

Precalc 11.3

Use the exponential
function $y=e^x$

exponential change

growth $k > 0$

decay $k < 0$

irrational

e

Exponential
Growth or
Decay
(in terms of e)

$N = N_0 e^{kt}$, where N is the final amount, N_0 is the initial amount, k is a constant and t is time.

9. **Physics** Newton's Law of Cooling expresses the relationship between the temperature of a cooling object y and the time t elapsed since cooling began. This relationship is given by $y = ae^{-kt} + c$, where c is the temperature of the medium surrounding the cooling object, a is the difference between the initial temperature of the object and the surrounding temperature, and k is a constant related to the cooling object.

a. The initial temperature of a liquid is 160°F . When it is removed from the heat, the temperature in the room is 76°F . For this object, $k = 0.23$. Find the temperature of the liquid after 15 minutes.

b. Alex likes his coffee at a temperature of 135° . If he pours a cup of 170°F coffee in a 72°F room and waits 5 minutes before drinking, will his coffee be too hot or too cold? Explain. For Alex's cup, $k = 0.34$.

☺ 135

$-kt \leftarrow + \text{time}$

$$y = a e^{-kt} + c$$

$\uparrow$ temp $\uparrow$ orig-room $\uparrow$ room

$$\begin{aligned}
 y &= 84e^{-0.23 \cdot 15} + 76 \\
 &= 84(0.0317) + 76 \\
 &= 78.2^\circ
 \end{aligned}$$

$$\begin{aligned}
 135 &= 98e^{-0.34 \cdot 5} + 72 \\
 &\approx 90
 \end{aligned}$$

3. **Describe** a situation that could be modeled by the equation $A = 3000e^{0.05t}$

6. **Demographics** Bakersfield, California was founded in 1859 when Colonel Thomas Baker planted ten acres of alfalfa for travelers going from Visalia to Los Angeles to feed their animals. The city's population can be modeled by the equation $y = 33,430e^{0.0397t}$, where t is the number of years since 1950.
- Has Bakersfield experienced growth or decline in population?
 - What was Bakersfield's population in 1950?
 - Find the projected population of Bakersfield in 2010.

$$y = 33430e^{0.0397 \cdot 60}$$

861,931

EXERCISES

8. **Psychology** Without further study, as time passes you forget things you have learned. The Ebbinghaus model of human memory gives the percent p of acquired knowledge that a person retains after t weeks. The formula is $p = (100 - 18e^{-bt}) + a$, where a and b vary from one person to another. If $a = 18$ and $b = 0.6$ for a certain student, how much information will the student retain two weeks after learning a new topic?

$$P = (100 - 18)e^{-0.6 \cdot 2}$$

WB 11-3