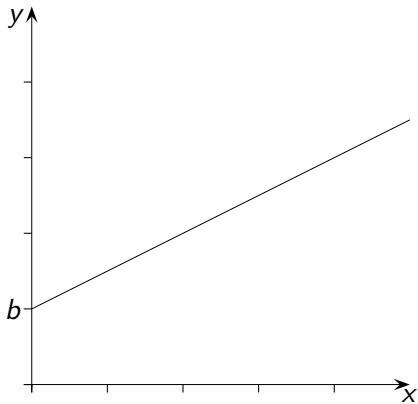
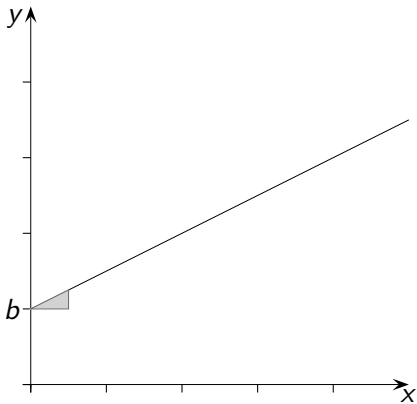
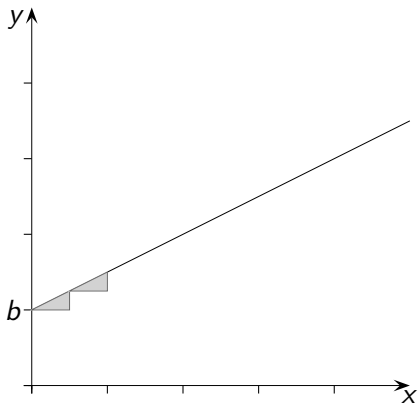


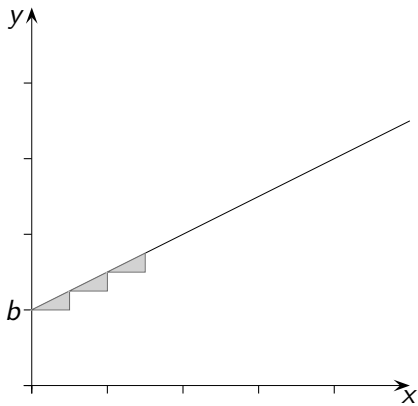
Wachstumsprozesse

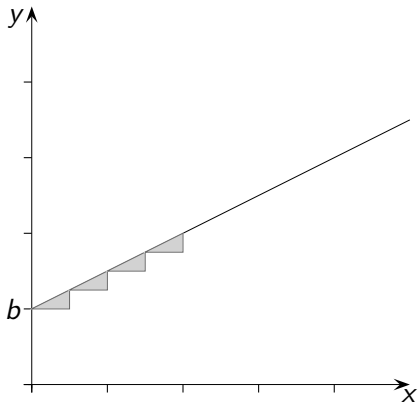
G.Roof's

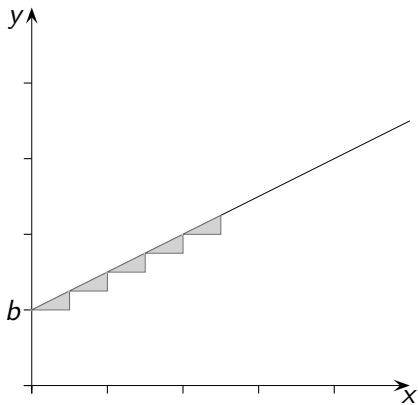


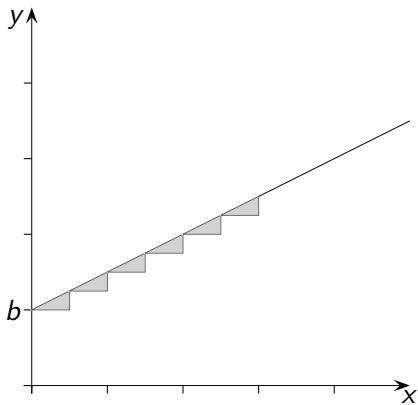


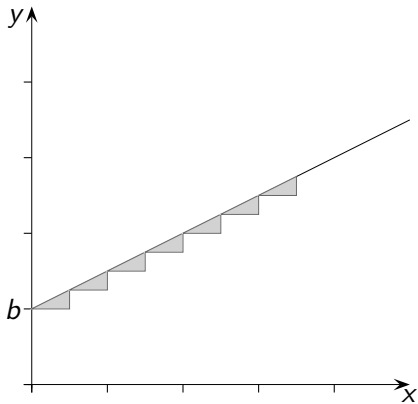


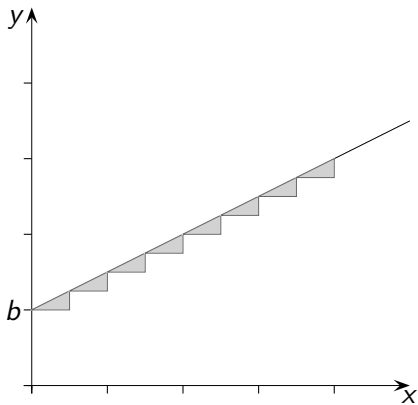


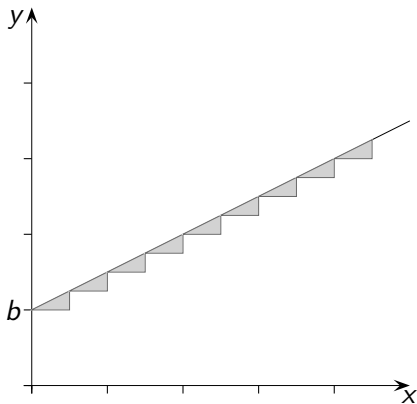




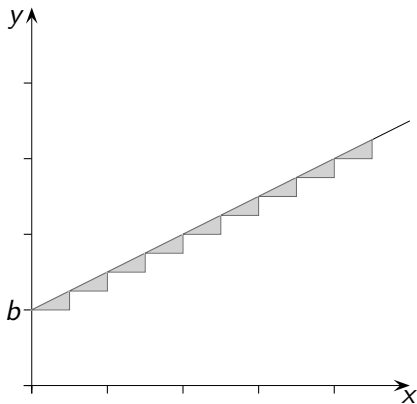




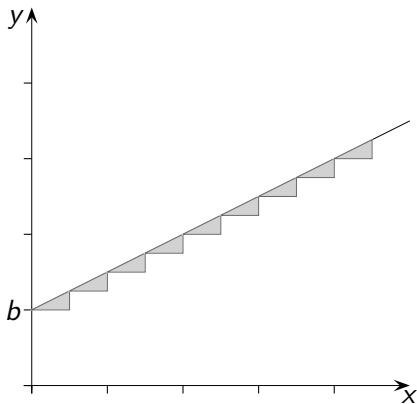




$$f'(x) =$$

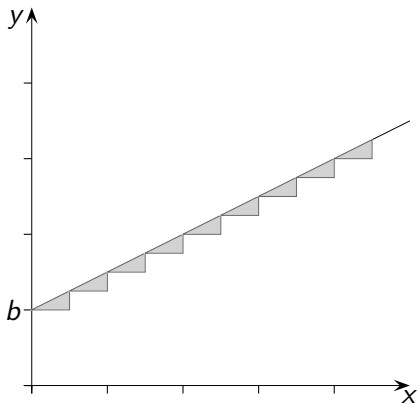


$$f'(x) = m$$



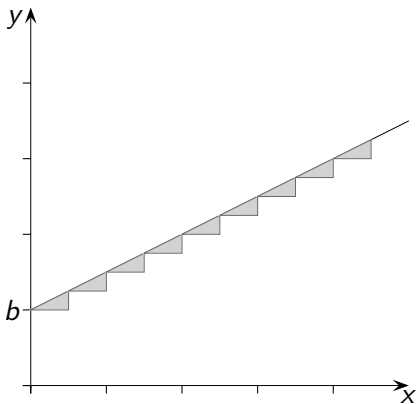
$$f'(x) = m$$

$$f(x) =$$



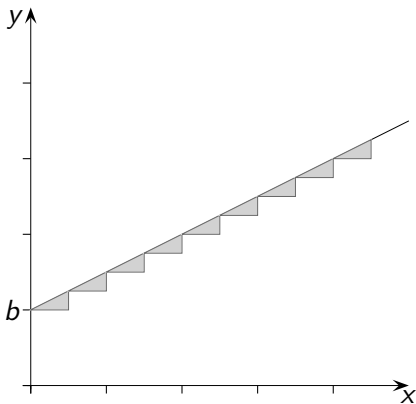
$$f'(x) = m$$

$$f(x) = mx + b$$



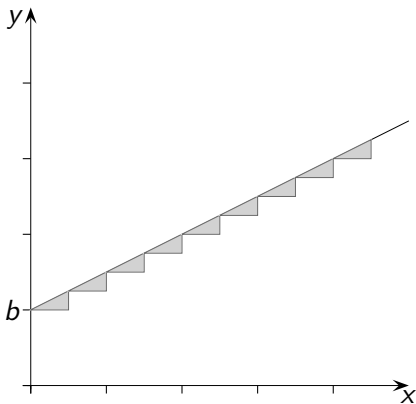
$$f'(x) = m$$

$$f(x) = mx + b \quad \text{mit } f(0) =$$



$$f'(x) = m$$

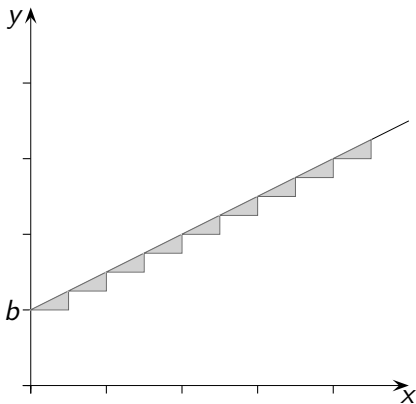
$$f(x) = mx + b \quad \text{mit } f(0) = b$$



$$f'(x) = m$$

$$f(x) = mx + b \quad \text{mit } f(0) = b$$

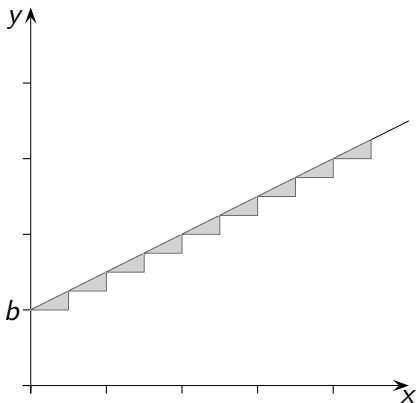
Lineares Wachstum,



$$f'(x) = m$$

$$f(x) = mx + b \quad \text{mit } f(0) = b$$

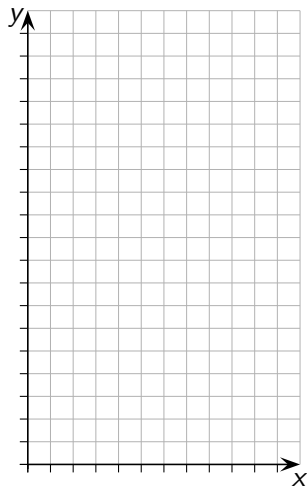
Lineares Wachstum, die Änderung ist

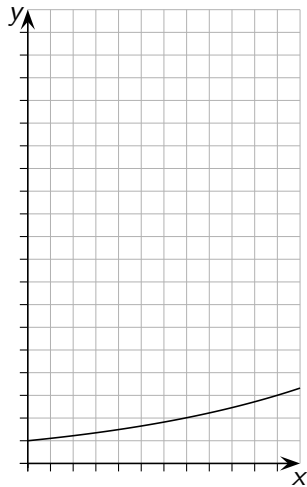


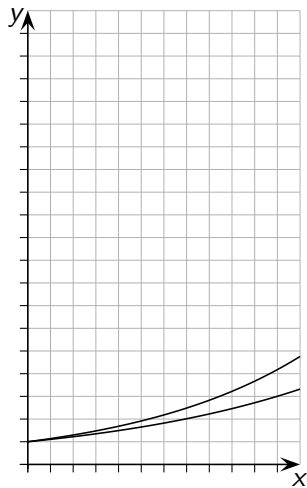
$$f'(x) = m$$

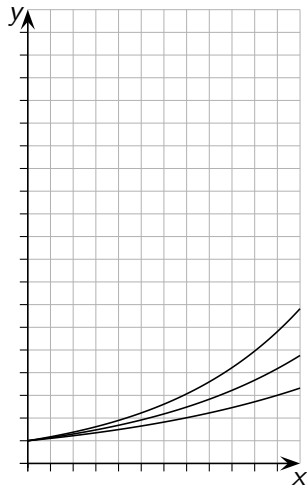
$$f(x) = mx + b \quad \text{mit } f(0) = b$$

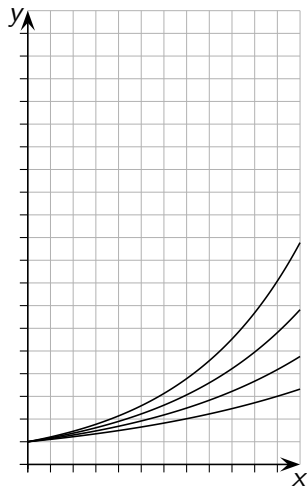
Lineares Wachstum, die Änderung ist konstant.

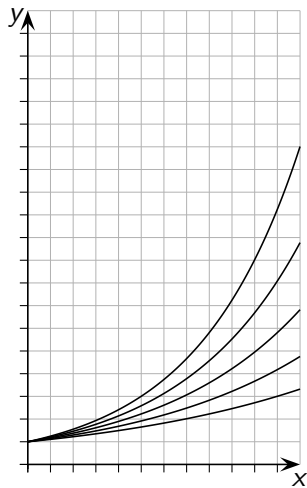


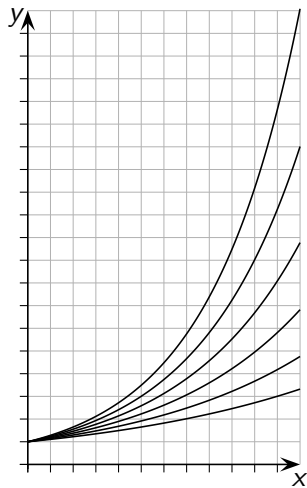




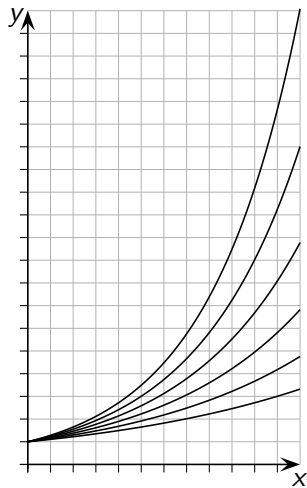




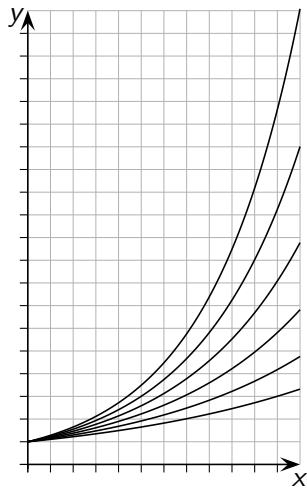




$$f'(x) =$$

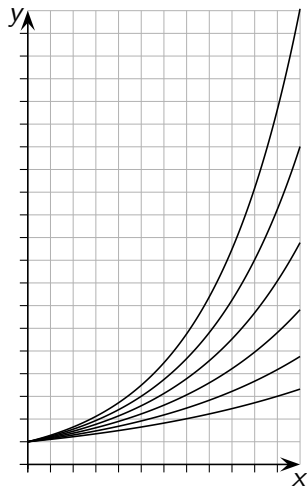


$$f'(x) = k \cdot f(x)$$



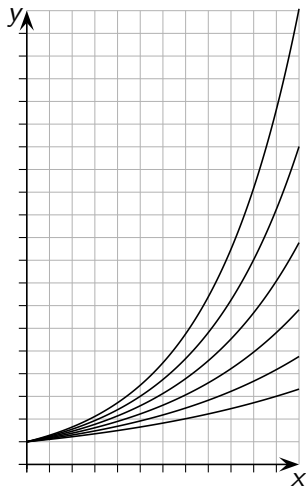
$$f'(x) = k \cdot f(x)$$

$$f(x) =$$



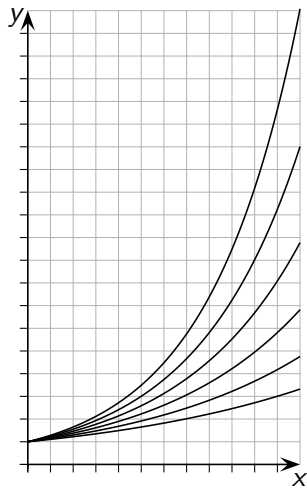
$$f'(x) = k \cdot f(x)$$

$$f(x) = a e^{kx}$$



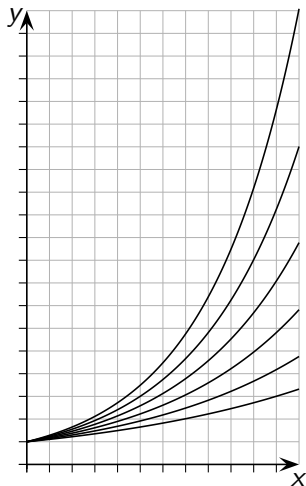
$$f'(x) = k \cdot f(x)$$

$$f(x) = a e^{kx} \text{ mit } f(0) =$$



$$f'(x) = k \cdot f(x)$$

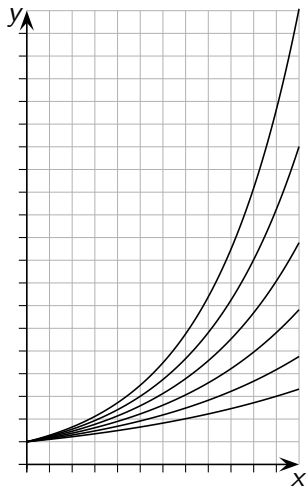
$$f(x) = a e^{kx} \text{ mit } f(0) = a$$



$$f'(x) = k \cdot f(x)$$

Exponentielles Wachstum,

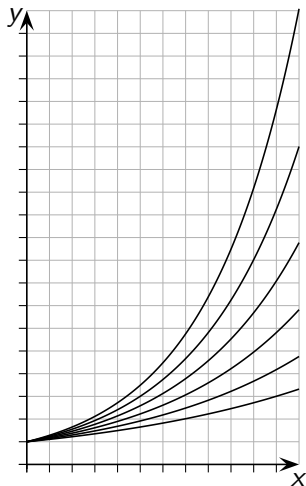
$$f(x) = a e^{kx} \text{ mit } f(0) = a$$



$$f'(x) = k \cdot f(x)$$

$$f(x) = a e^{kx} \text{ mit } f(0) = a$$

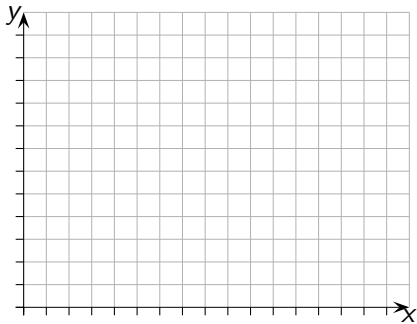
Exponentielles Wachstum, der Zuwachs ist

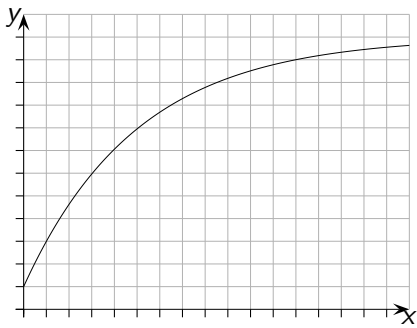


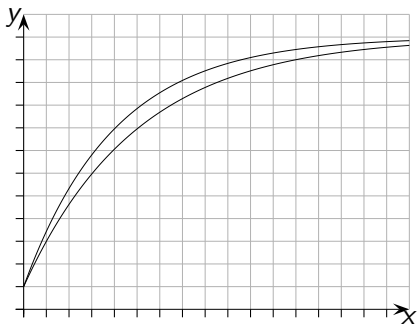
$$f'(x) = k \cdot f(x)$$

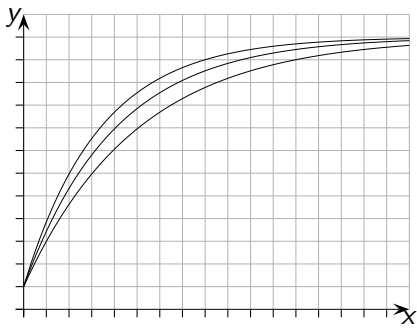
$$f(x) = a e^{kx} \text{ mit } f(0) = a$$

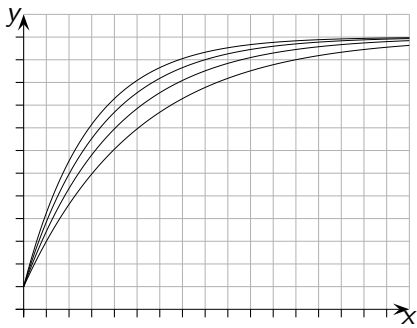
Exponentielles Wachstum, der Zuwachs ist proportional zum Bestand.

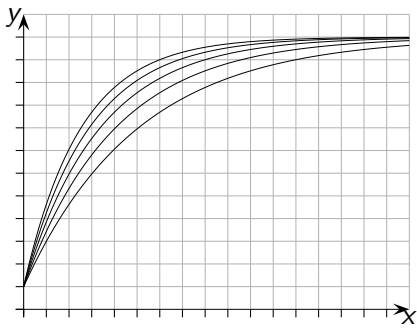


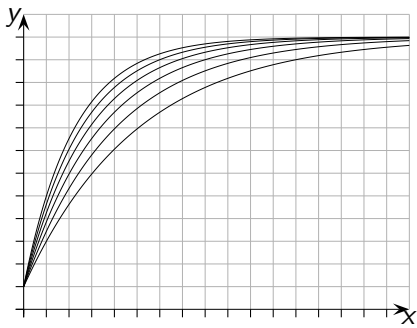


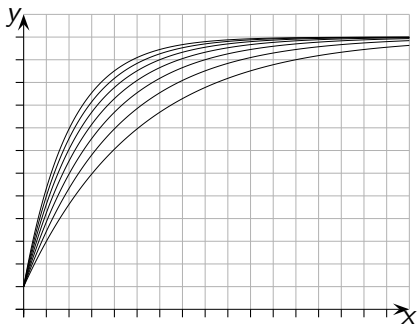


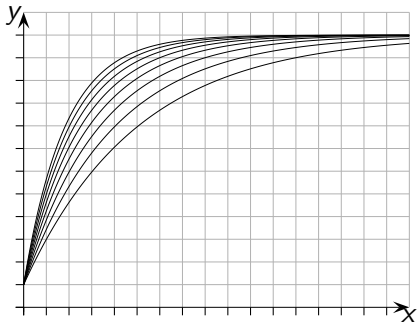


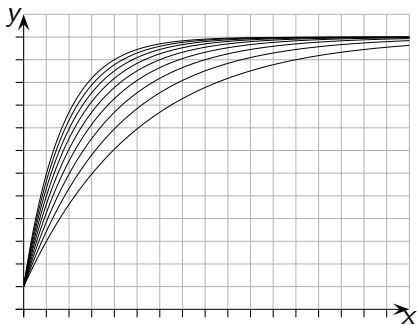




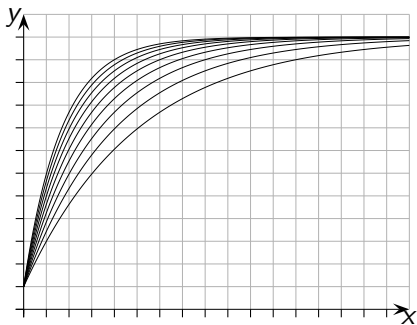




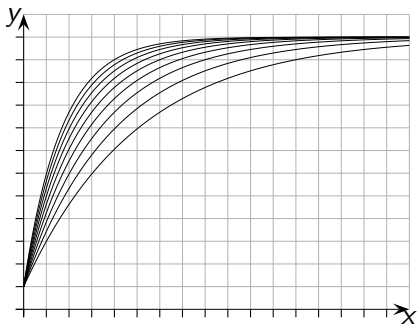




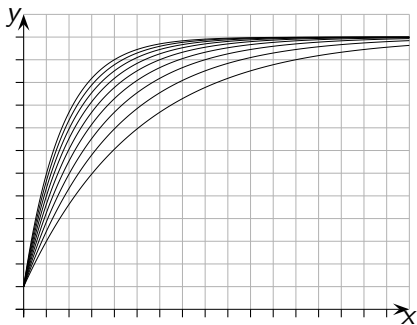
$$f'(x) =$$



$$f'(x) = k \cdot (G - f(x))$$

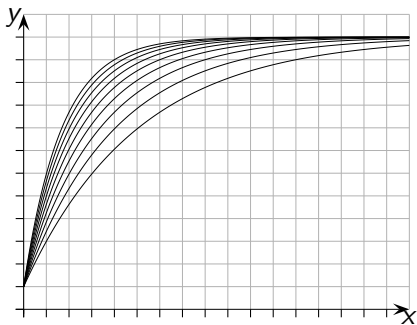


$$f'(x) = k \cdot (G - f(x)) \quad f(x) =$$



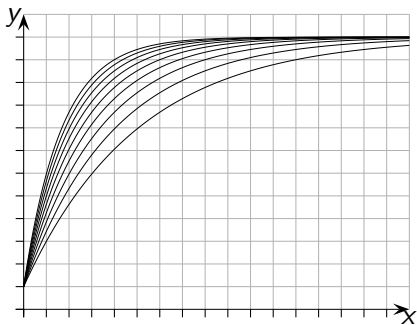
$$f'(x) = k \cdot (G - f(x))$$

$$f(x) = G - a e^{-kx}$$



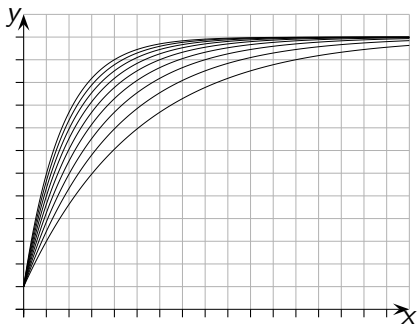
$$f'(x) = k \cdot (G - f(x))$$

$$f(x) = G - a e^{-kx} \text{ mit } f(0) =$$



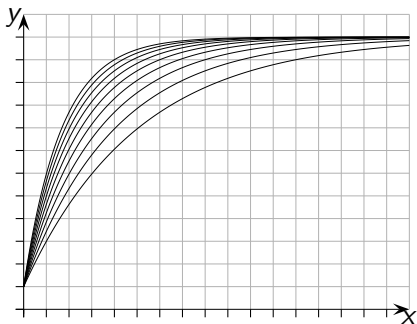
$$f'(x) = k \cdot (G - f(x))$$

$$f(x) = G - a e^{-kx} \text{ mit } f(0) = G - a$$



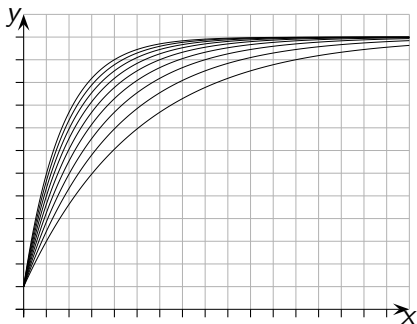
$$f'(x) = k \cdot (G - f(x)) \quad f(x) = G - a e^{-kx} \text{ mit } f(0) = G - a$$

Begrenztes (beschränktes) Wachstum,



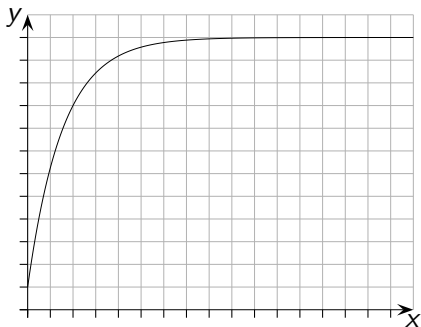
$$f'(x) = k \cdot (G - f(x)) \quad f(x) = G - a e^{-kx} \quad \text{mit } f(0) = G - a$$

Begrenztes (beschränktes) Wachstum,
der Zuwachs ist

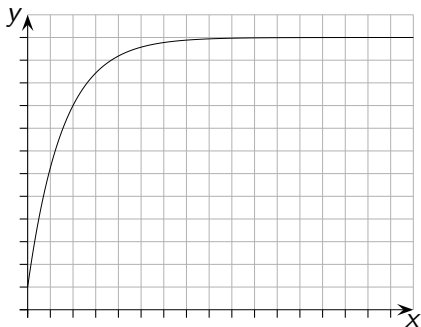


$$f'(x) = k \cdot (G - f(x)) \quad f(x) = G - a e^{-kx} \quad \text{mit } f(0) = G - a$$

Begrenztes (beschränktes) Wachstum,
 der Zuwachs ist proportional zum Sättigungsmanko
 (Differenz: Grenze G minus Bestand).



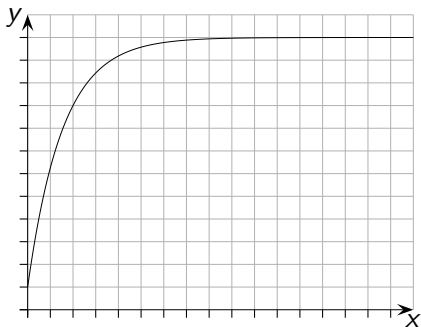
$$f'(x) = k \cdot (G - f(x))$$



$$f'(x) = k \cdot (G - f(x))$$

$$f(x) =$$

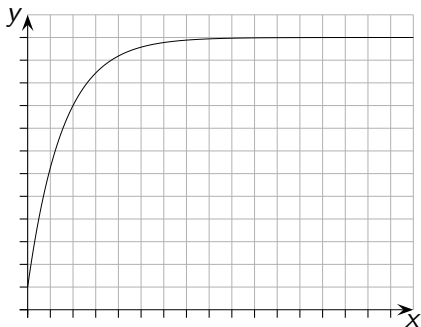
Begrenztes Wachstum, 2. Sichtweise (Klammern werden aufgelöst)



$$f'(x) = k \cdot (G - f(x))$$

$$f(x) = G - \underbrace{(G - f(0))}_a e^{-kx}$$

$$f'(x) =$$

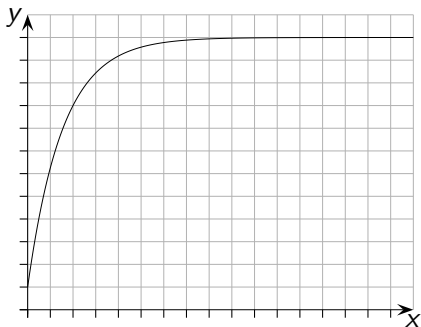


$$f'(x) = k \cdot (G - f(x))$$

$$f(x) = G - \underbrace{(G - f(0))}_a e^{-kx}$$

$$f'(x) = \underbrace{k \cdot G}_m - k \cdot f(x)$$

Begrenztes Wachstum, 2. Sichtweise (Klammern werden aufgelöst)

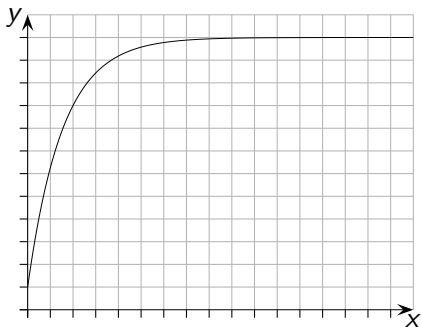


$$f'(x) = k \cdot (G - f(x))$$

$$f'(x) = \underbrace{k \cdot G}_m - k \cdot f(x)$$

$$f(x) = G - \underbrace{(G - f(0))}_a e^{-kx}$$

$$f(x) =$$

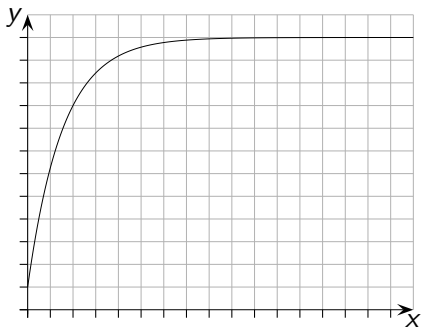


$$f'(x) = k \cdot (G - f(x))$$

$$f'(x) = \underbrace{k \cdot G}_m - k \cdot f(x)$$

$$f(x) = G - \underbrace{(G - f(0))}_a e^{-kx}$$

$$f(x) = \frac{m}{k} - \dots$$



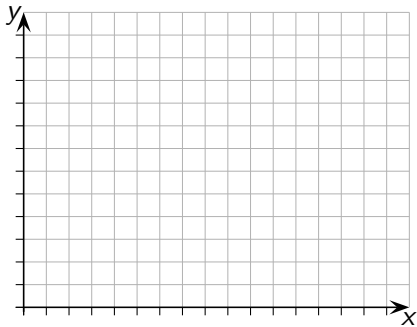
$$f'(x) = k \cdot (G - f(x))$$

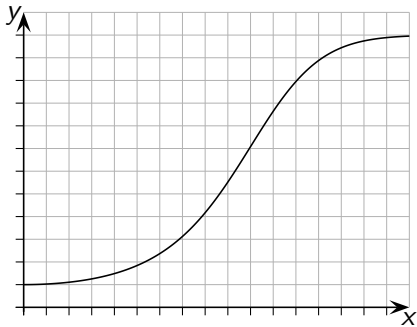
$$f(x) = G - \underbrace{(G - f(0))}_a e^{-kx}$$

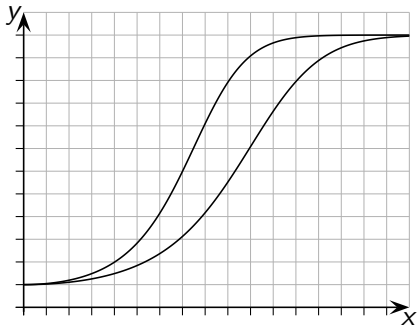
$$f'(x) = \underbrace{k \cdot G}_m - k \cdot f(x)$$

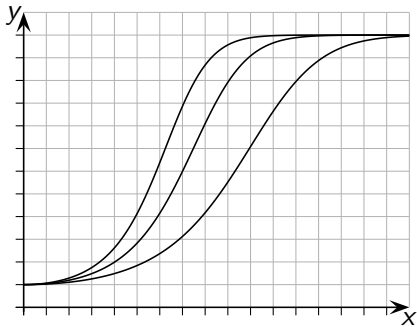
$$f(x) = \frac{m}{k} - \dots$$

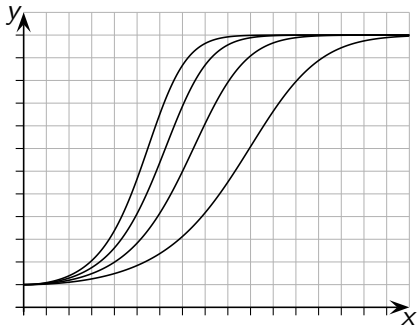
Ein konstanter Zuwachs wird um einen zum Bestand proportionalen Betrag verringert (siehe Tropfinfusion).

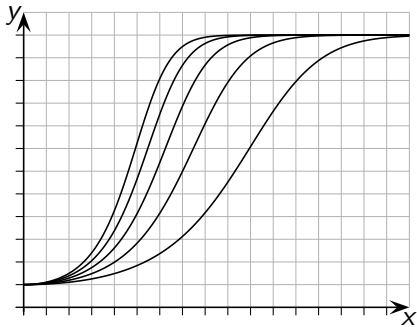


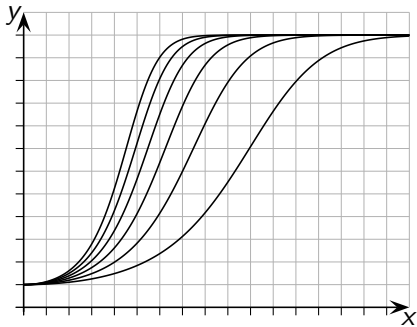


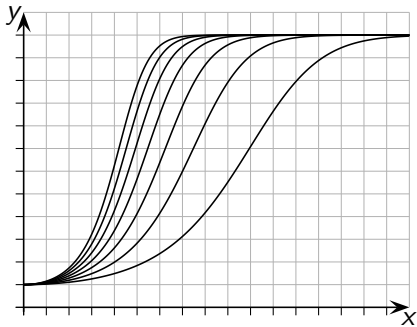


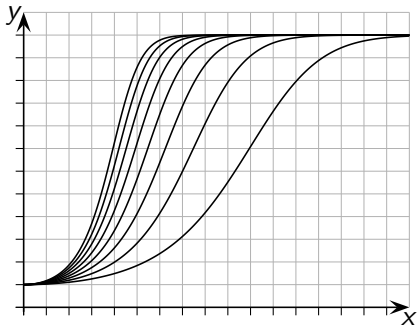


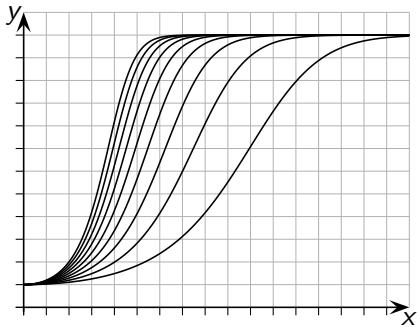


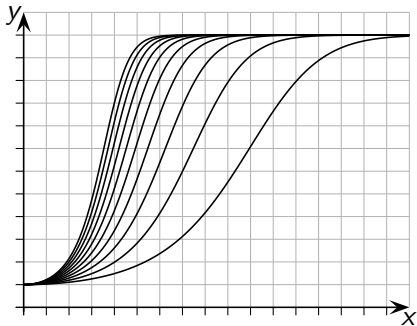




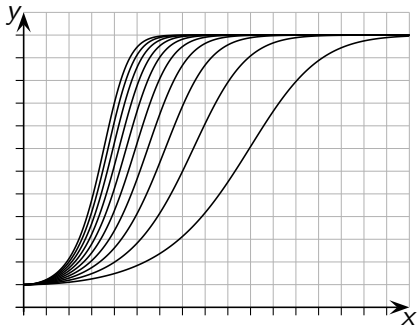






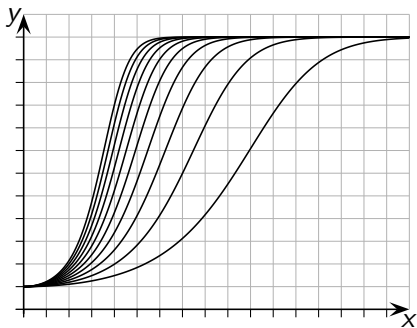


$$f'(x) =$$



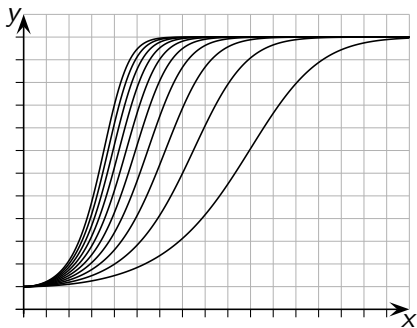
$$f'(x) = k \cdot (G - f(x)) \cdot f(x)$$

$$f(x) =$$



$$f'(x) = k \cdot (G - f(x)) \cdot f(x)$$

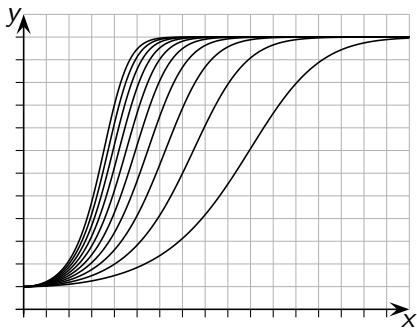
$$f(x) = \frac{G}{1 + ae^{-kGx}}, \quad a = \frac{G - f(0)}{f(0)}$$



$$f'(x) = k \cdot (G - f(x)) \cdot f(x)$$

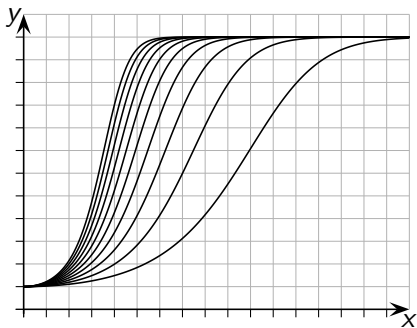
$$f(x) = \frac{G}{1 + ae^{-kGx}}, \quad a = \frac{G - f(0)}{f(0)}$$

Logistisches Wachstum,



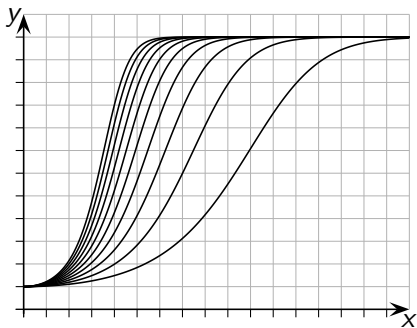
$$f'(x) = k \cdot (G - f(x)) \cdot f(x) \qquad f(x) = \frac{G}{1 + a e^{-kGx}}, \quad a = \frac{G - f(0)}{f(0)}$$

Logistisches Wachstum, der Zuwachs ist



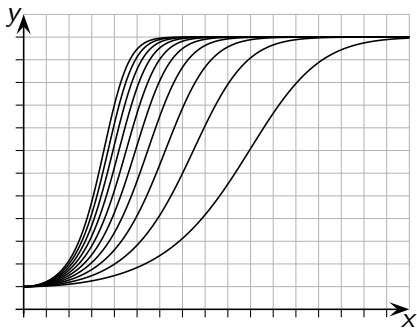
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Logistisches Wachstum, der Zuwachs ist proportional zum



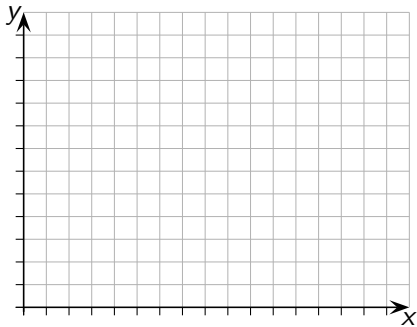
$$f'(x) = k \cdot (G - f(x)) \cdot f(x) \qquad f(x) = \frac{G}{1 + a e^{-kGx}}, \quad a = \frac{G - f(0)}{f(0)}$$

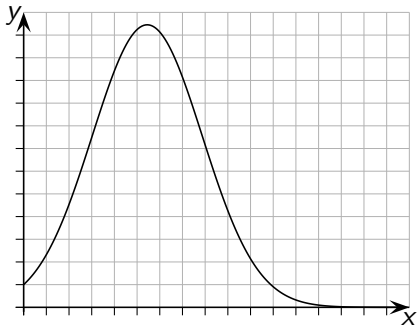
Logistisches Wachstum, der Zuwachs ist proportional zum Bestand und zum

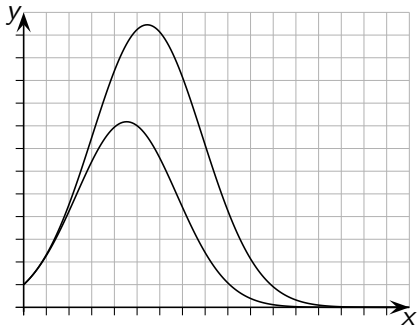


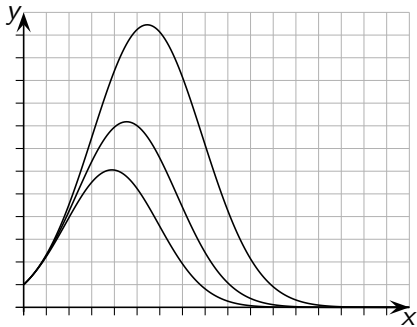
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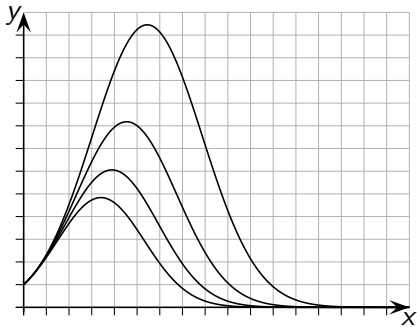
Logistisches Wachstum, der Zuwachs ist proportional zum Bestand und zum Sättigungsmanko (Differenz: Grenze G minus Bestand).

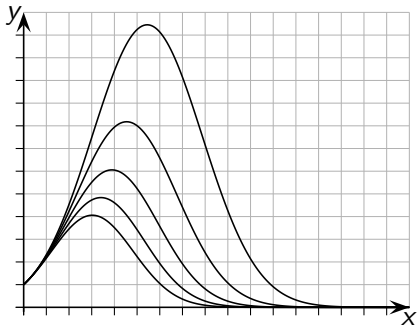


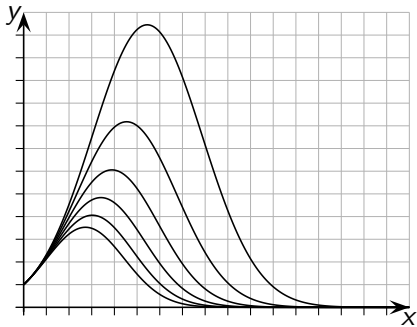


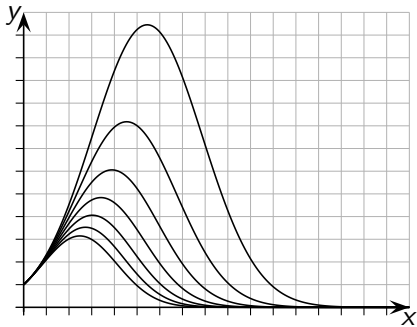


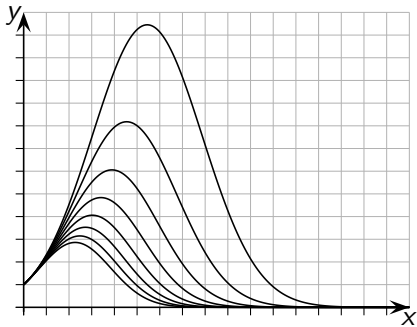


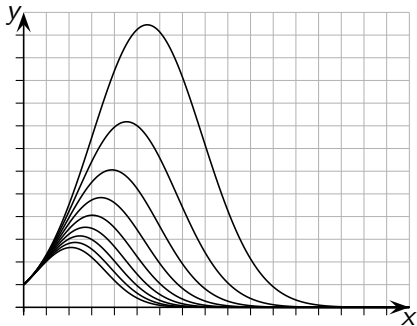




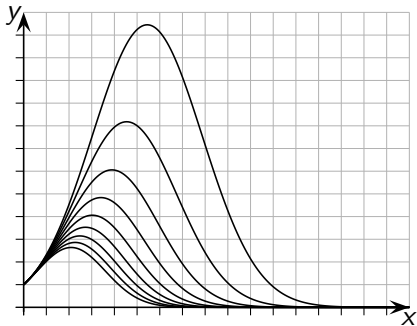






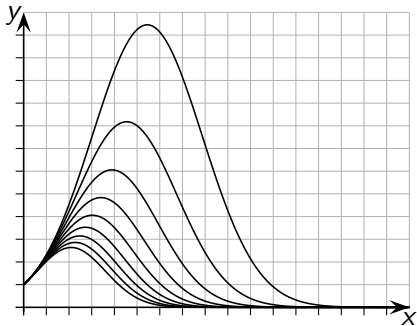


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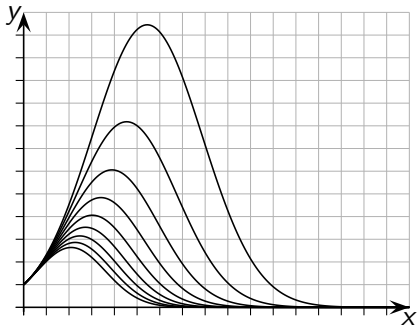
$$f(x) = a e^{gx - \frac{1}{2}sx^2}$$



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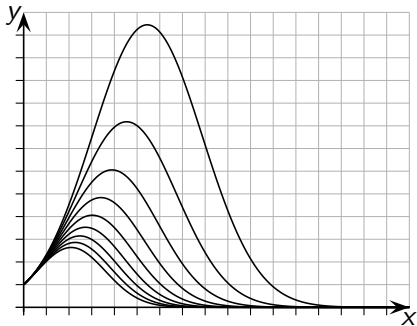
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Vergiftetes Wachstum,



$$f'(x) = (g - sx) \cdot f(x) \qquad f(x) = a e^{gx - \frac{1}{2}sx^2}$$

Vergiftetes Wachstum, g der Wachstumsfaktor



$$f'(x) = (g - sx) \cdot f(x) \qquad f(x) = a e^{gx - \frac{1}{2}sx^2}$$

Vergiftetes Wachstum, der Wachstumsfaktor nimmt mit der Zeit ab.