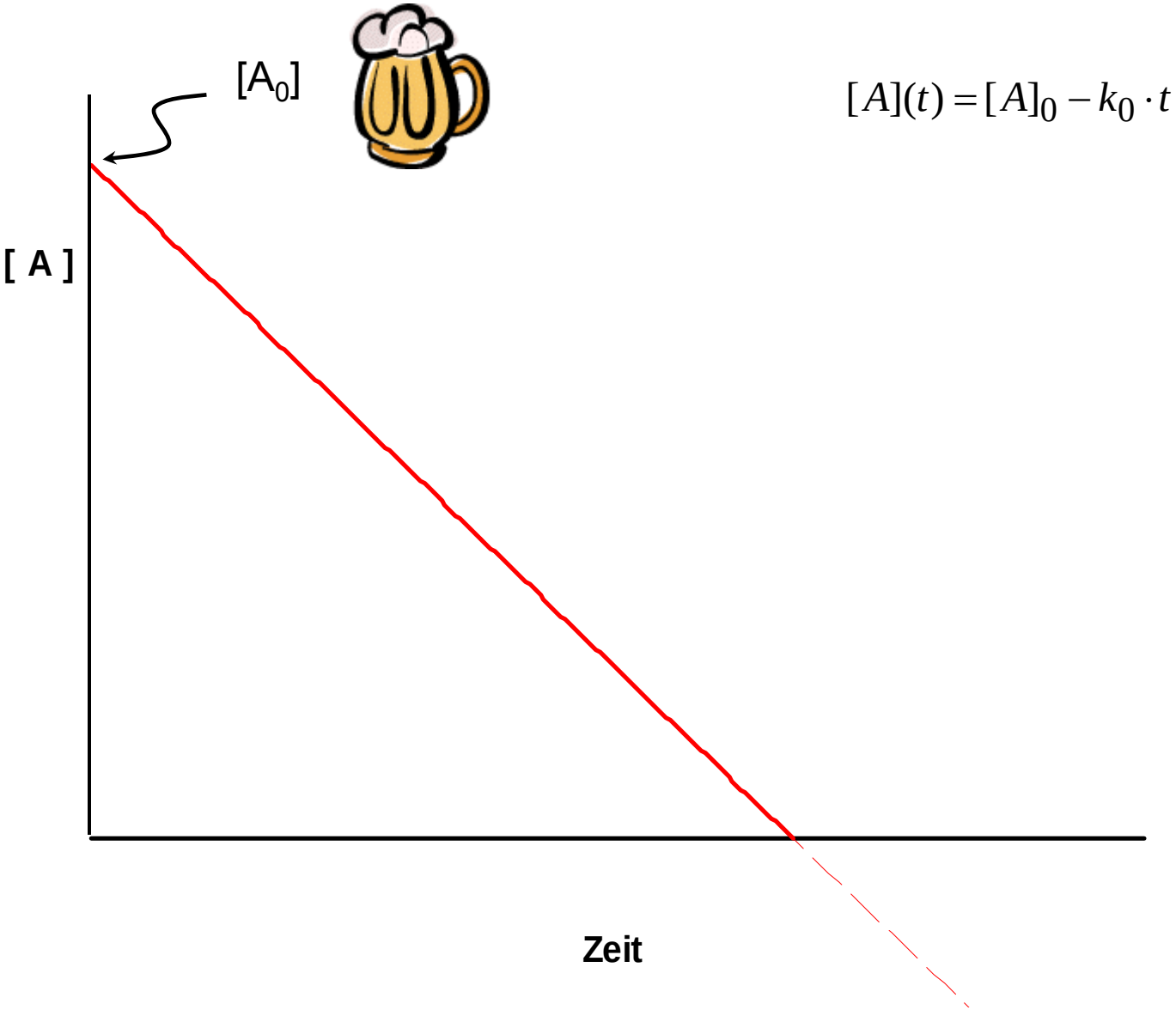
1.2.1) Reaktionen Nullter Ordnung

1.2.2) Reaktionen Erster Ordnung

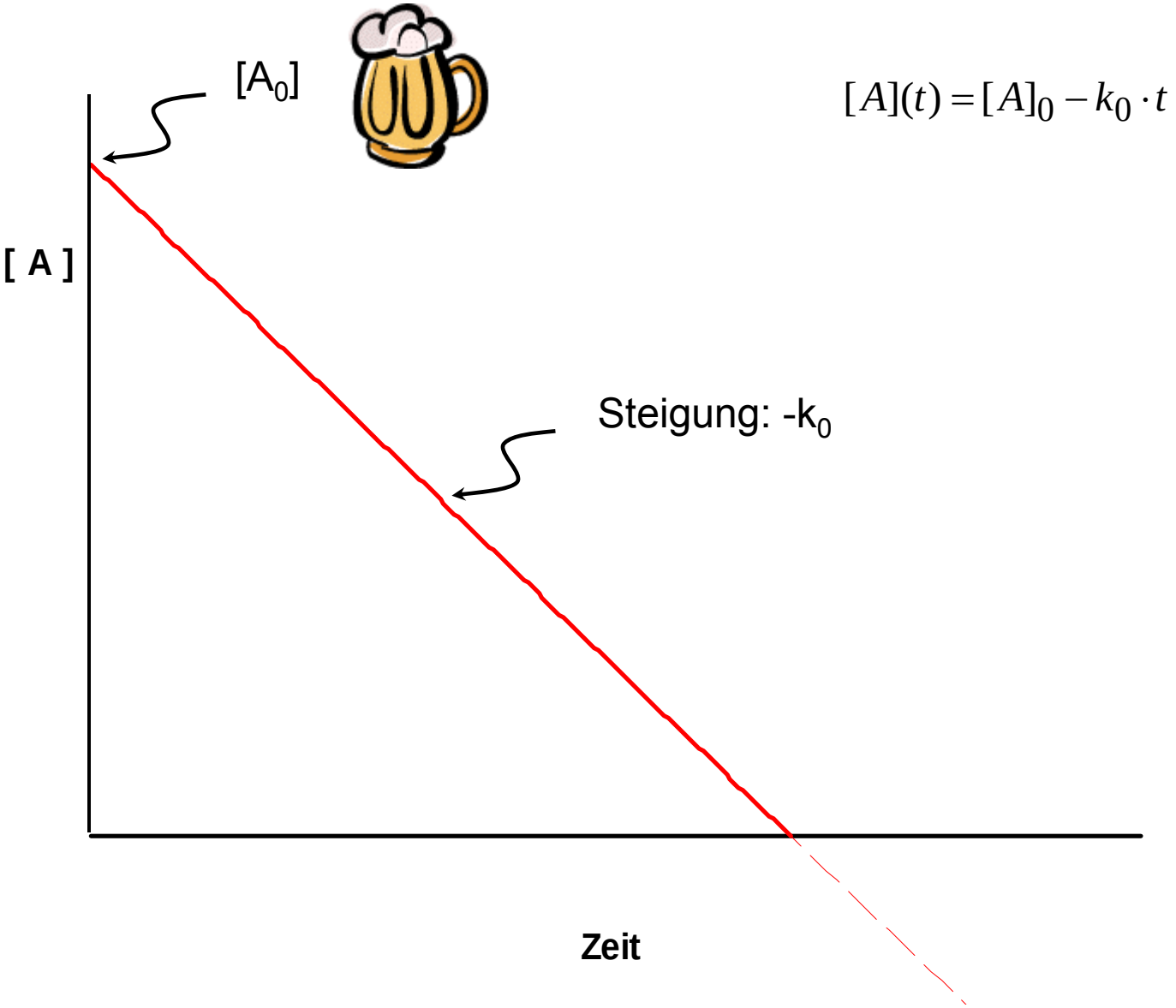
1.2.3) Reaktionen Erster Ordnung mit Rückreaktion erster Ordnung

$$[A](t) = [A]_0 - k_0 \cdot t$$

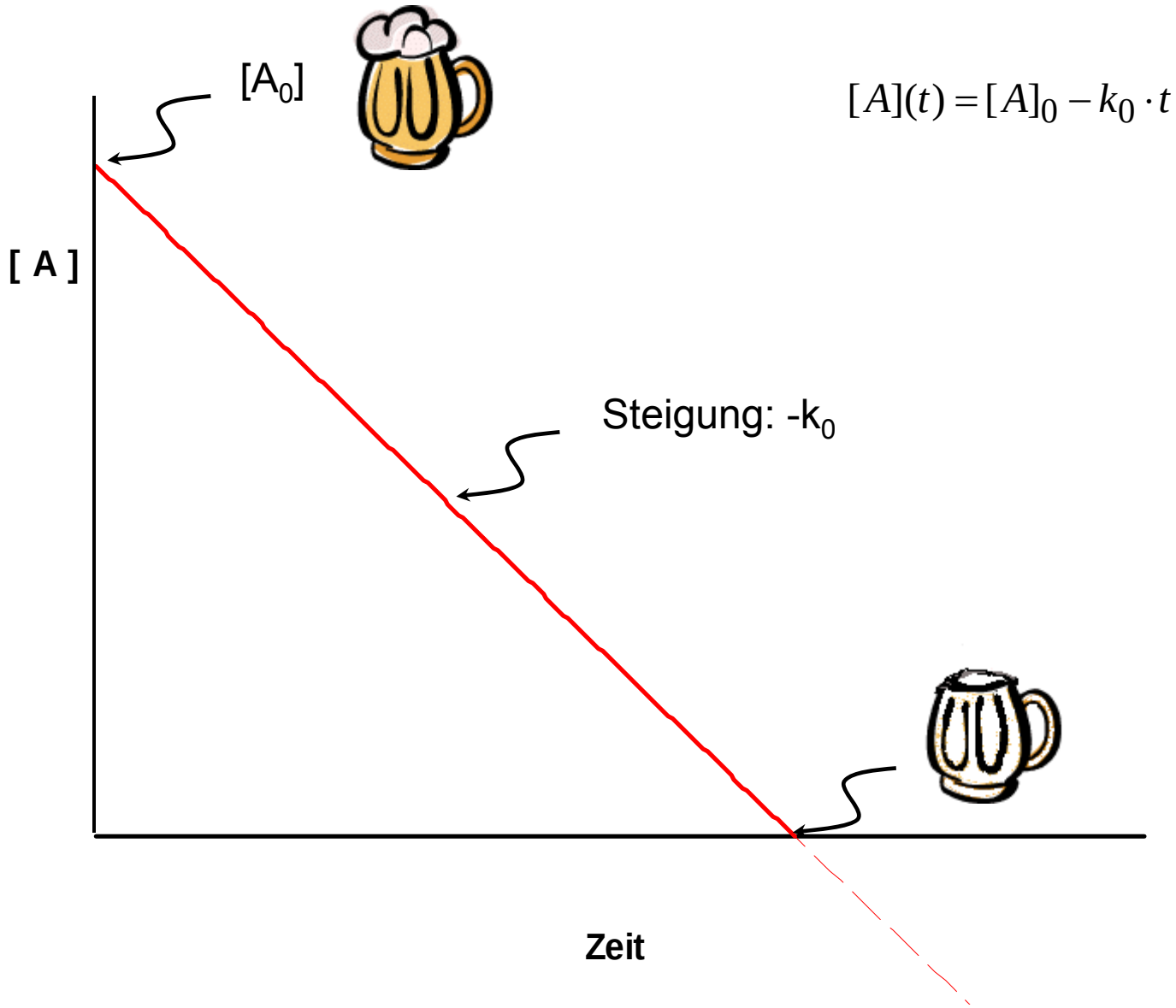




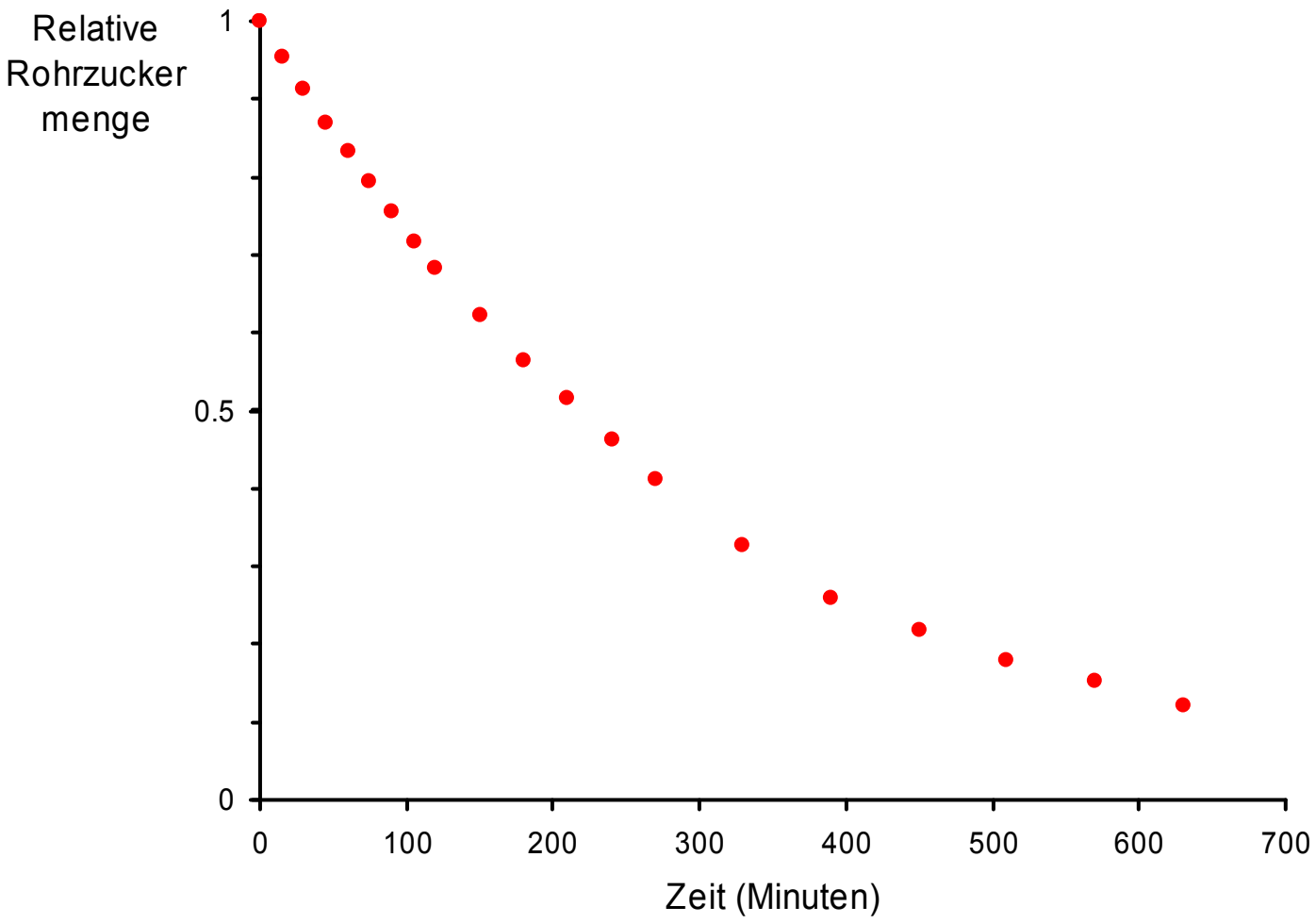
$$[A](t) = [A]_0 - k_0 \cdot t$$

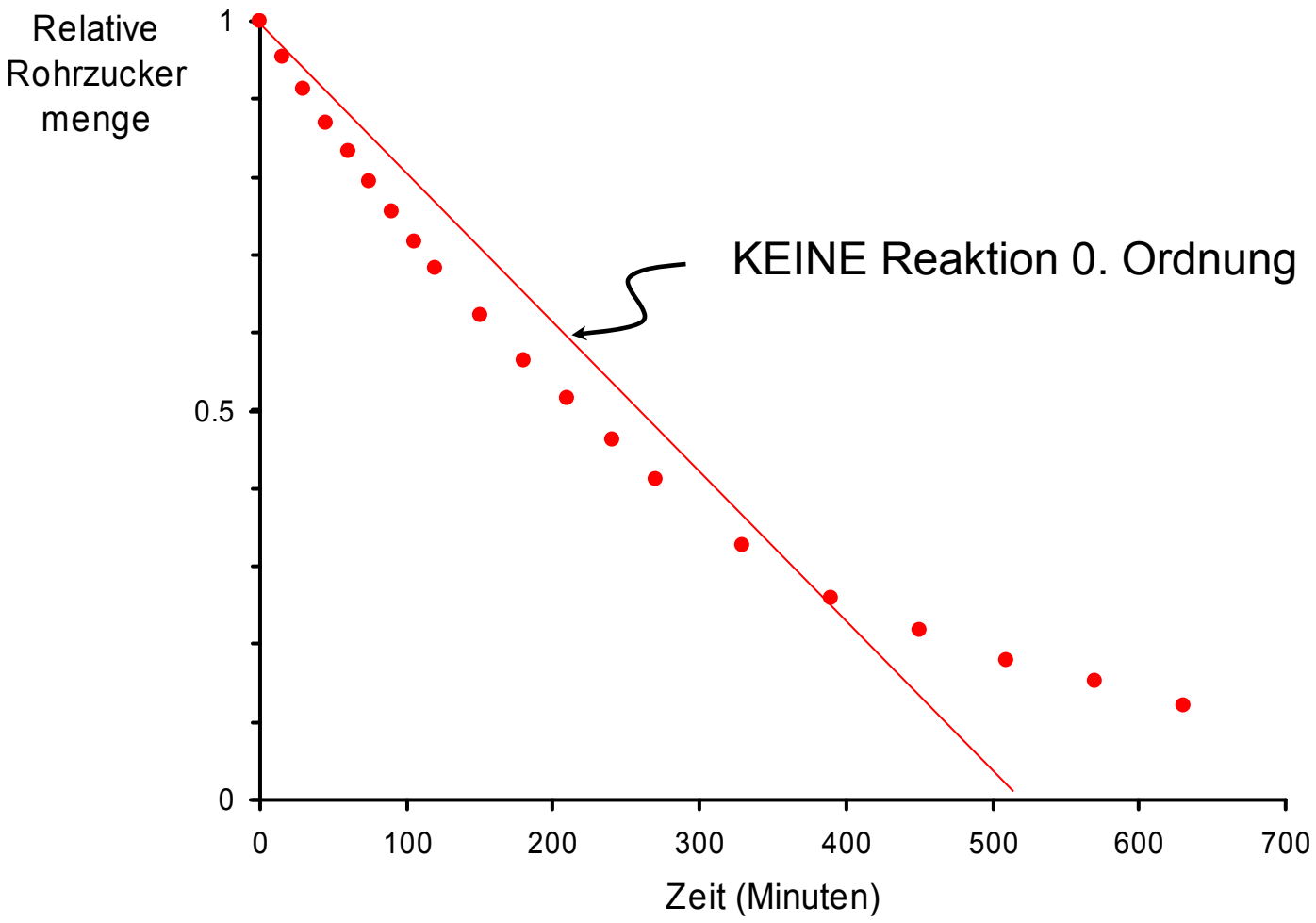


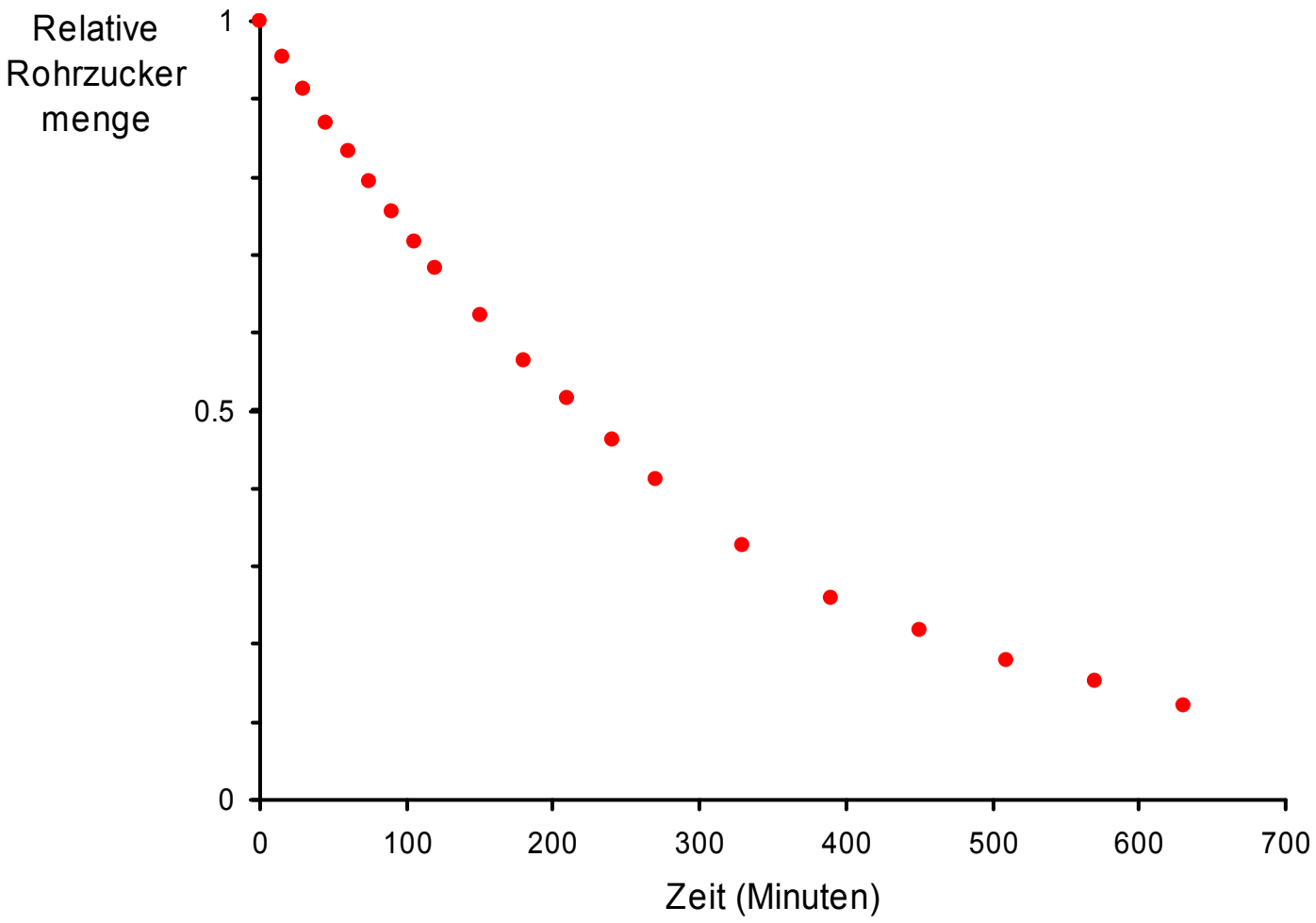
$$[A](t) = [A]_0 - k_0 \cdot t$$

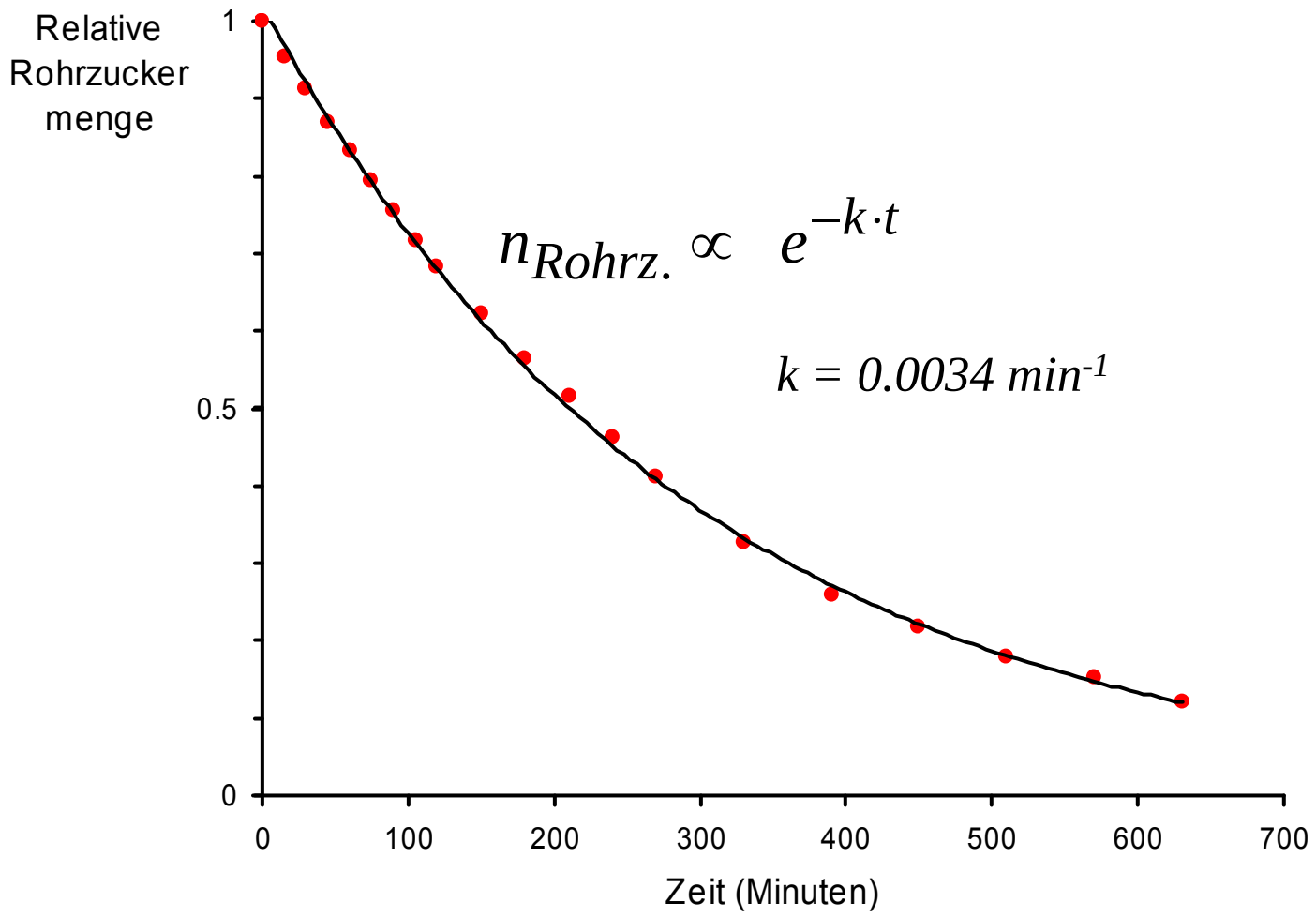


$$[A](t) = [A]_0 - k_0 \cdot t$$

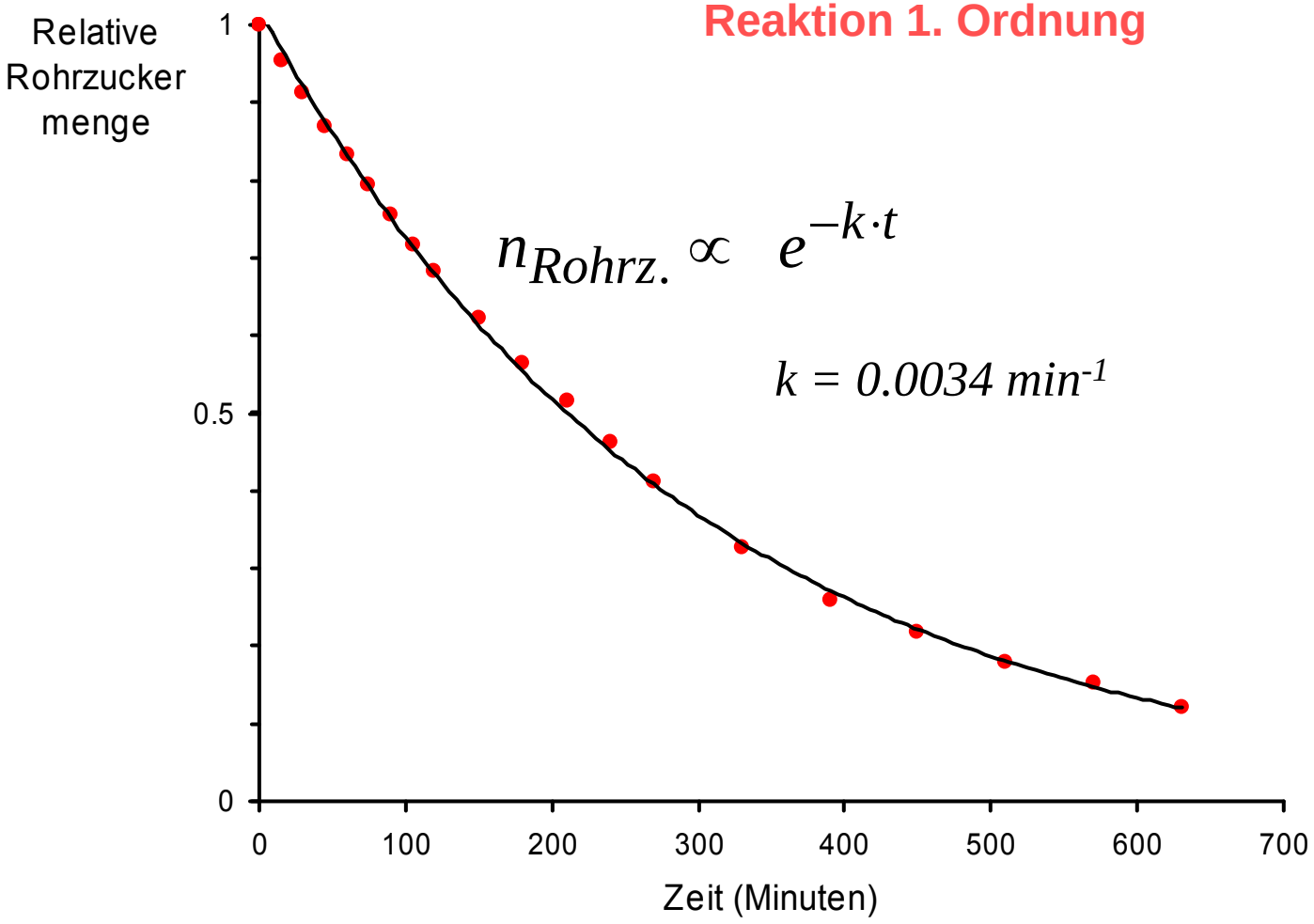

Relative
Rohrzucker
menge
1
0.5
0
0
100
200
300
400
500
600
700
Zeit (Minuten)


Relative
Rohrzucker
menge
1
0.5
0
KEINE Reaktion 0. Ordnung
0
100
200
300
400
500
600
700
Zeit (Minuten)

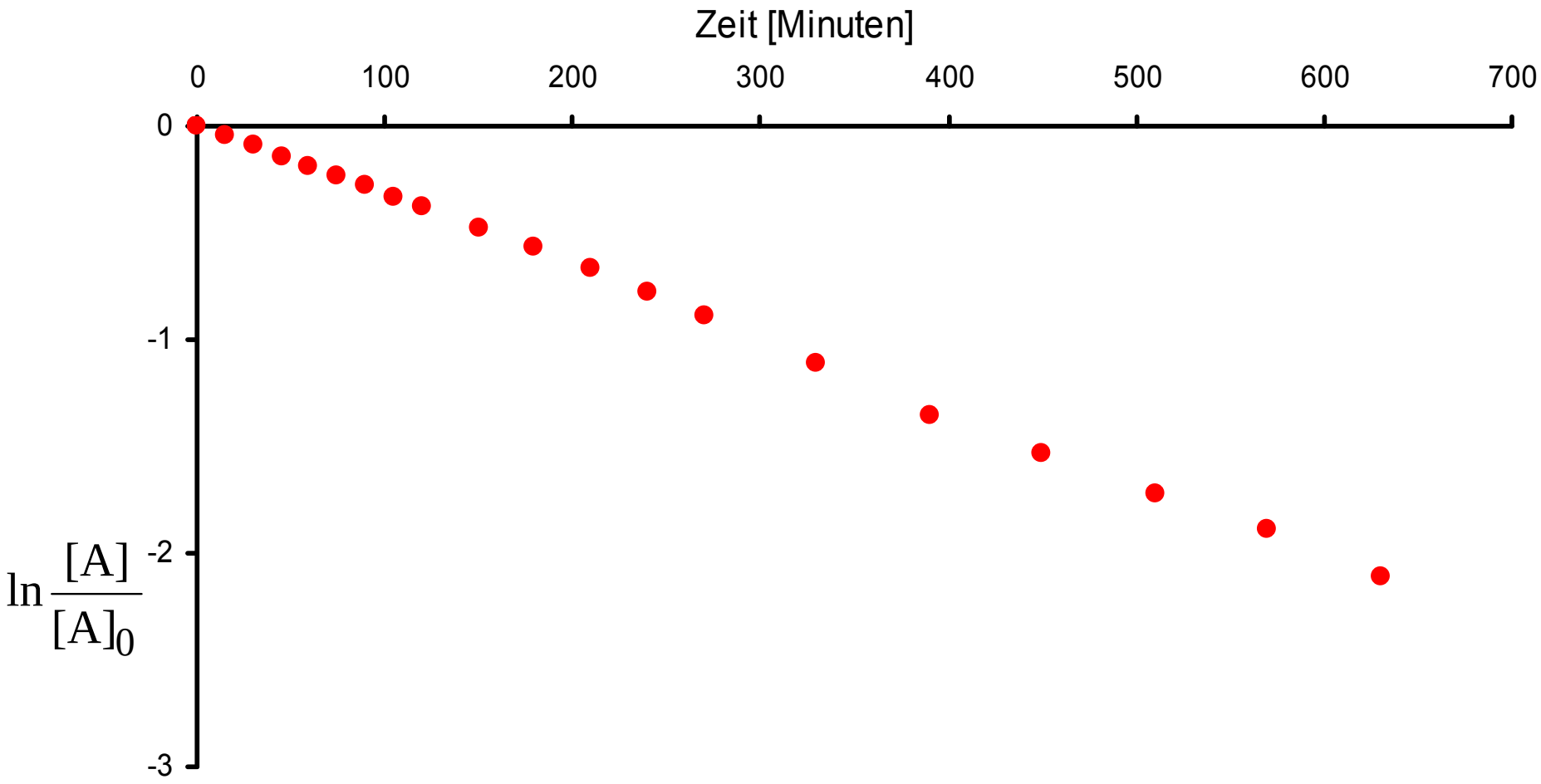

Relative
Rohrzucker
menge
1
0.5
0
0
100
200
300
400
500
600
700
Zeit (Minuten)


Relative Rohrzucker menge
1
0.5
0
$n_{Rohrz.} \propto e^{-k \cdot t}$
$k = 0.0034\ min^{-1}$
0
100
200
300
400
500
600
700
Zeit (Minuten)

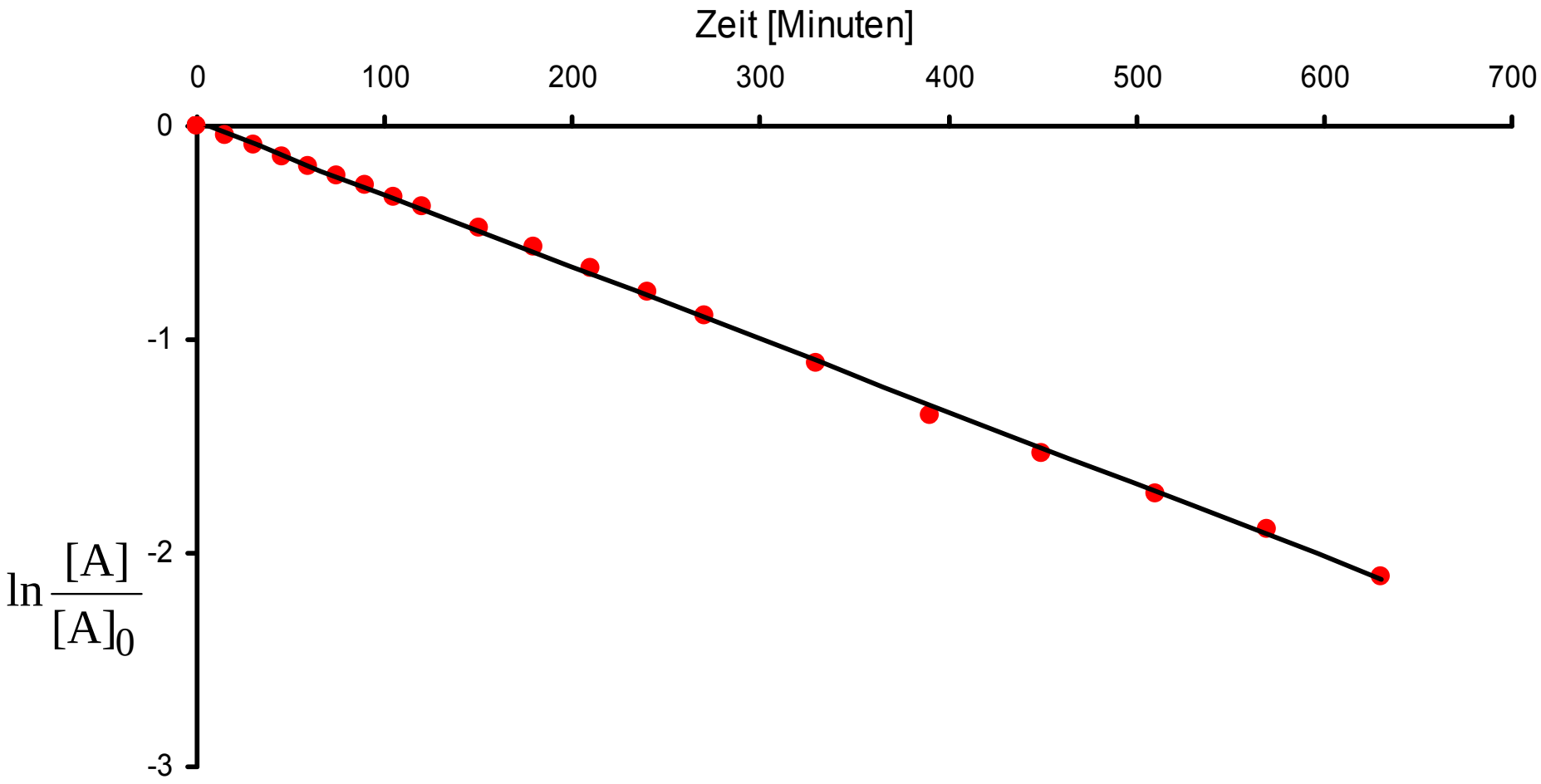
Reaktion 1. Ordnung



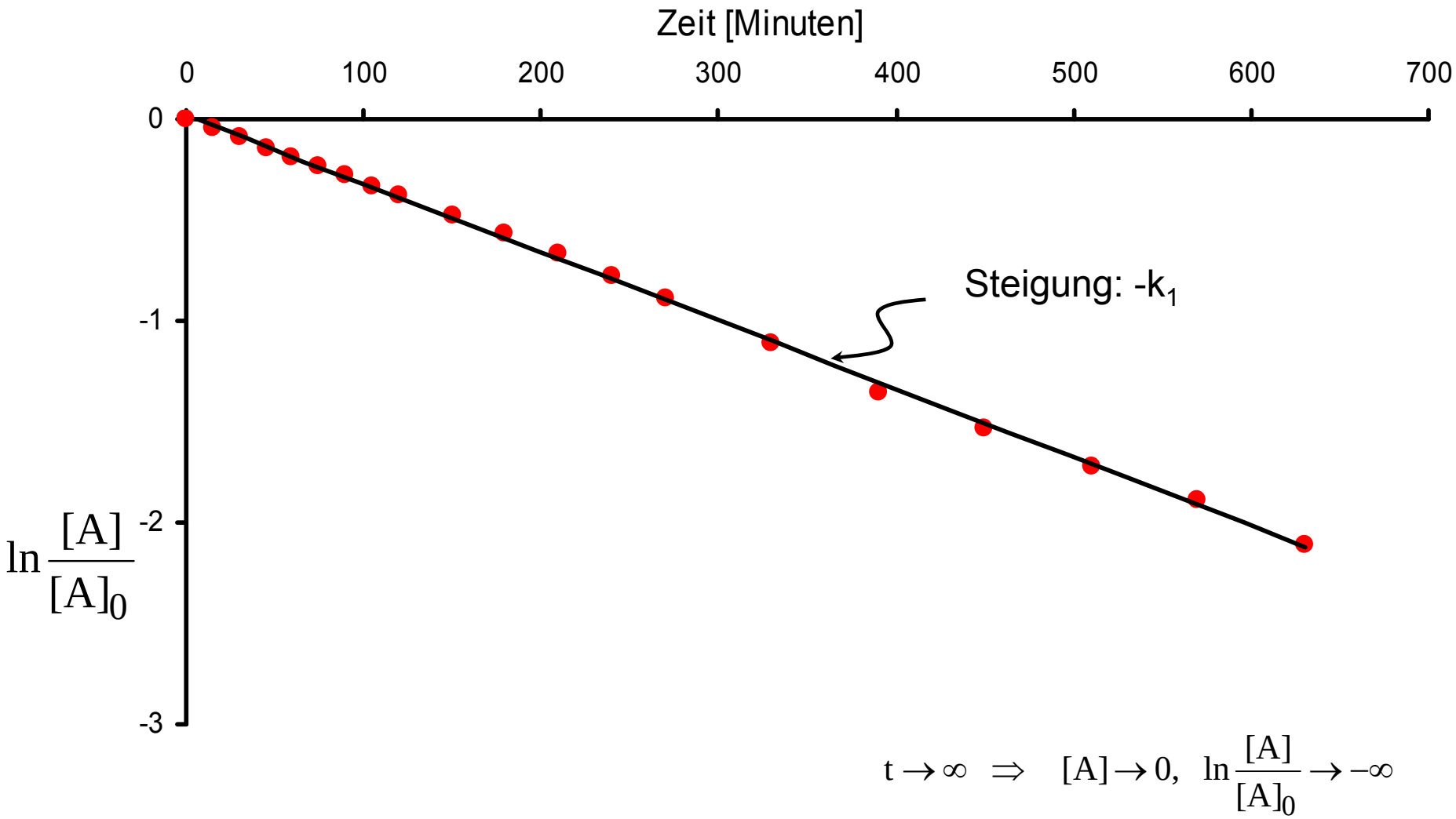
Reaktion 1. Ordnung *– geschickte graphische Darstellung*



Reaktion 1. Ordnung *– geschickte graphische Darstellung*



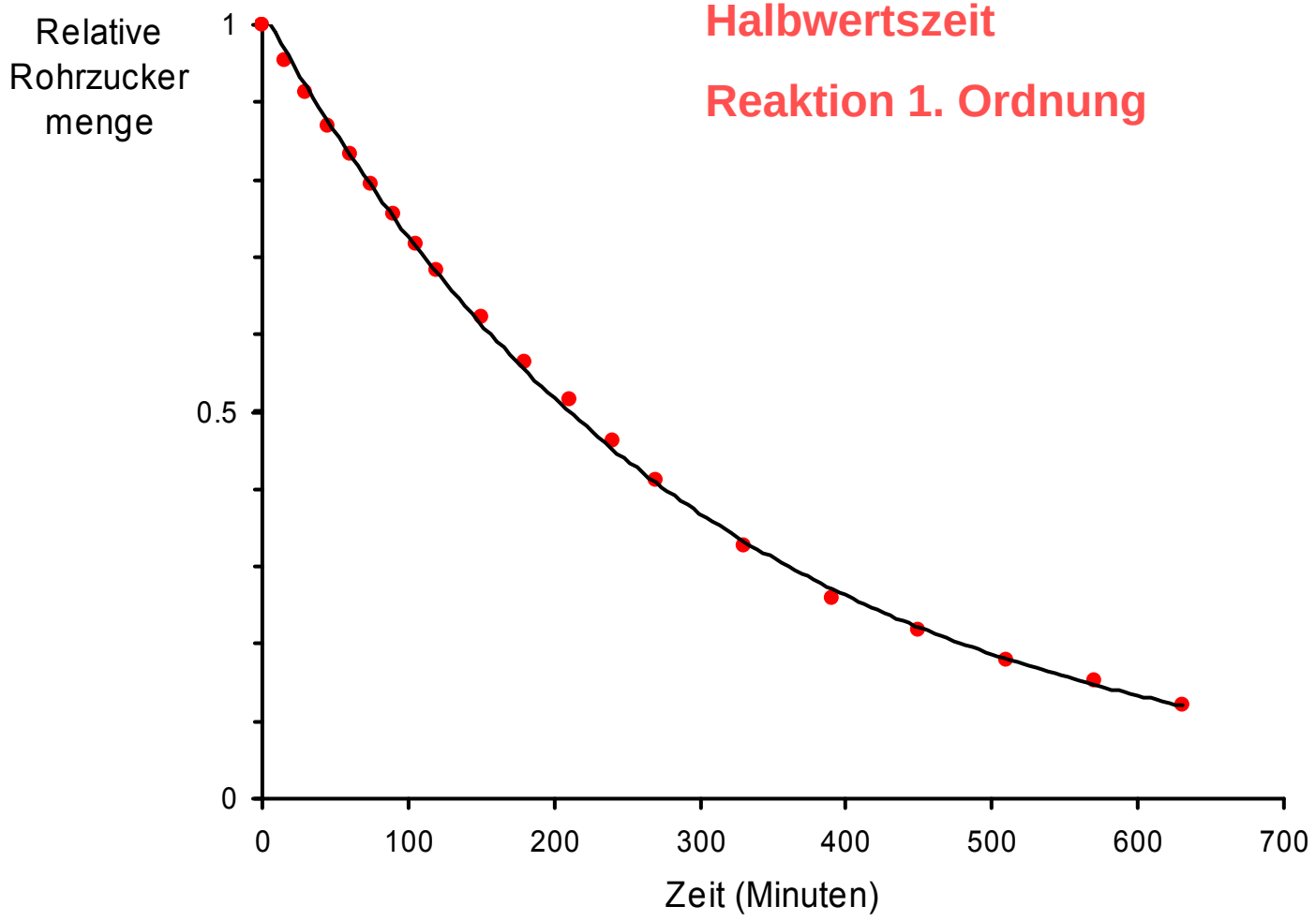
Reaktion 1. Ordnung *– geschickte graphische Darstellung*



$$t \to \infty \quad \Rightarrow \quad [A] \to 0, \quad \ln \frac{[A]}{[A]_0} \to -\infty$$

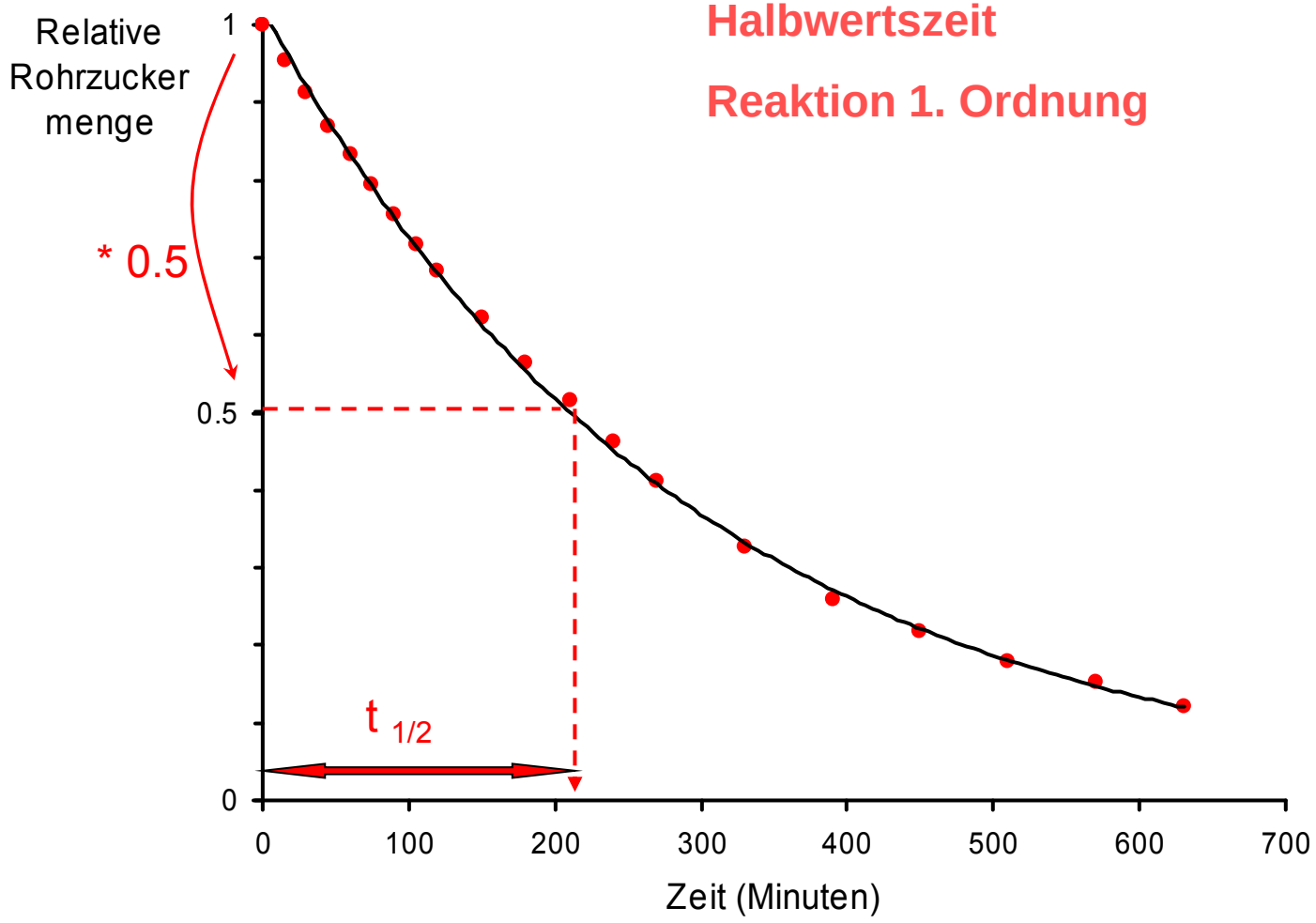
Halbwertszeit

Reaktion 1. Ordnung



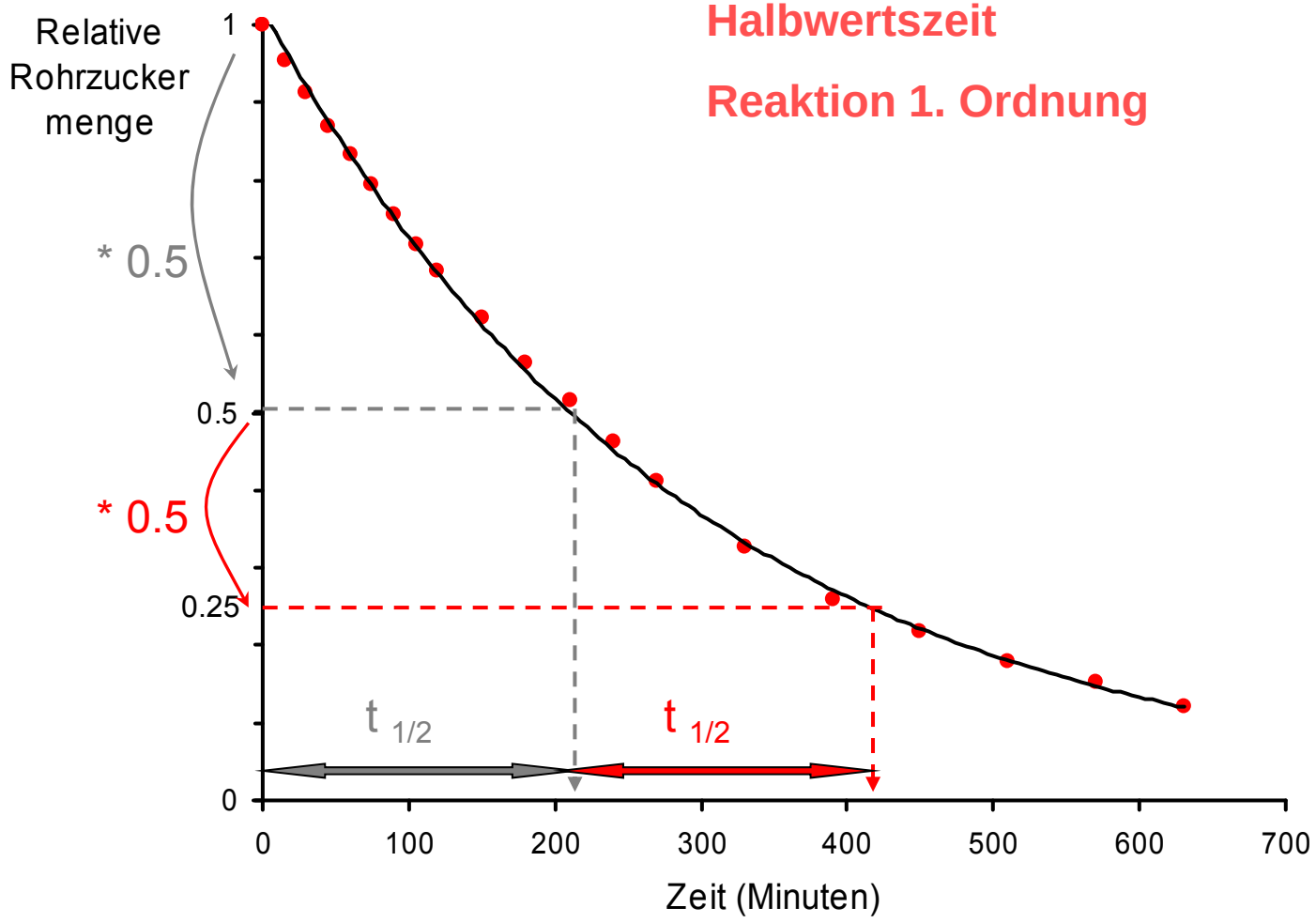
Halbwertszeit

Reaktion 1. Ordnung



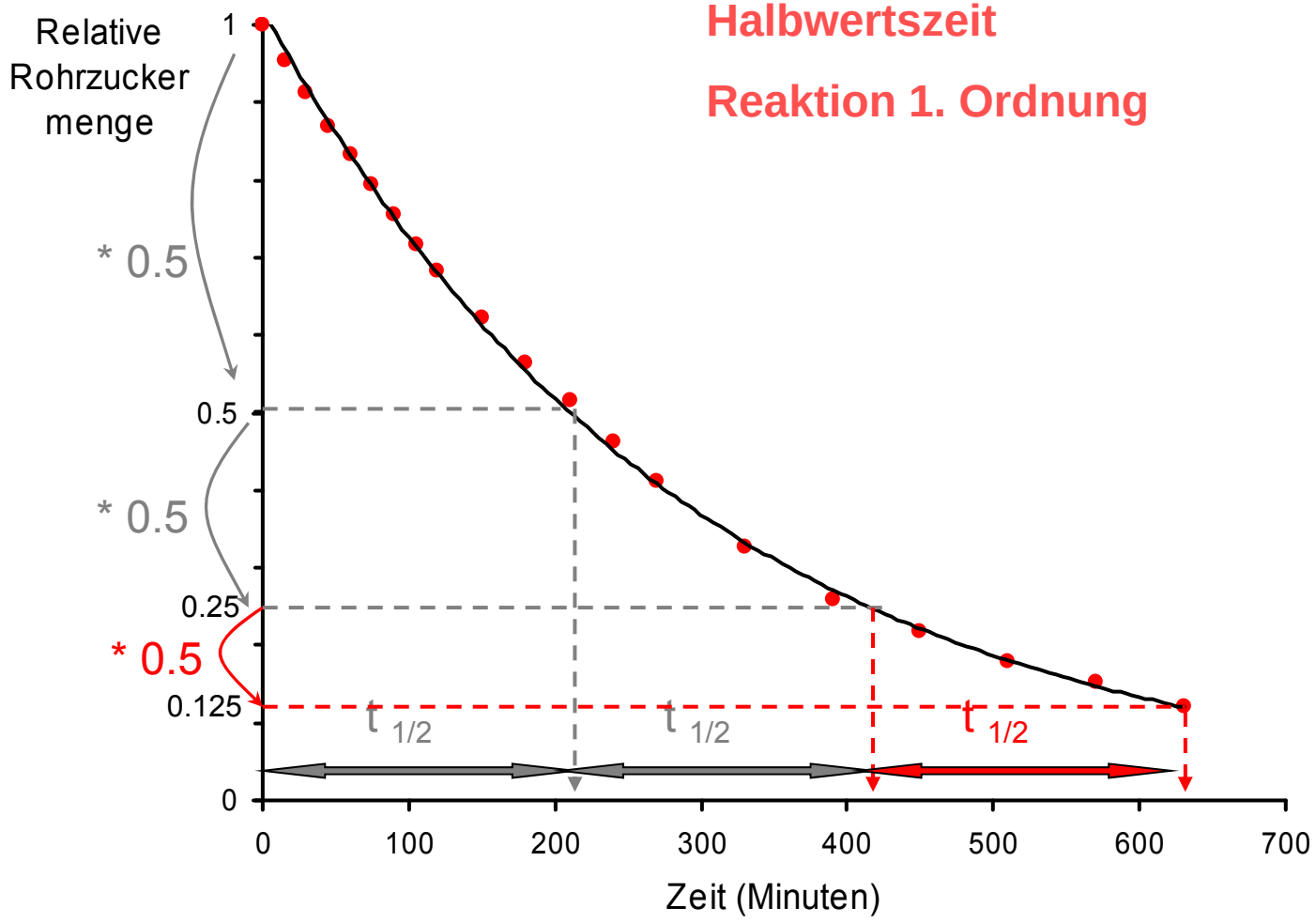
Halbwertszeit

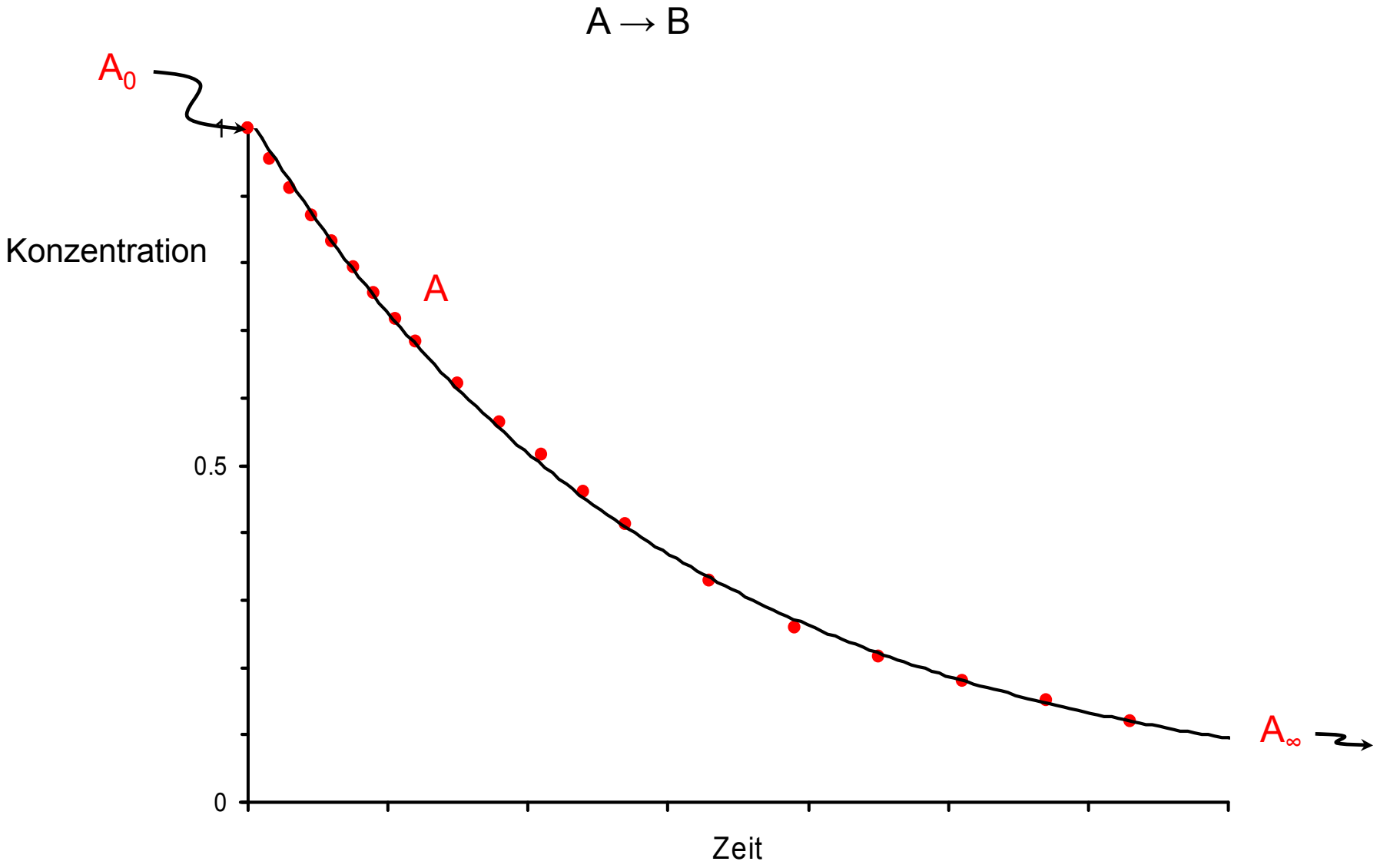
Reaktion 1. Ordnung

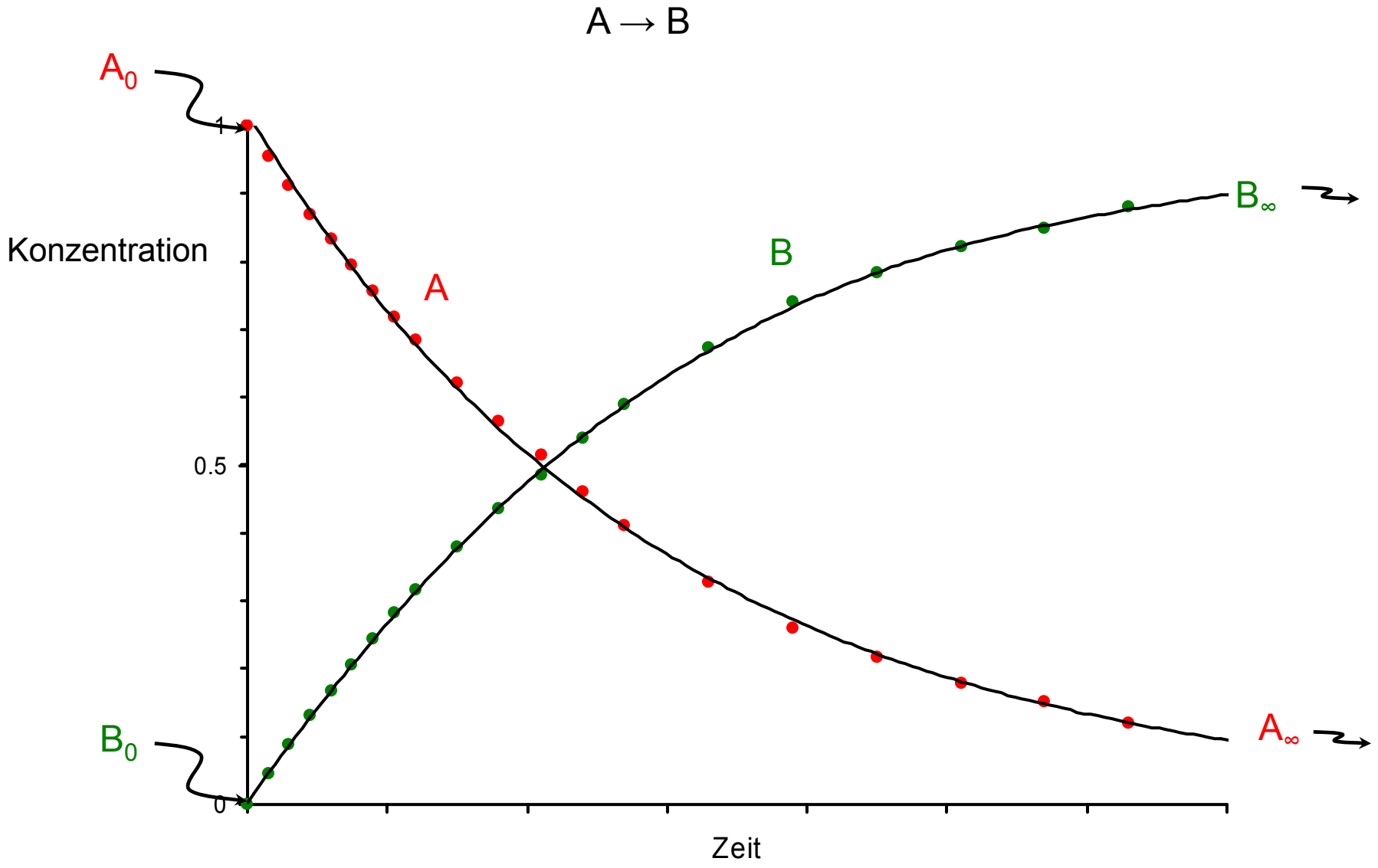


Halbwertszeit

Reaktion 1. Ordnung




A → B
A0
Konzentration
A
0.5
0
A∞
Zeit


A → B
A0
1
Konzentration
A
B
B∞
0.5
B0
0
A∞
Zeit

1.2.3 Reaktion mit Rückreaktion

$$A \underset{k_{-1}}{\overset{k_1}{\leftrightarrow}} B$$

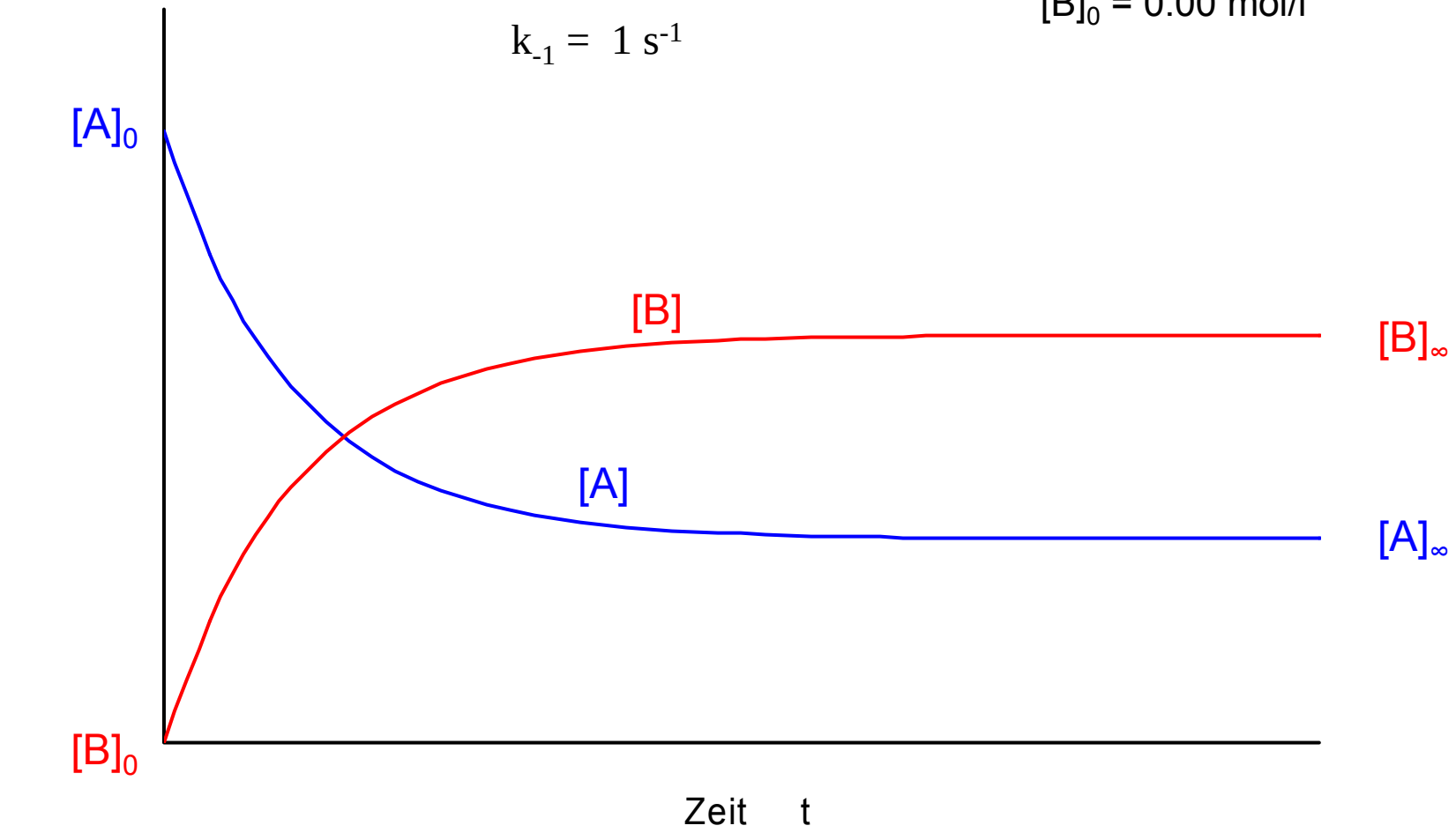
$k_1 = 2\ s^{-1}$

$k_{-1} = 1\ s^{-1}$

Variation der Anfangskonzentration

$[A]_0 = 1.00$ mol/l

$[B]_0 = 0.00$ mol/l



$$A \underset{k_{-1}}{\overset{k_1}{\leftrightarrow}} B$$

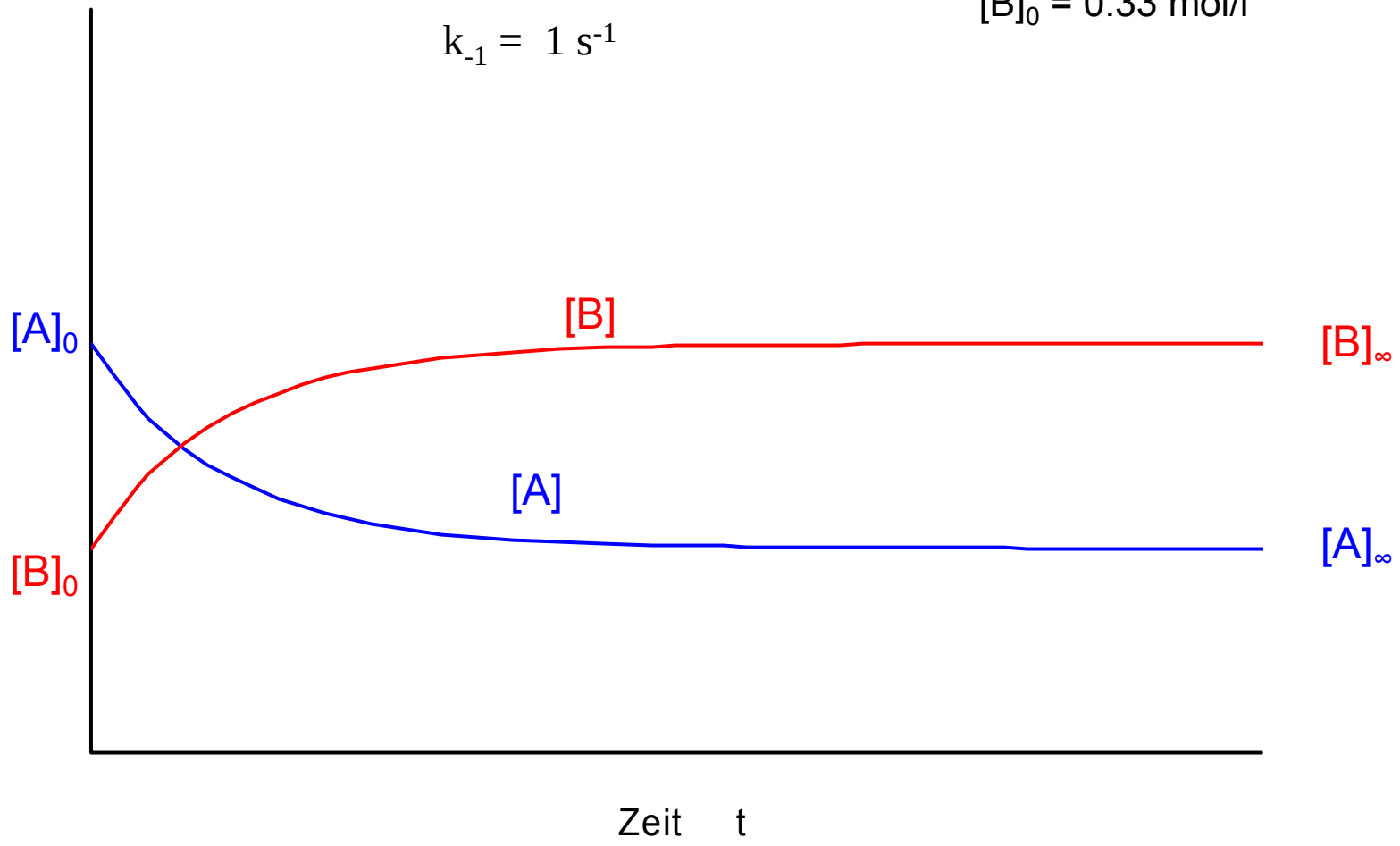
$k_1 = 2\ s^{-1}$

$k_{-1} = 1\ s^{-1}$

Variation der Anfangskonzentration

$[A]_0 = 0.67$ mol/l

$[B]_0 = 0.33$ mol/l



$$A \underset{k_{-1}}{\overset{k_1}{\leftrightarrow}} B$$

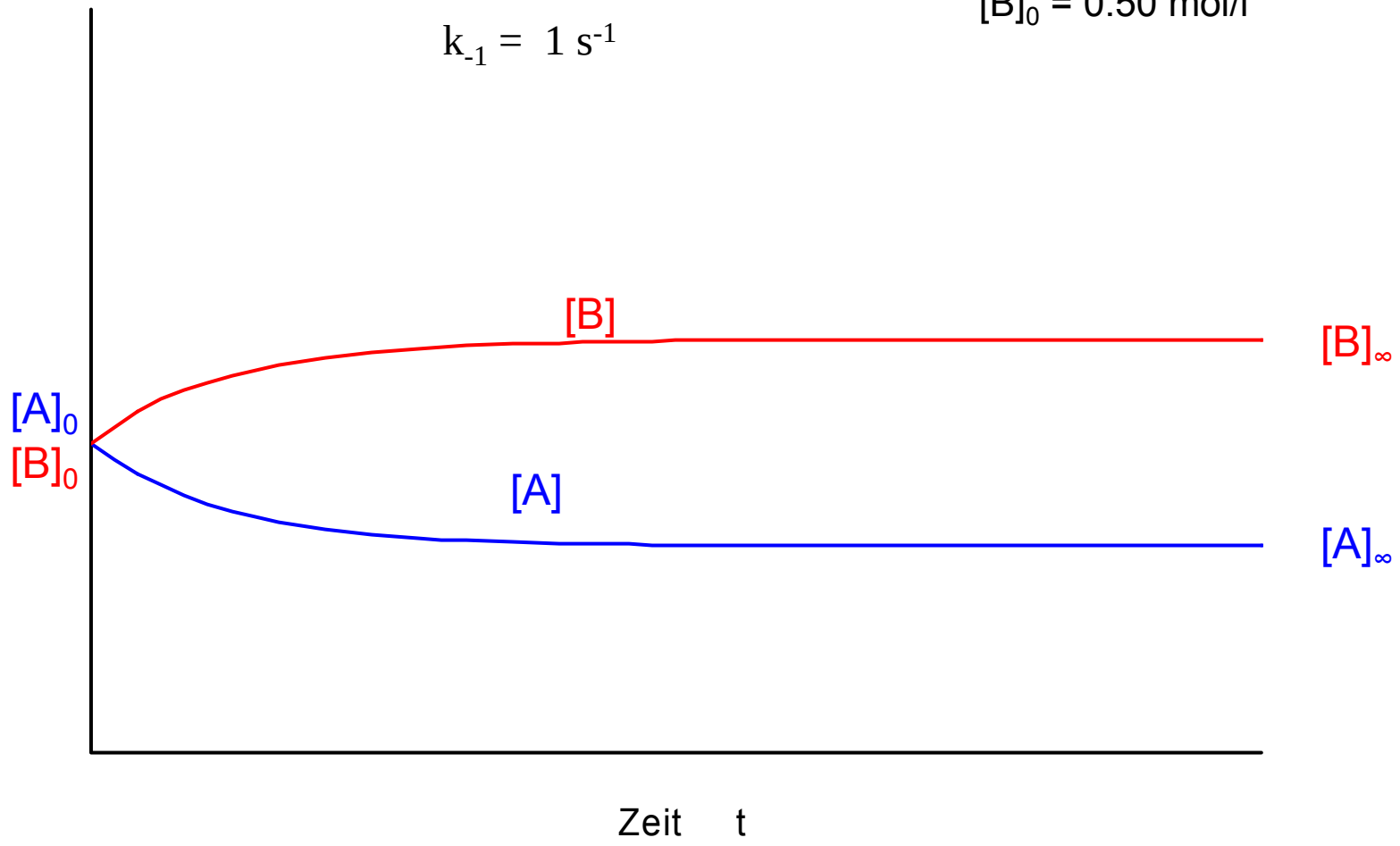
$k_1 = 2\ s^{-1}$

$k_{-1} = 1\ s^{-1}$

Variation der Anfangskonzentration

$[A]_0 = 0.50$ mol/l

$[B]_0 = 0.50$ mol/l



1.2.3 Reaktion mit Rückreaktion

$$A \underset{k_{-1}}{\overset{k_1}{\leftrightarrow}} B$$

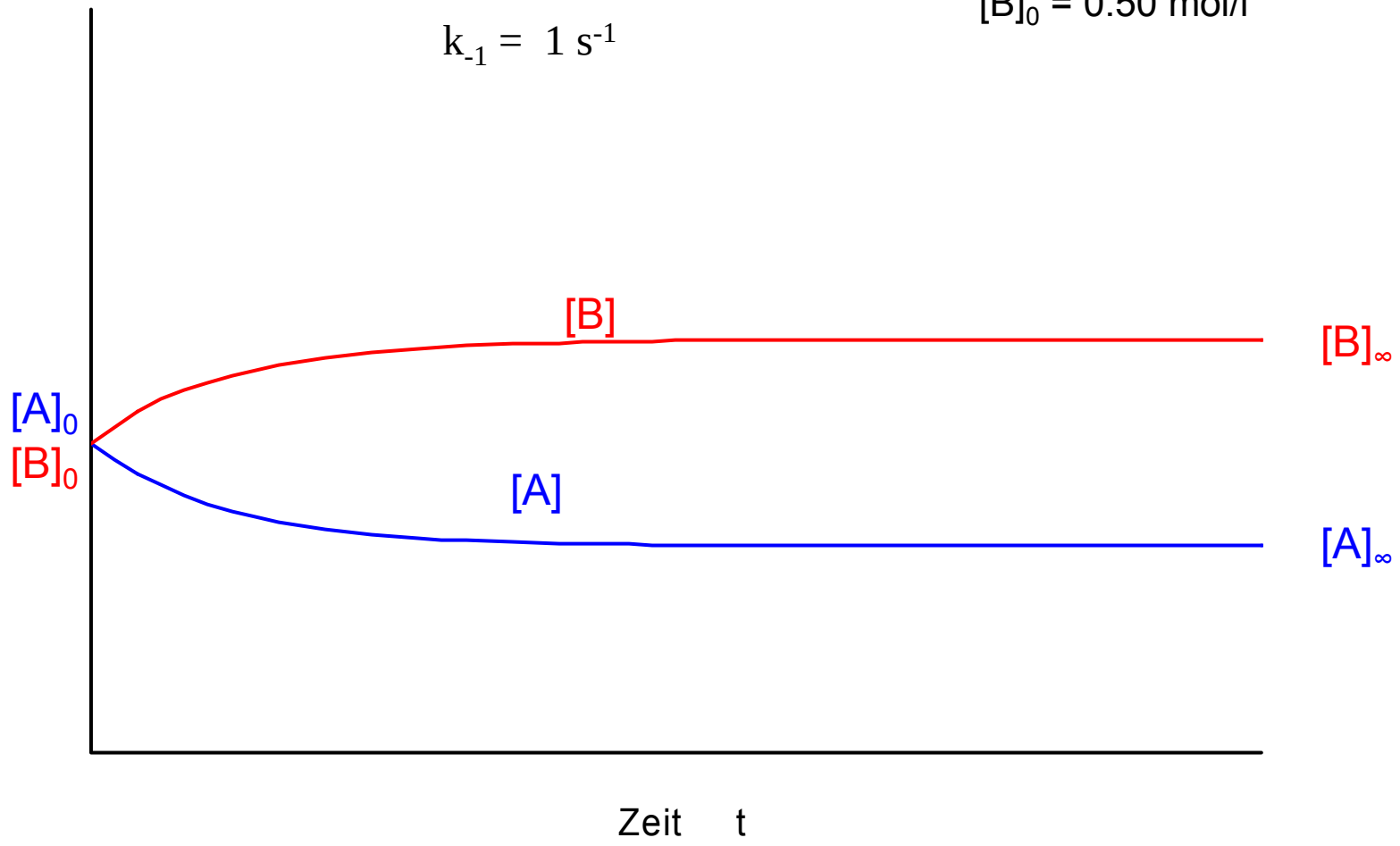
$k_1 = 2\ s^{-1}$

$k_{-1} = 1\ s^{-1}$

Variation der Anfangskonzentration

$[A]_0 = 0.50$ mol/l

$[B]_0 = 0.50$ mol/l



1.2.3 Reaktion mit Rückreaktion

$$A \underset{k_{-1}}{\overset{k_1}{\leftrightarrow}} B$$

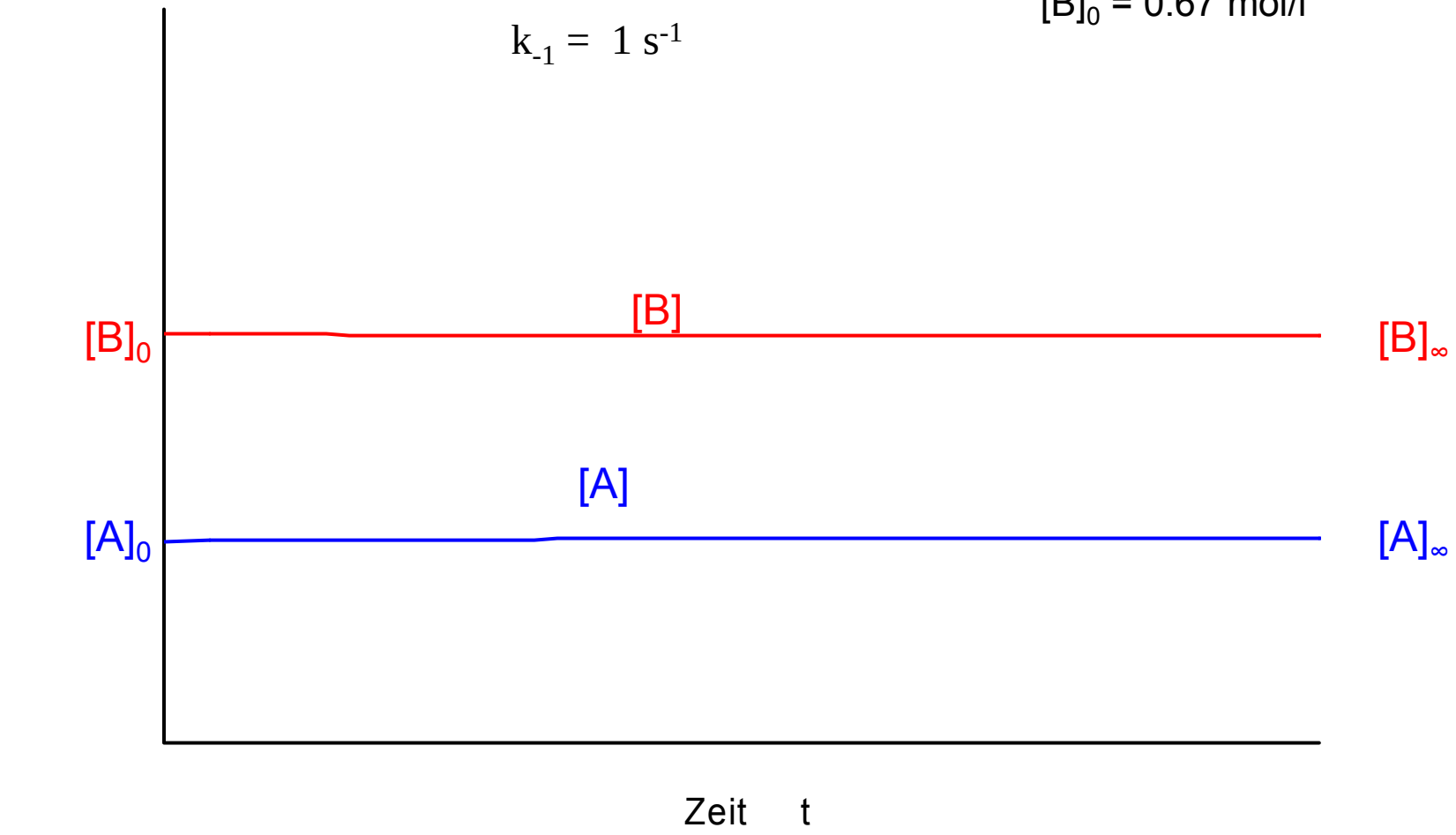
$k_1 = 2\ s^{-1}$

$k_{-1} = 1\ s^{-1}$

Variation der Anfangskonzentration

$[A]_0 = 0.33$ mol/l

$[B]_0 = 0.67$ mol/l



1.2.3 Reaktion mit Rückreaktion

$$A \underset{k_{-1}}{\overset{k_1}{\leftrightarrow}} B$$

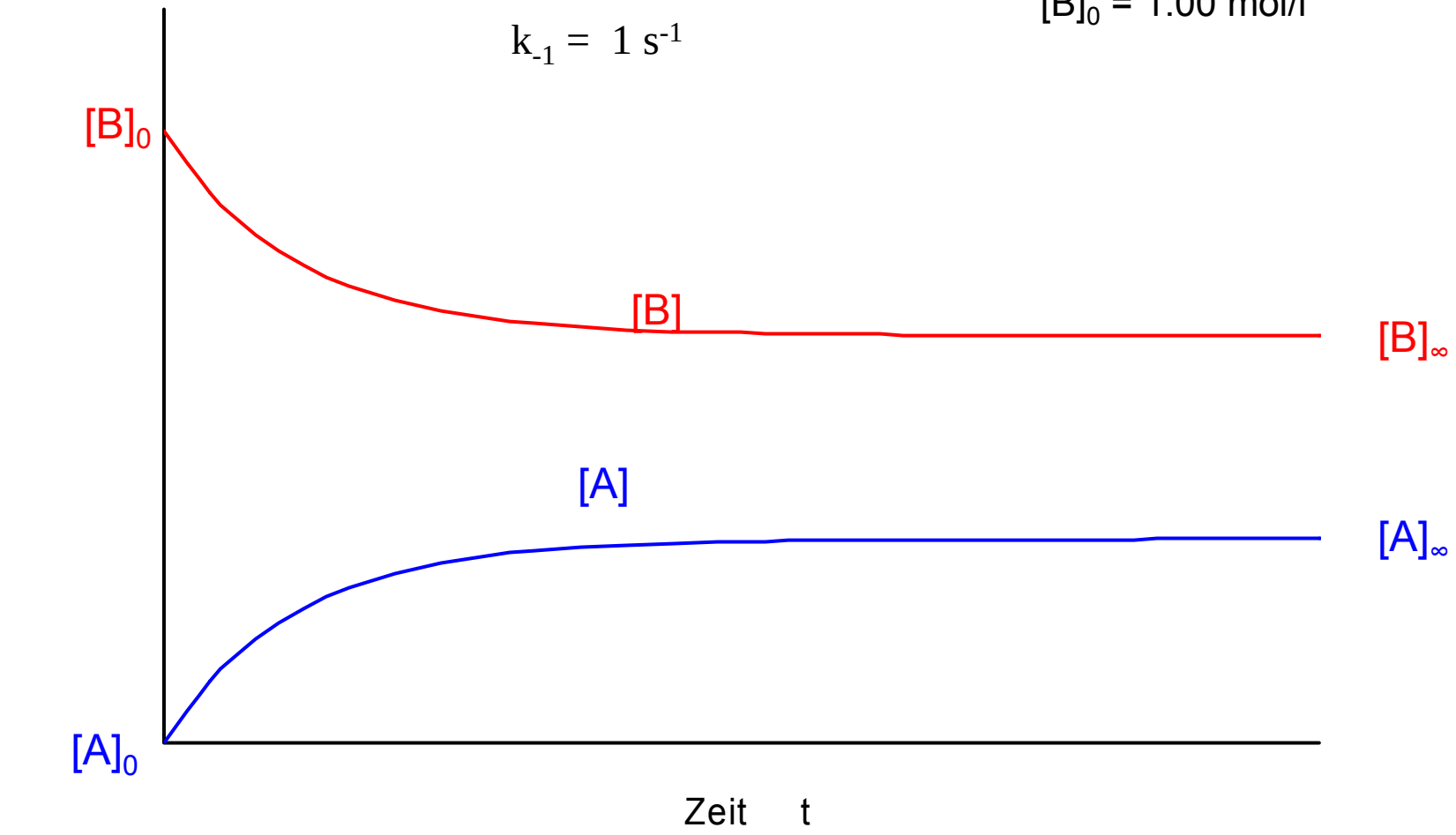
$k_1 = 2\ s^{-1}$

$k_{-1} = 1\ s^{-1}$

Variation der Anfangskonzentration

$[A]_0 = 0.00$ mol/l

$[B]_0 = 1.00$ mol/l



$$A \underset{k_{-1}}{\overset{k_1}{\leftrightarrow}} B$$

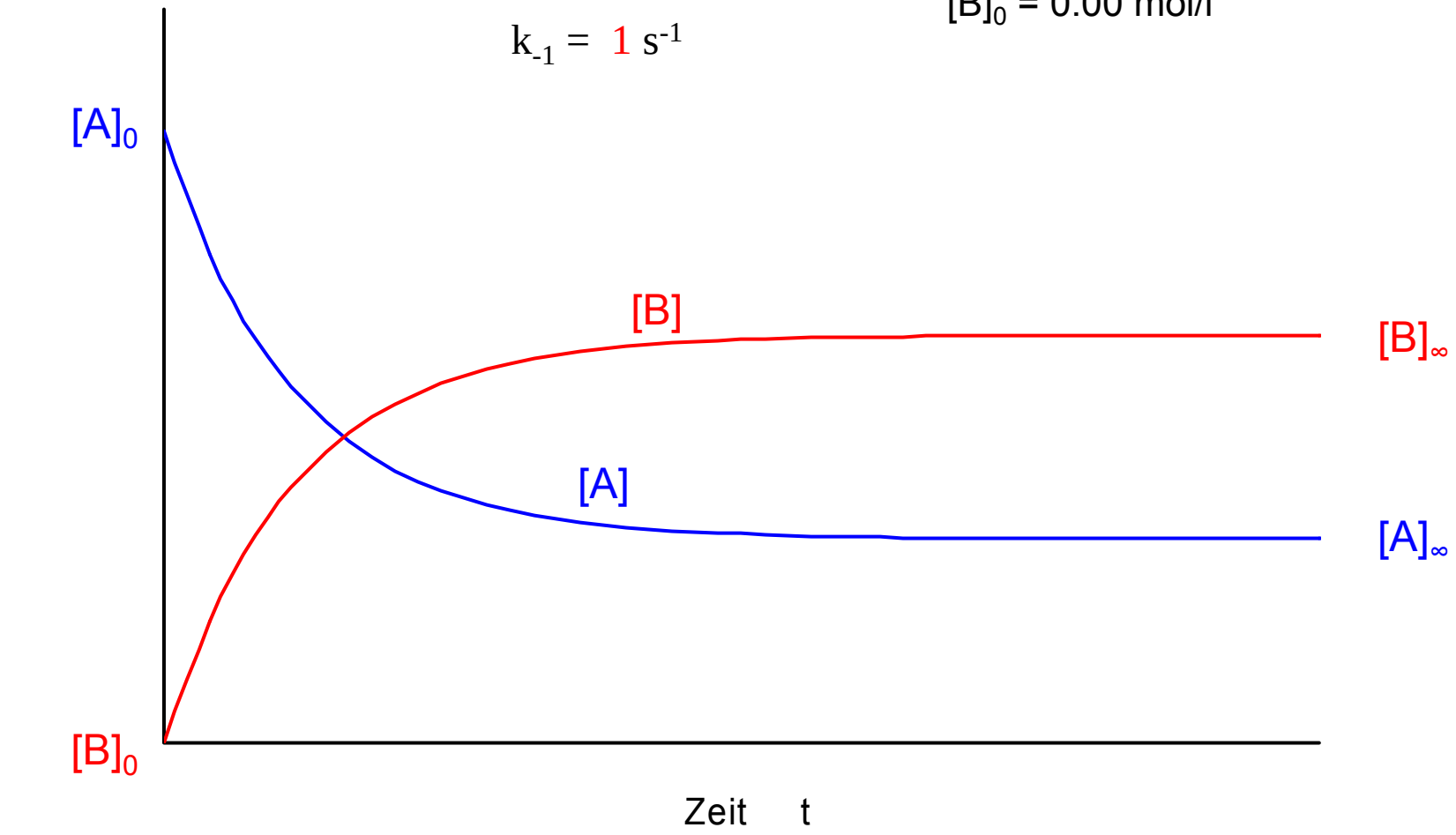
$k_1 = 2\ s^{-1}$

$k_{-1} = 1\ s^{-1}$

Variation der Geschwindigkeitskonstanten

$[A]_0 = 1.00$ mol/l

$[B]_0 = 0.00$ mol/l



$$A \underset{k_{-1}}{\overset{k_1}{\leftrightarrow}} B$$

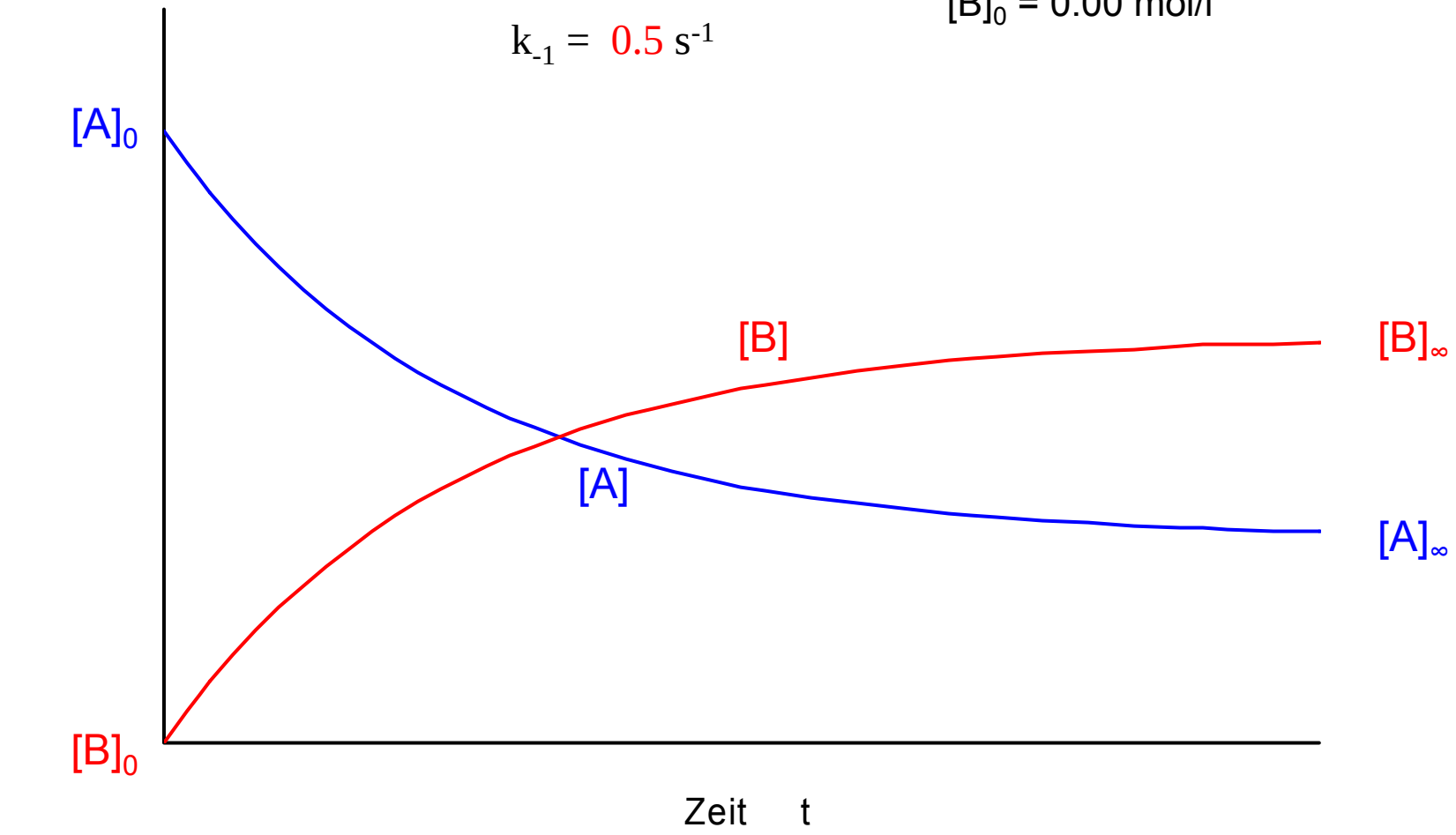
$k_1 = 1\ s^{-1}$

$k_{-1} = 0.5\ s^{-1}$

Variation der Geschwindigkeitskonstanten

$[A]_0 = 1.00$ mol/l

$[B]_0 = 0.00$ mol/l



$$A \underset{k_{-1}}{\overset{k_1}{\leftrightarrow}} B$$

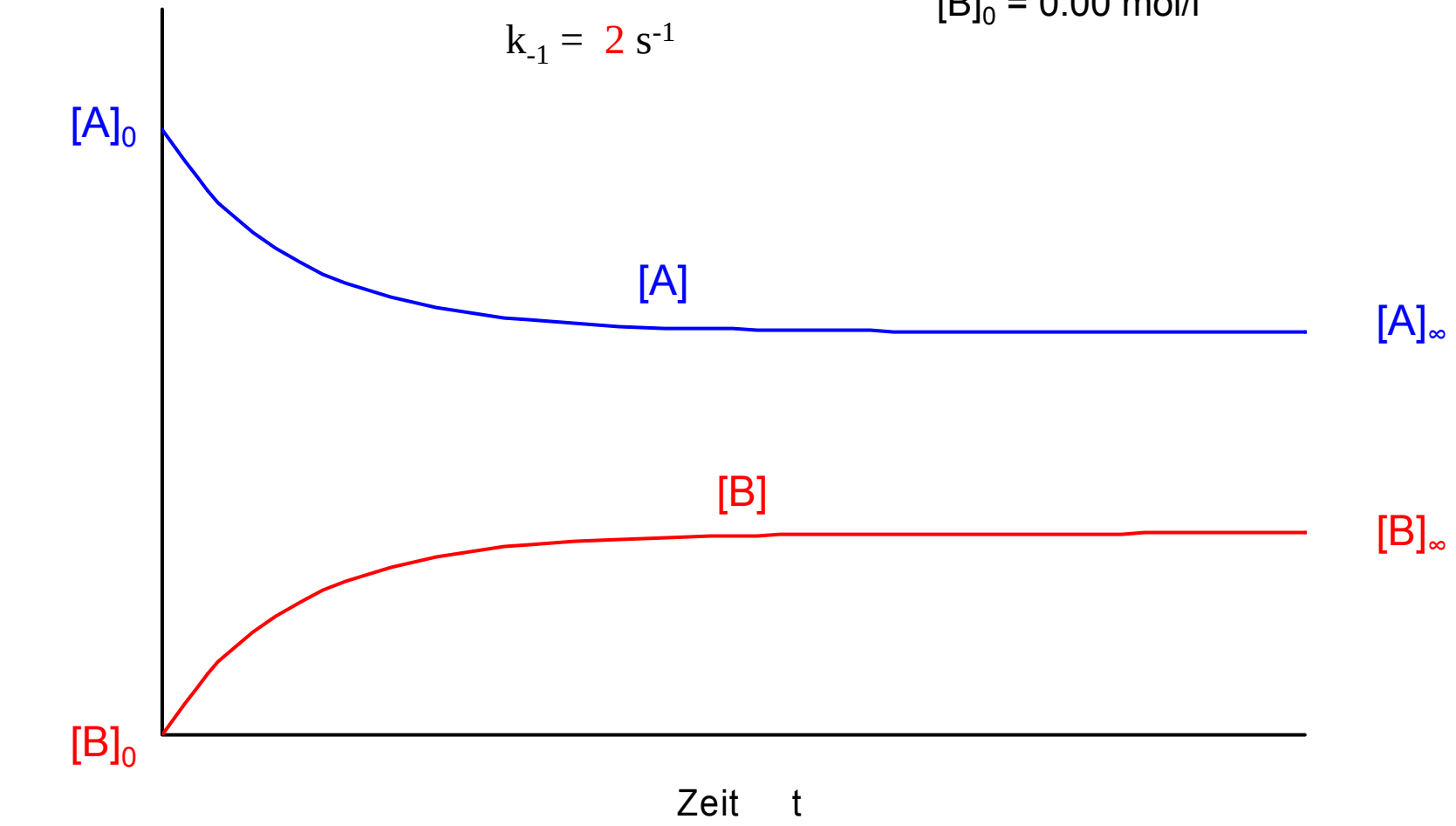
$k_1 = 1\ s^{-1}$

$k_{-1} = 2\ s^{-1}$

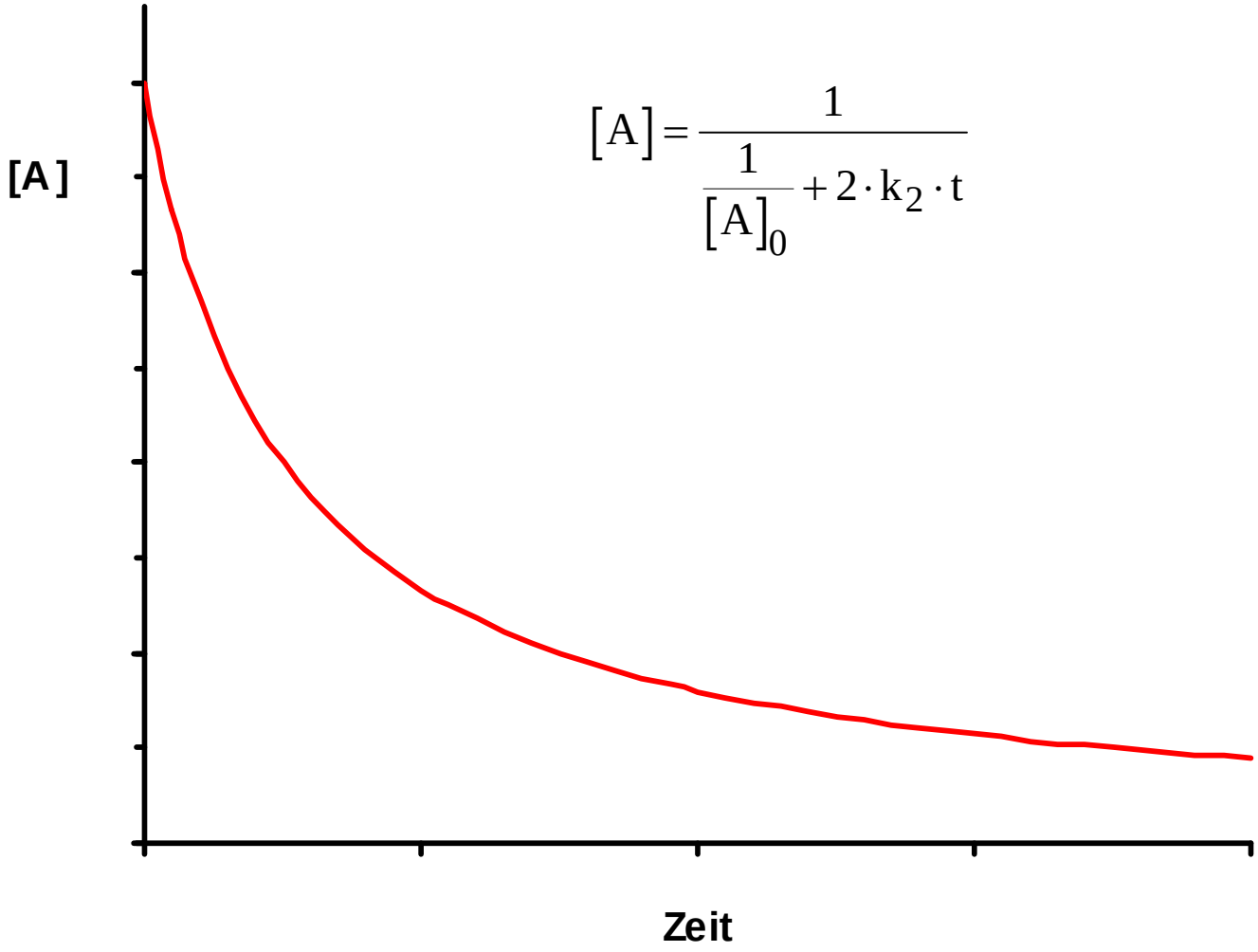
Variation der Geschwindigkeitskonstanten

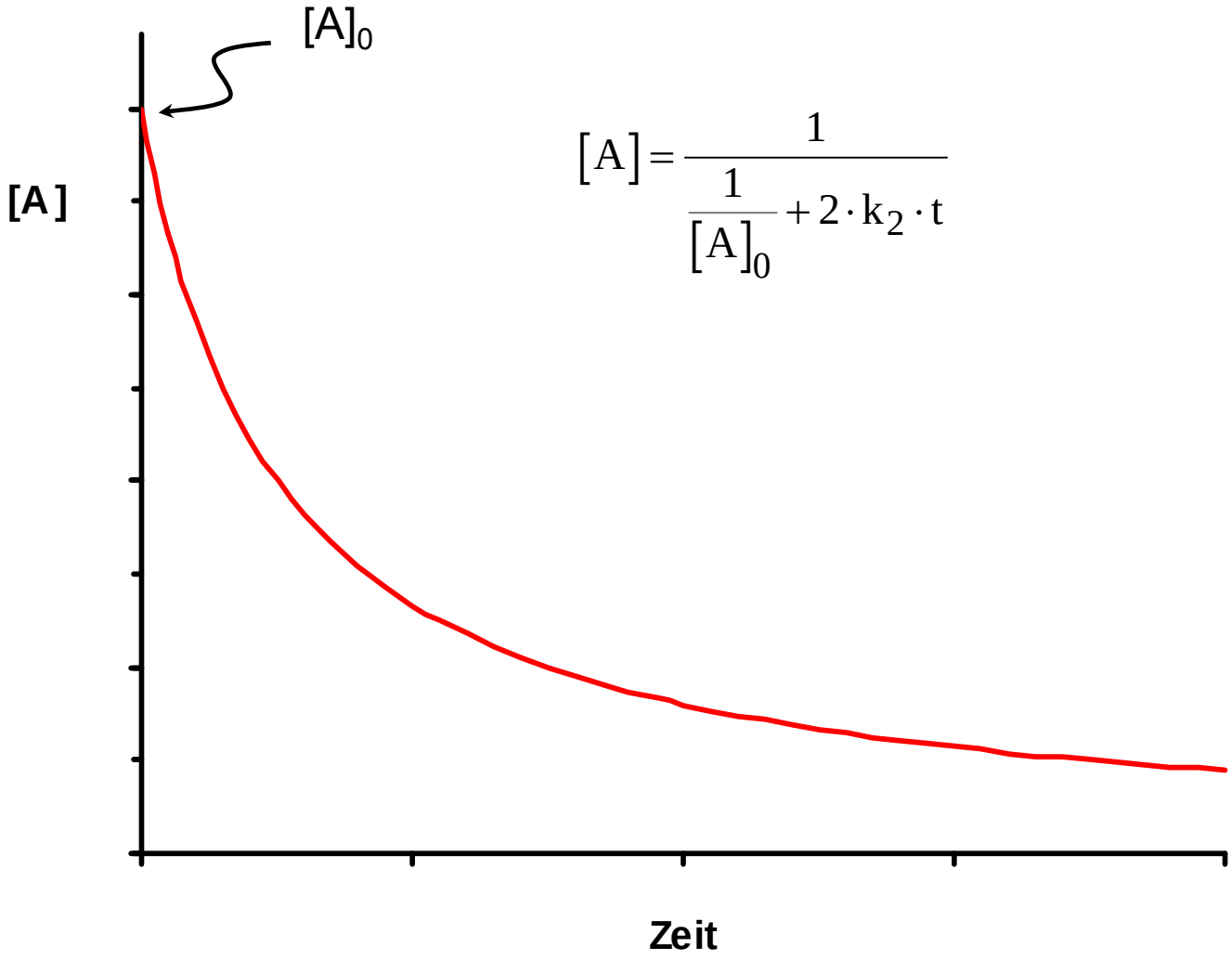
$[A]_0 = 1.00$ mol/l

$[B]_0 = 0.00$ mol/l

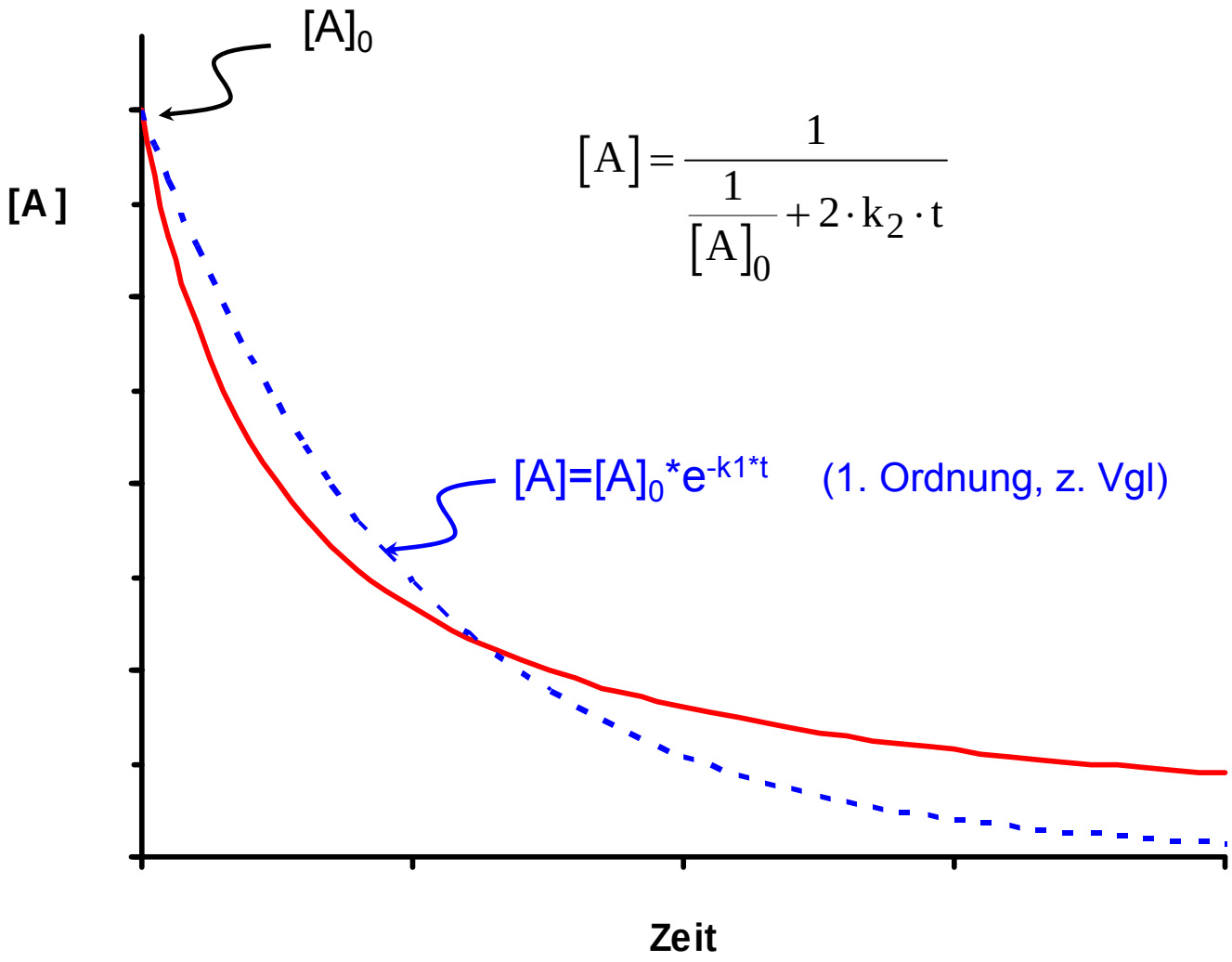


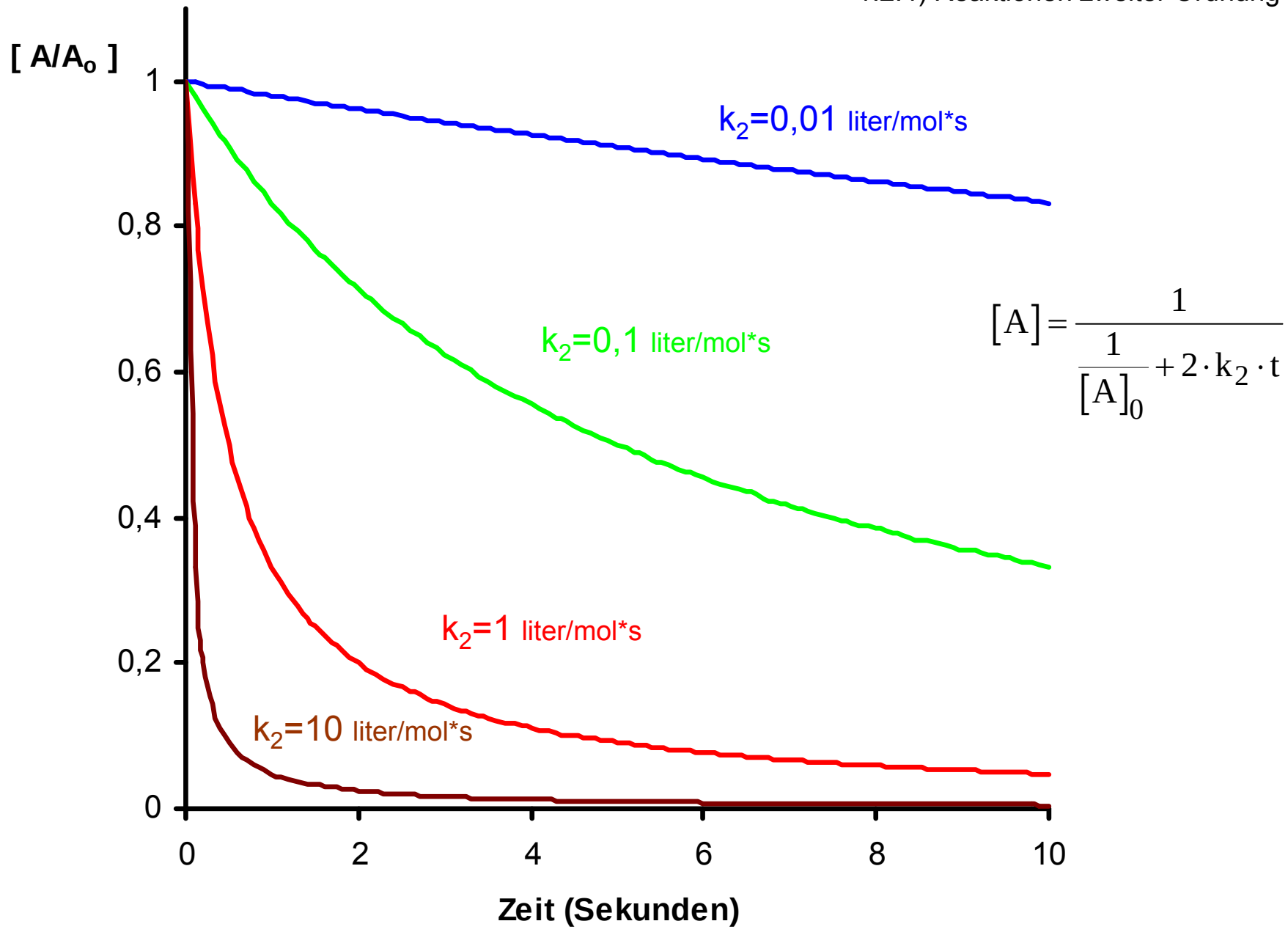
$$[A] = \frac{1}{\frac{1}{[A]_0} + 2 \cdot k_2 \cdot t}$$





$$[A] = \frac{1}{\frac{1}{[A]_0} + 2 \cdot k_2 \cdot t}$$

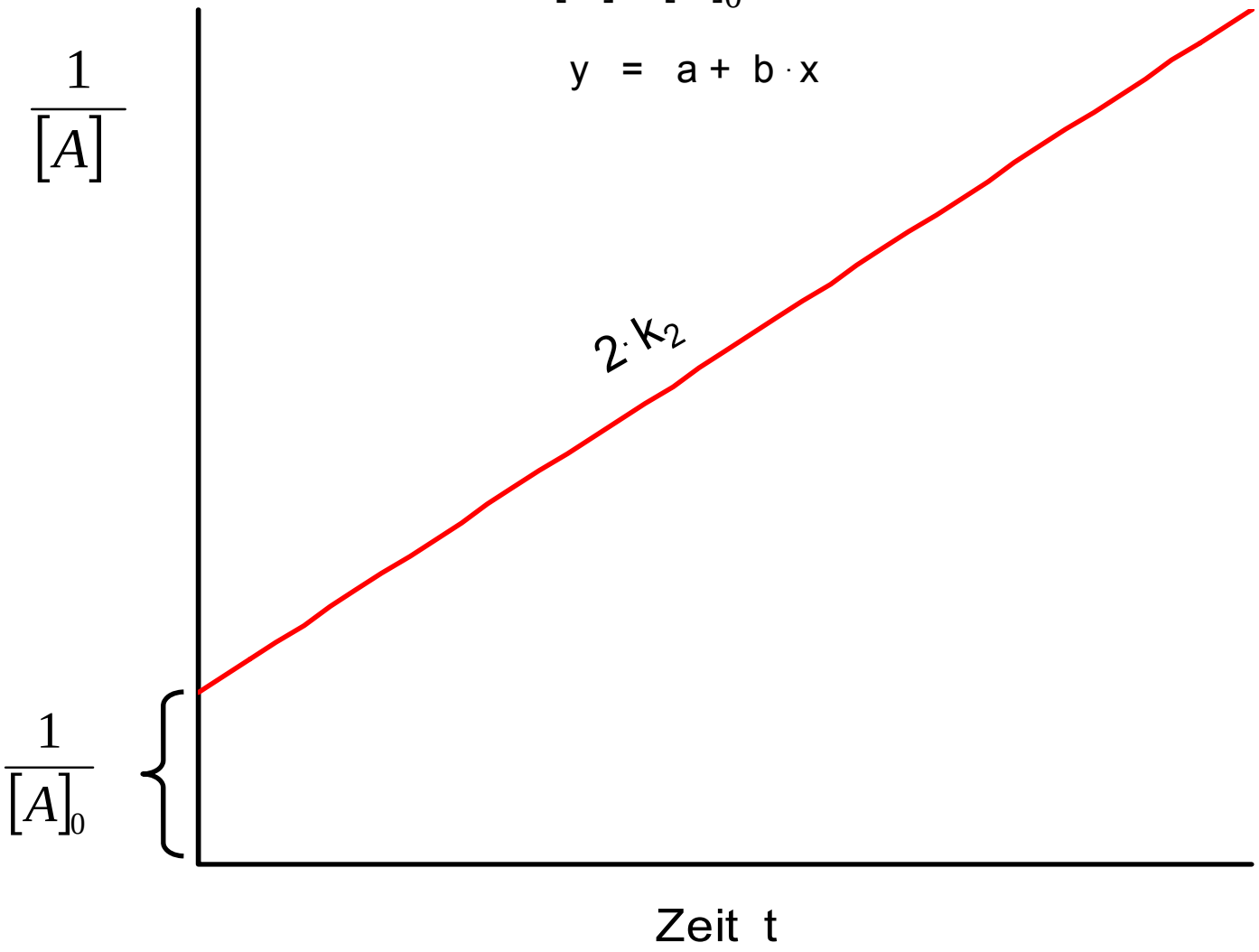

[A]0
[A]
$[A] = \frac{1}{\frac{1}{[A]_0} + 2 \cdot k_2 \cdot t}$
[A]=[A]0*e-k1*t
(1. Ordnung, z. Vgl)
Zeit


[A/A$_o$]
1
0,8
0,6
0,4
0,2
0
0
2
4
6
8
10
Zeit (Sekunden)
k_2=0,01 liter/mol*s
k_2=0,1 liter/mol*s
k_2=1 liter/mol*s
k_2=10 liter/mol*s
$[A] = \frac{1}{\frac{1}{[A]_0} + 2 \cdot k_2 \cdot t}$

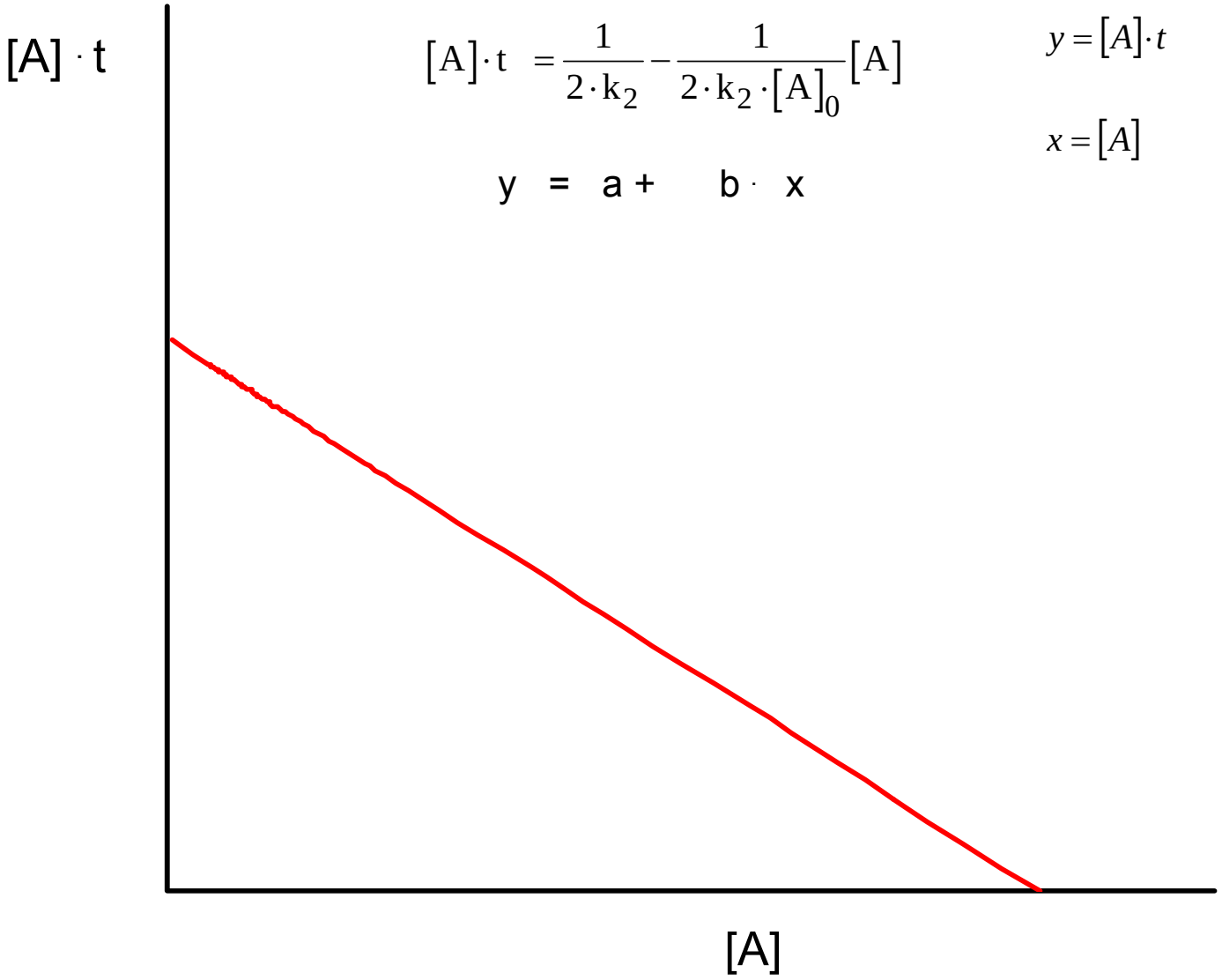
Reaktion 2. Ordnung *– geschickte graphische Darstellung (1)*

$$\frac{1}{[A]} = \frac{1}{[A]_0} + 2 \cdot k_2 \cdot t$$

$y = a + b \cdot x$



Reaktion 2. Ordnung *– geschickte graphische Darstellung (2)*



$$[A]\cdot t = \frac{1}{2\cdot k_2} - \frac{1}{2\cdot k_2\cdot [A]_0}[A]$$

$$y = a + b \cdot x$$

$$y = [A]\cdot t \qquad a = \frac{1}{2\cdot k_2}$$

$$x = [A] \qquad b = -\frac{1}{2\cdot k_2\cdot [A]_0}$$

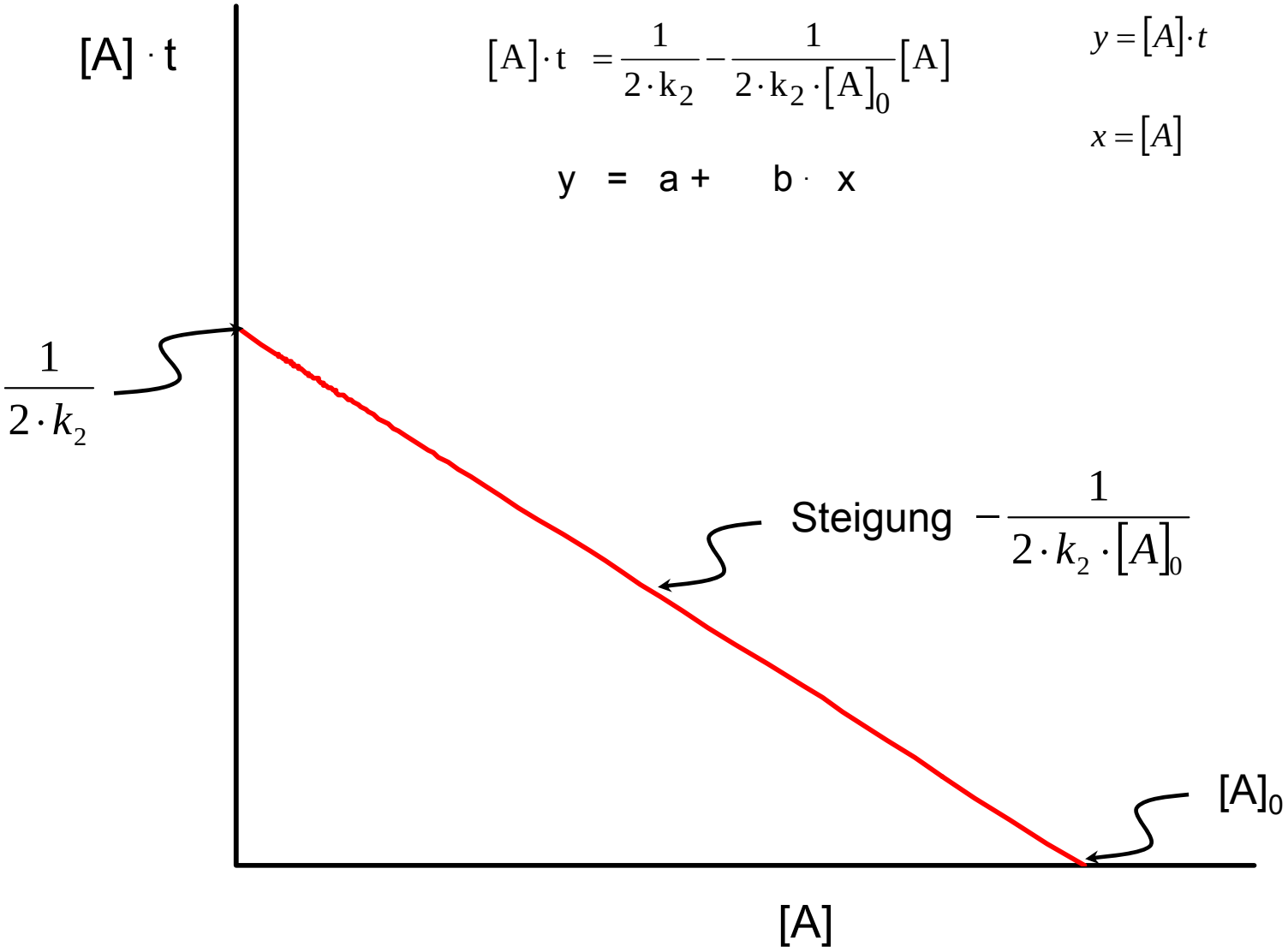
Reaktion 2. Ordnung *– geschickte graphische Darstellung (2)*

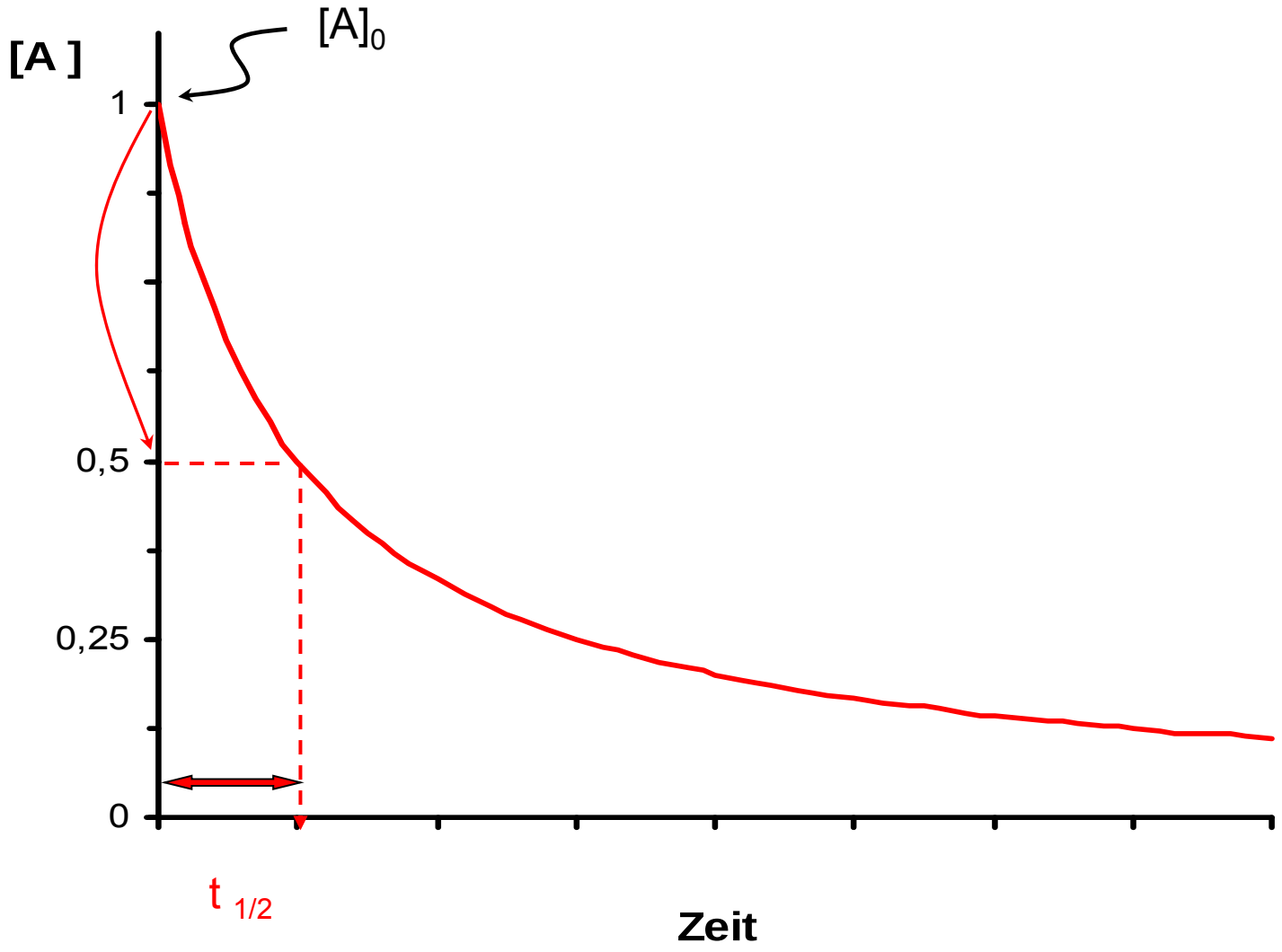
$$[A]\cdot t = \frac{1}{2\cdot k_2} - \frac{1}{2\cdot k_2\cdot [A]_0}[A]$$

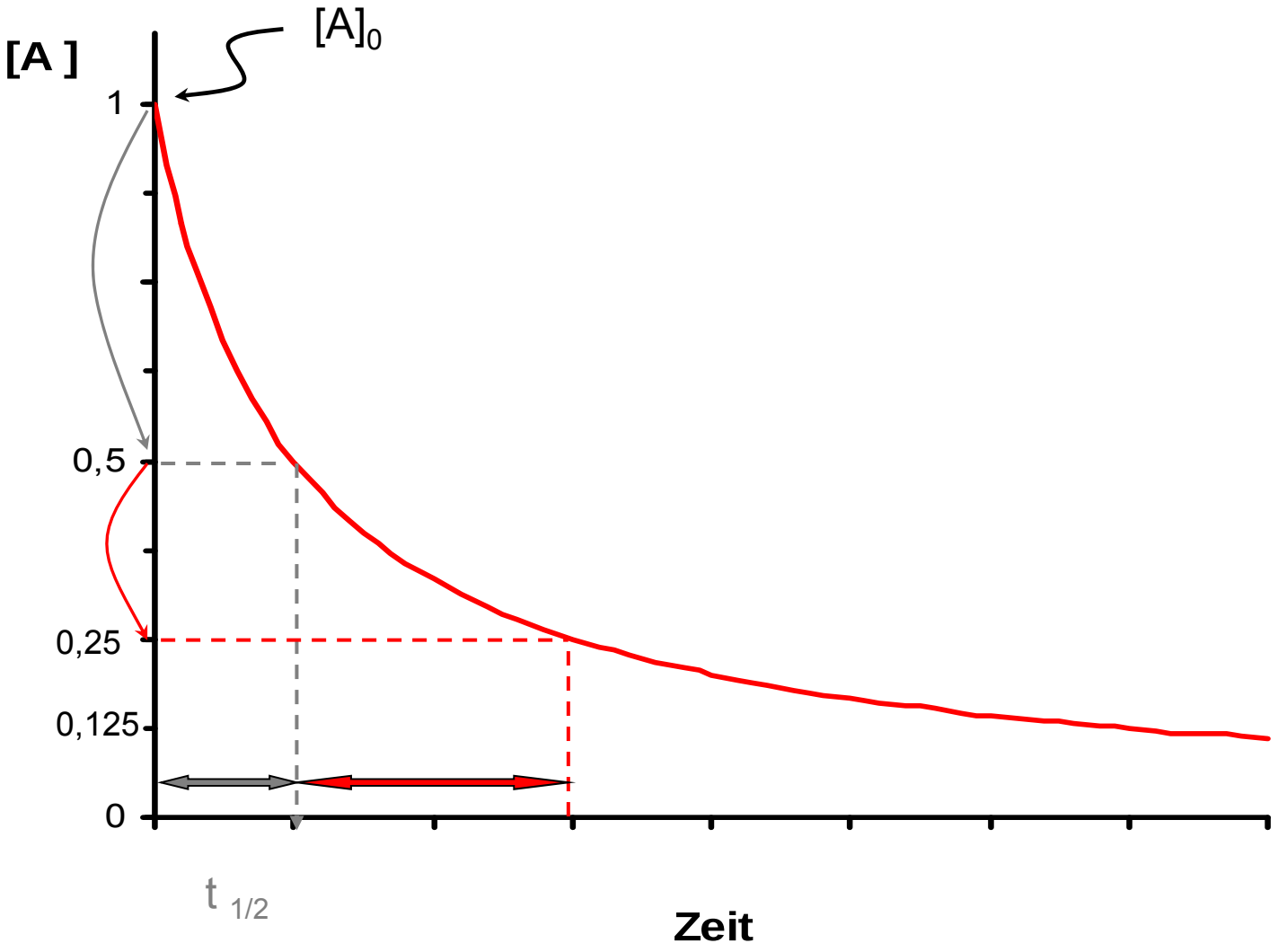
$$y = a + b\cdot x$$

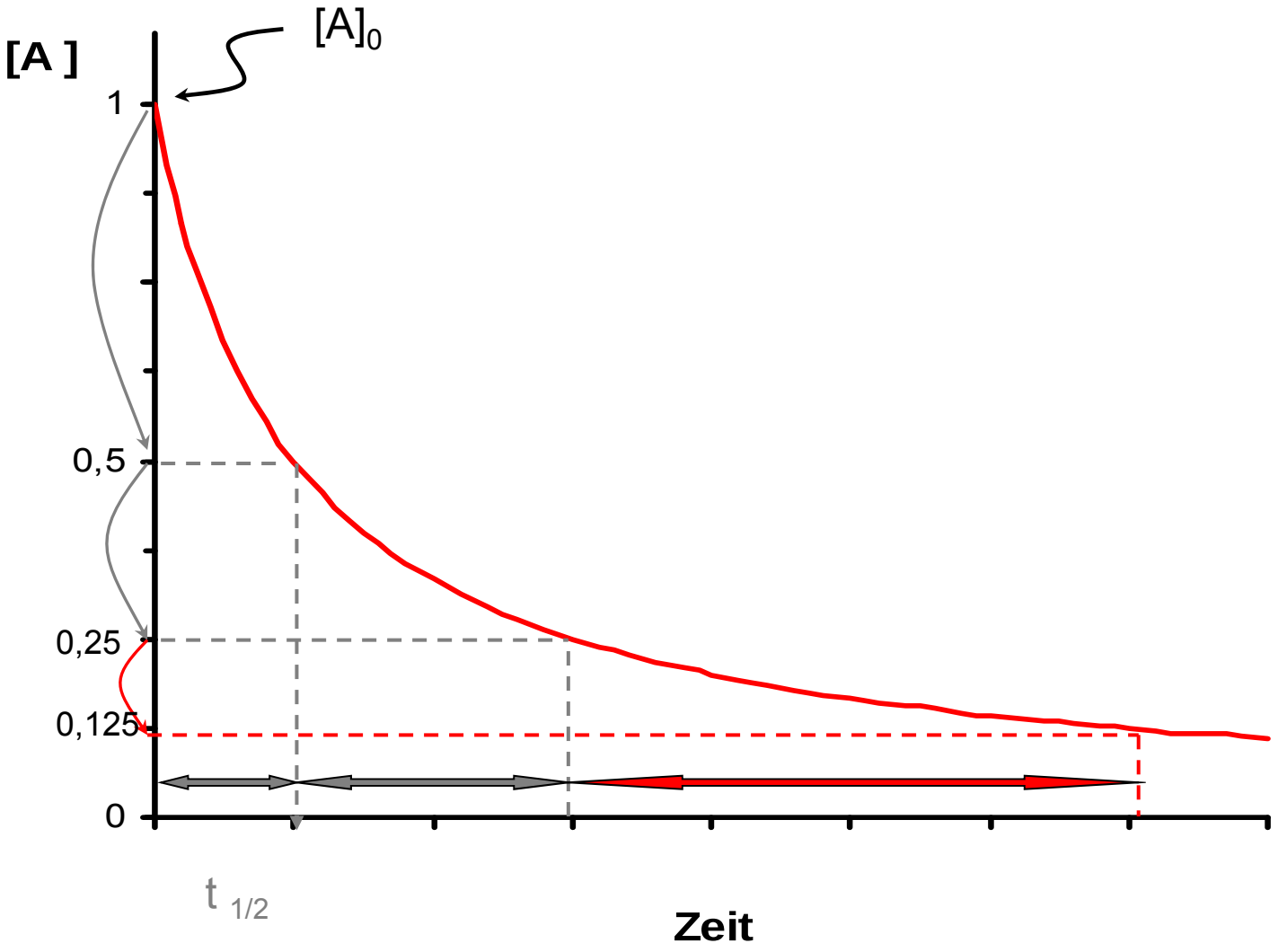
$$y = [A]\cdot t \qquad a = \frac{1}{2\cdot k_2}$$

$$x = [A] \qquad b = -\frac{1}{2\cdot k_2\cdot [A]_0}$$

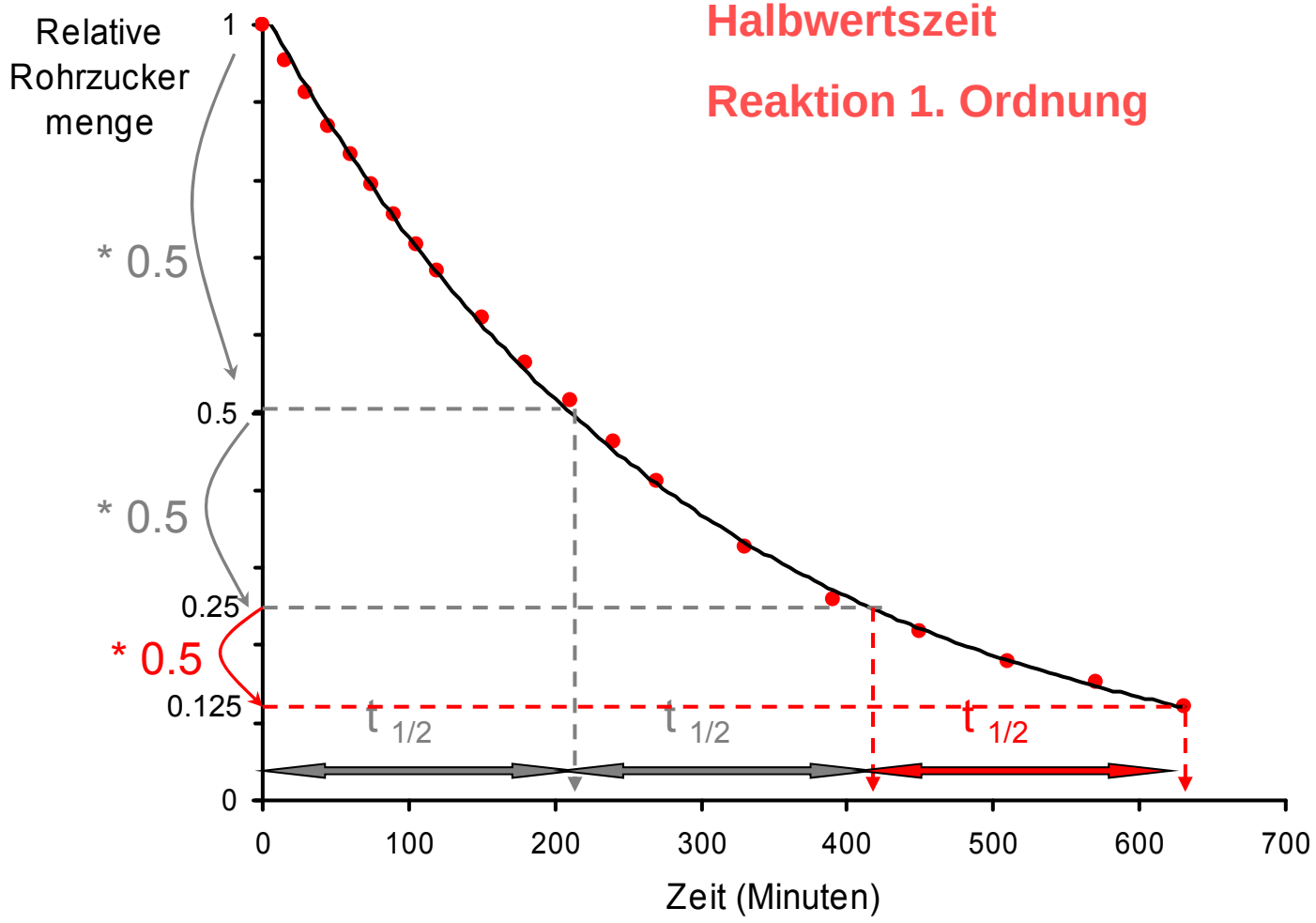



[A]
[A]0
1
0,5
0,25
0
t 1/2
Zeit


[A]
[A]0
1
0,5
0,25
0,125
0
t 1/2
Zeit


[A]
[A]0
1
0,5
0,25
0,125
0
t 1/2
Zeit

Zum Vergleich



$$\frac{-1}{[B]_0-[A]_0}\cdot\ \ln\left(\frac{([A]_0-x)\cdot[B]_0}{([B]_0-x)\cdot[A]_0}\right)=k_2t \qquad \Big|\ \cdot(-1)\cdot([B]_0-[A]_0)$$

$$\ln\left(\frac{([A]_0-x)\cdot[B]_0}{([B]_0-x)\cdot[A]_0}\right)=-([B]_0-[A]_0)k_2t \qquad \Big|\ \cdot\exp$$

$$\frac{([A]_0-x)\cdot[B]_0}{([B]_0-x)\cdot[A]_0}=e^{-([B]_0-[A]_0)k_2t} \qquad \Big|\ \cdot\frac{[A]_0}{[B]_0}$$

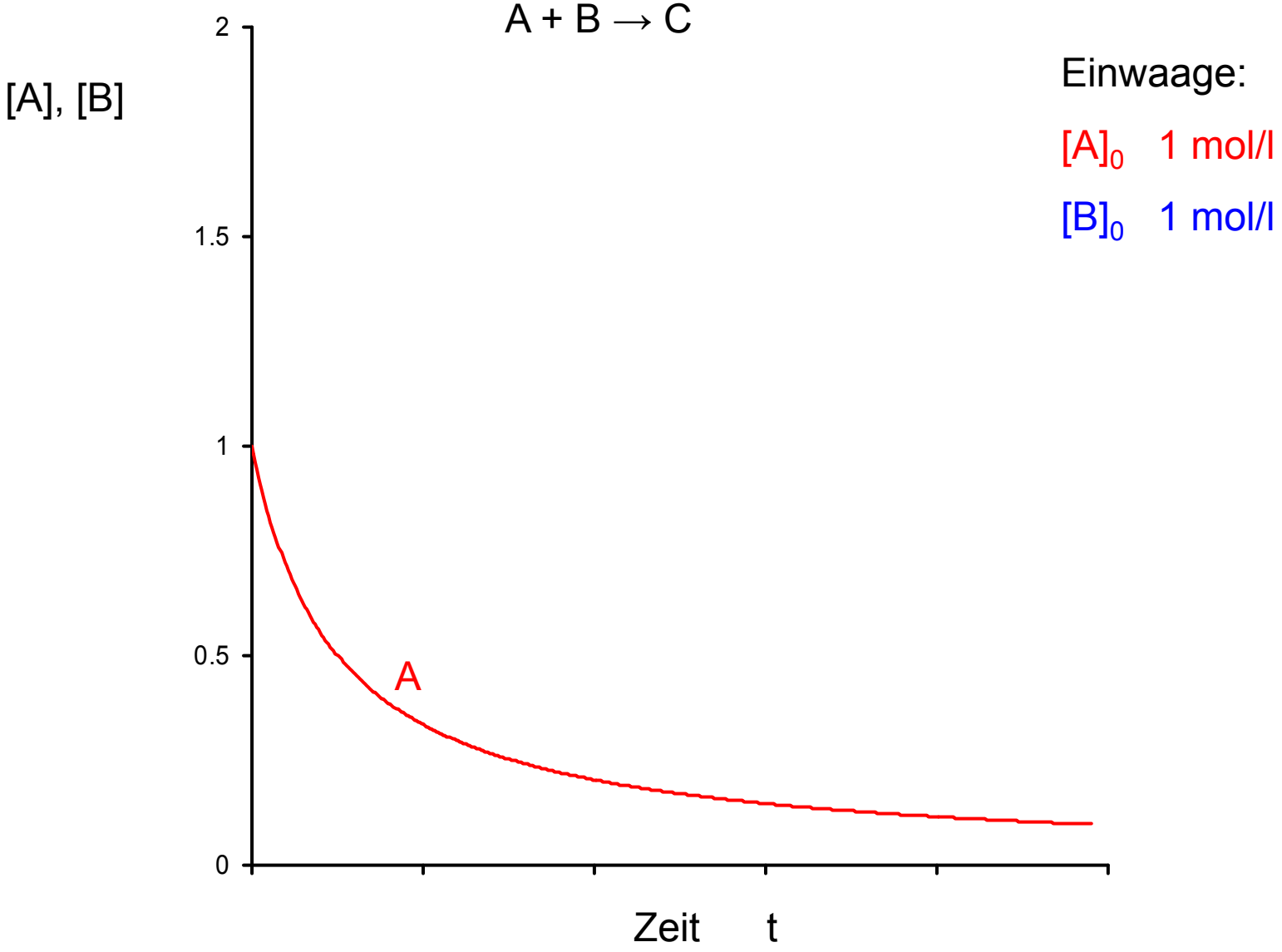
$$\frac{([A]_0-x)}{([B]_0-x)}=\underbrace{\frac{[A]_0}{[B]_0}e^{-([B]_0-[A]_0)k_2t}}_{f(t)} \qquad \Big|\ \cdot([B]_0-x)$$

$$([A]_0-x)=([B]_0-x)\cdot f(t)$$

$$x=\frac{[A]_0-f(t)[B]_0}{1-f(t)}$$

Reaktion 2. Ordnung

$A + B \rightarrow C$



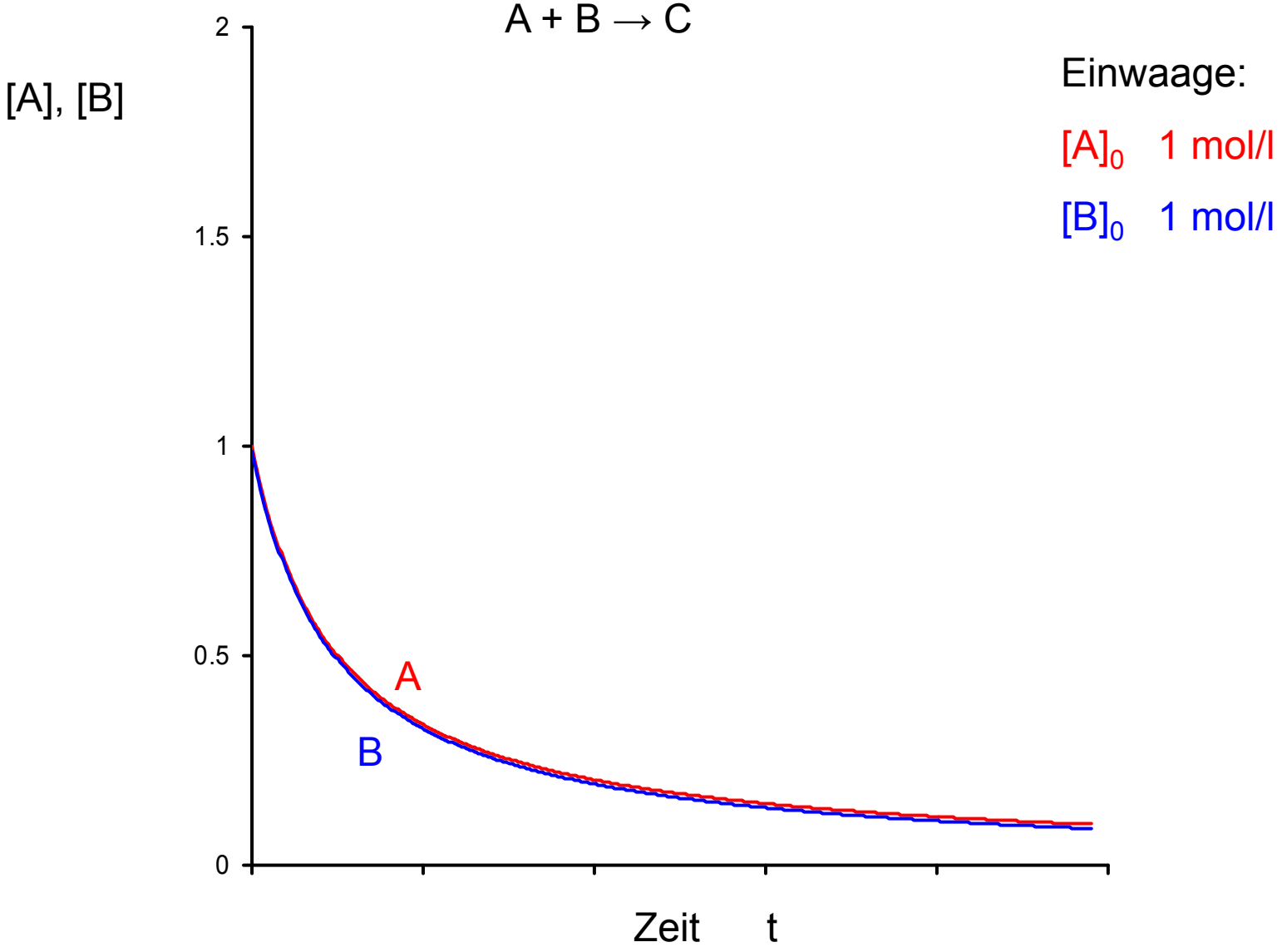
Einwaage:

$[A]_0$ 1 mol/l

$[B]_0$ 1 mol/l

Reaktion 2. Ordnung

$A + B \rightarrow C$



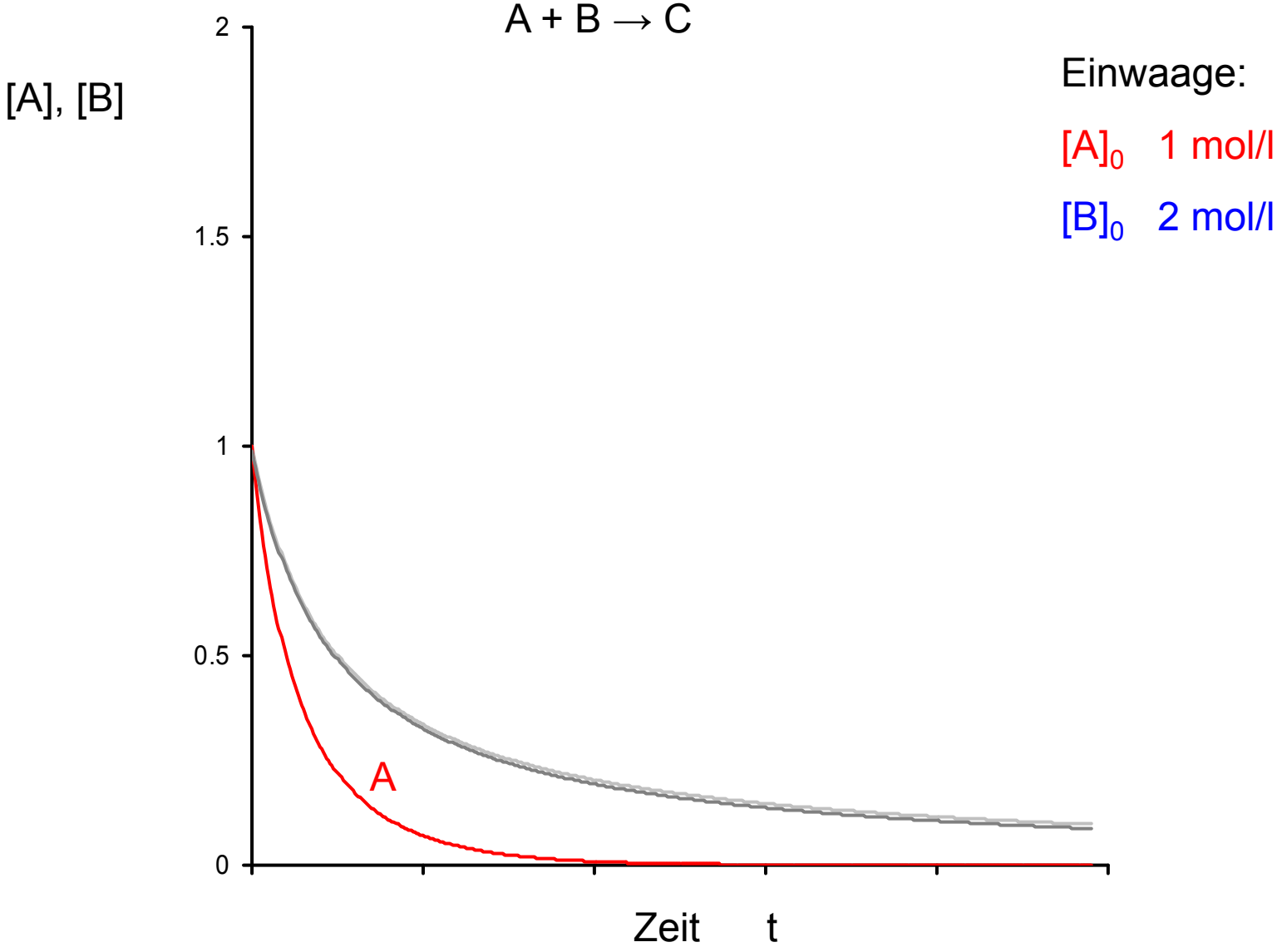
Einwaage:

$[A]_0$ 1 mol/l

$[B]_0$ 1 mol/l

Reaktion 2. Ordnung

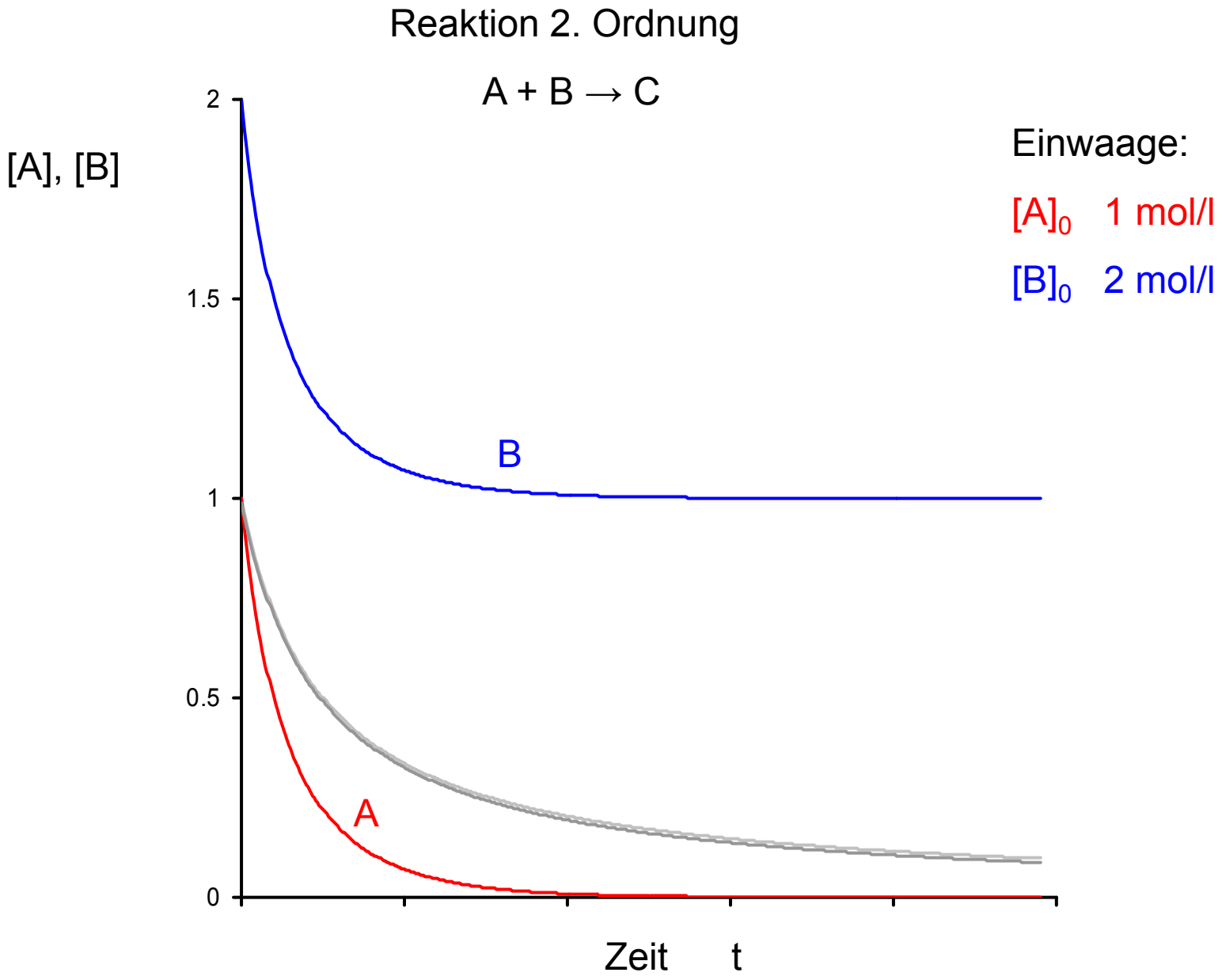
$A + B \rightarrow C$



Einwaage:

$[A]_0$ 1 mol/l

$[B]_0$ 2 mol/l


Reaktion 2. Ordnung
A + B → C
[A], [B]
2
1.5
1
0.5
0
B
A
Zeit t
Einwaage:
[A]0 1 mol/l
[B]0 2 mol/l