

Sales decline

If sales of a product are consistently declining at an exponential rate, we can model that decline with the formula

$$F = Pe^{rt}$$

where P is the number of items being sold, r is the rate of decline, and F is the number of items being sold after sales have continued to decline for some specified amount of time t .

It's important to remember that the rate r and the time t need to have complementary units. For instance, if r is given as some rate per *month*, then time t needs to be measured in *months*. If r is in years, then t should also be in years.

When the units of rate and time don't match, we'll need to convert one to match the other. So, for example, if r was given as a rate per year, and t was given in months, we could either divide t by 12 to convert it into years to match the rate, or we could multiply r by 12 to convert it into months to match the time.

Let's work through an example where we solve for the rate of decline.

Example

Sales of Isaac Newton bobbleheads have decreased over the last 4 years. Four years ago, 285,674 bobbleheads were sold, but over the last year, sales were only 97,546 bobbleheads. Assuming that sales have declined at a steady exponential rate, what is the rate of decline?



We know that fourth year sales are $F = 97,546$, and that first year sales were $P = 285,674$. Time is $t = 4$ and, we need to calculate r , so we'll substitute what we know into the sales decline formula.

$$F = Pe^{rt}$$

$$97,546 = 285,674e^{r(4)}$$

Solve for r .

$$\frac{97,546}{285,674} = e^{4r}$$

$$0.3415 = e^{4r}$$

$$\ln 0.3415 = \ln(e^{4r})$$

$$-1.075 = 4r$$

$$r = -0.269$$

This result tells us that sales of Isaac Newton bobbleheads have declined at an annual rate of about $r = -0.269$, or $r = -26.9\%$ per year.

We'll do one more example, and in this one we'll use the exponential model we come up with to predict the future sales decline of a product.

Example



One year ago, a company sold 5,698 disposable sandwich bags in a month. But over the last 12 months, sales have decreased at a steady exponential rate of -0.015 per month. How many disposable sandwich bags did the company sell last month, and how many are predicted to sell in 6 months from now?

The rate of decline is $r = -0.015$, the original amount from one year ago (12 months ago) was $P = 5,698$. Therefore, we could say that last month is at $t_{\text{last month}} = 12$, and 6 months from now is $t_{\text{in 6 months}} = 18$.

We'll substitute into the sales decline formula to find sales for last month.

$$F = Pe^{rt}$$

$$F_{\text{last month}} = 5,698e^{-0.015(12)}$$

$$F_{\text{last month}} = 4,759.37$$

In the past month, about 4,759 units of disposable sandwich bags were sold. Now we'll calculate expected sales for 6 months from now.

$$F_{\text{in 6 months}} = 5,698e^{-0.015(18)}$$

$$F_{\text{in 6 months}} = 4,349.74$$

Assuming the rate of decline remains the same, in 6 months from now, the company will sell about 4,350 disposable sandwich bags.

