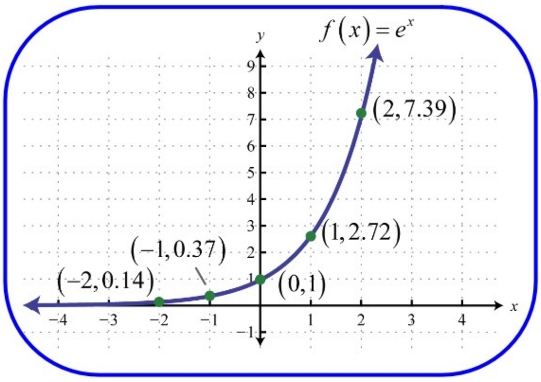
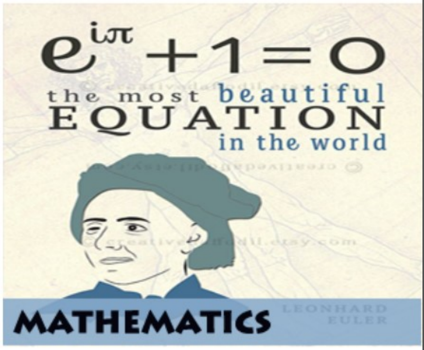
The Base *e*

Objectives To explore the properties of functions of the form $y = ab^x$
To graph exponential functions that have base e





Sometimes called "Euler's Number" after Swiss Mathematican Leonhard Euler, ***e*** is an irrational number that is approximately 2.718.

Even though e is an irrational number, it can be used as the base of an exponential function. The number e is sometimes called the natural base of an exponential function and is used extensively in scientific and other applications involving exponential growth and decay.

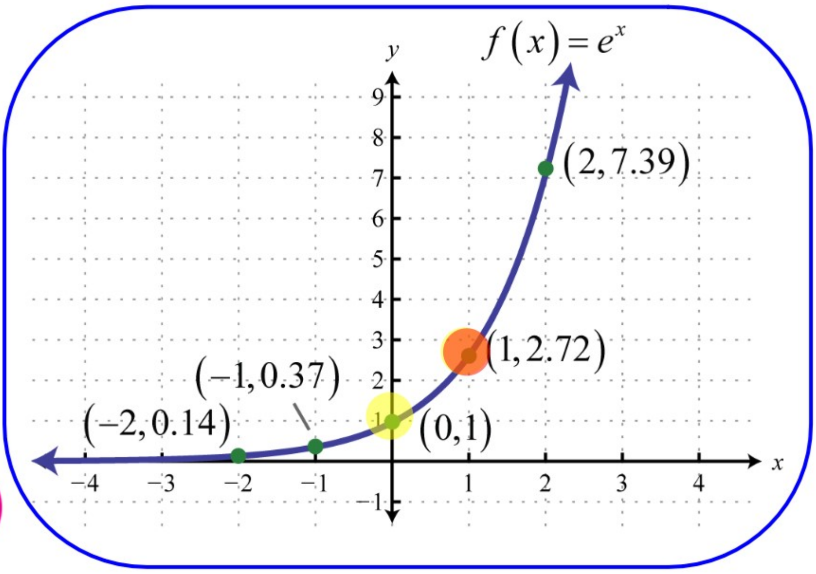
The Base *e*

Domain: $\{x \mid -\infty < x < \infty\}$.

Range: $\{y \mid y > 0\}$.

The asymptote : $y = 0$

The reference points : $(0, 1), (1, e)$



e is usually approximated to 2.72

The Base *e*

Graphing Combined Transformations of $f(x) = e^x$

When graphing combined transformations of $f(x) = e^x$ that result in the function $g(x) = a \cdot e^{x-h} + k$, it helps to focus on two reference points on the graph of $f(x)$, $(0, 1)$ and $(1, e)$, as well as on the asymptote $y = 0$. The table shows these reference points and the asymptote $y = 0$ for $f(x) = e^x$ and the corresponding points and asymptote for the transformed function, $g(x) = a \cdot e^{x-h} + k$.

	Parent function $f(x) = e^x$	*Transformation* $g(x) = a \cdot e^{x-h} + k$
First reference point	$(0, 1)$	$(h, a + k)$
Second reference point	$(1, e)$	$(h + 1, ae + k)$
Asymptote	$y = 0$	$y = k$

The Base *e*

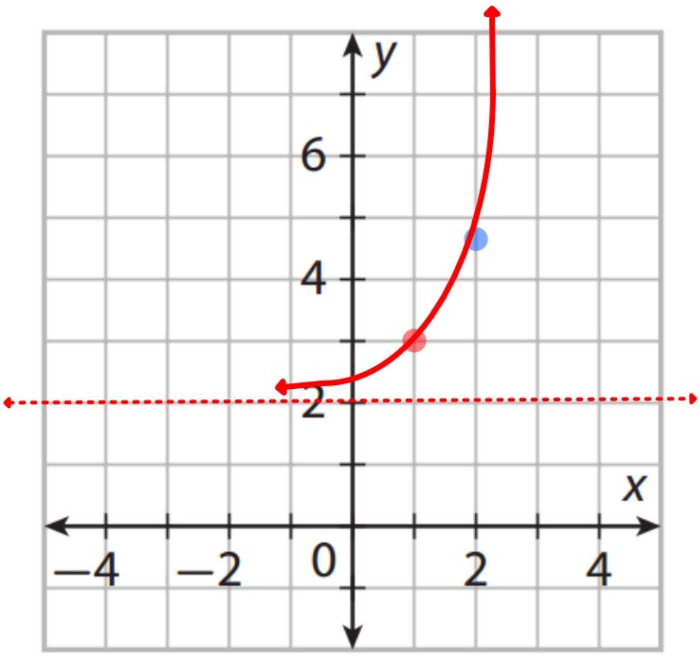
Graphing and Analyzing $g(x) = e^{x-1} + 2$

first reference point

$(h, a + k)$ ***(1, 3)***

$(1 + h, ae + k)$ ***(2, 2e + 2)***

second reference point



The Base *e*

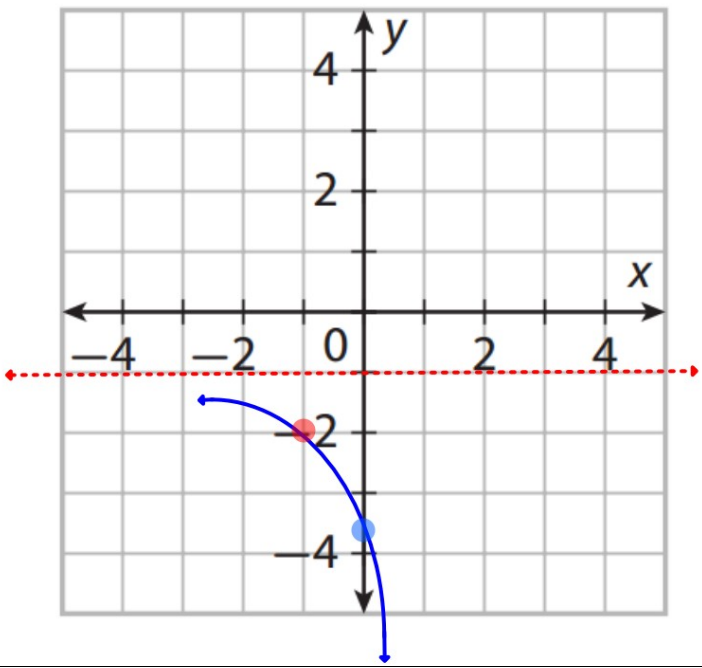
Graphing and Analyzing $g(x) = -e^{x+1} - 1$

first reference point

$\left(h, a + k\right)$ ***(-1, -2)***

$\left(1 + h, ae + k\right)$ ***(0, -e - 1)***

second reference point



The Base e

Writing Equations for Combined Transformations of $f(x) = e^x$

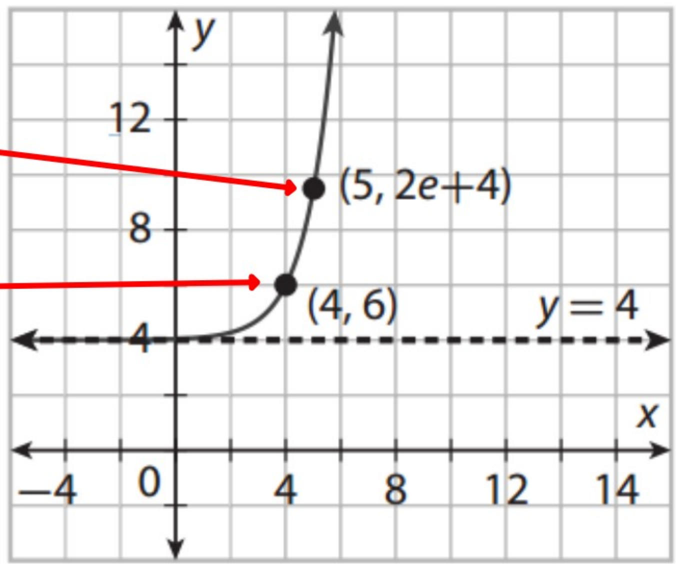
$$g(x) = a \cdot e^{x-h} + k$$

second reference point

$\left(1 + h, ae + k\right)$

$\left(h, a + k\right)$

first reference point

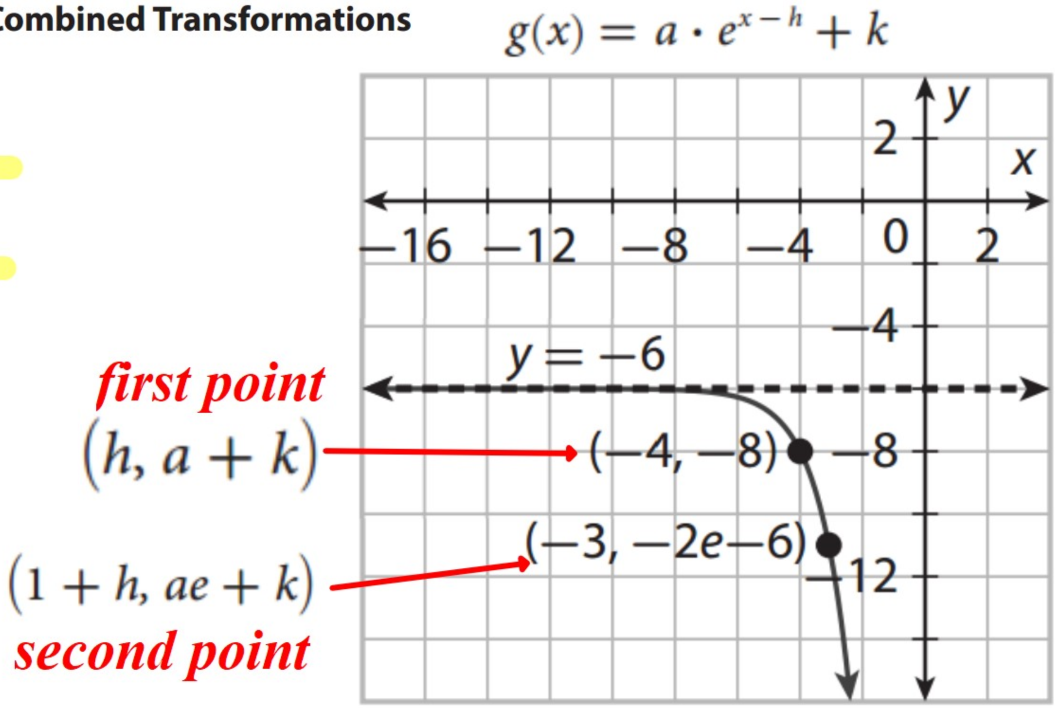


$$g(x) = 2e^{x-4} + 4$$

The Base e

Writing Equations for Combined Transformations of $f(x) = e^x$

$g(x) = -2e^{x+4} - 6$



The Base e

take note

Key Concept Continuously Compounded Interest

$$A(t) = P \cdot e^{rt}$$

- amount in account at time t
- interest rate (annual)
- Principal
- time in years

Scholarships Suppose you won a contest at the start of 5th grade that deposited $3000 in an account that pays 5% annual interest compounded continuously. How much will you have in the account when you enter high school 4 years later? Express the answer to the nearest dollar.

The Base *e*

Scholarships **Suppose you won a contest at the start of 5th grade that deposited $3000 in an account that pays 5% annual interest compounded continuously. How much will you have in the account when you enter high school 4 years later? Express the answer to the nearest dollar.**

$$A = P \cdot e^{rt}$$

Plug & Chug!

$= 3000e^{(0.05)(4)}$ Substitute values for P, r, and t.

$= 3000e^{0.2}$ Simplify.

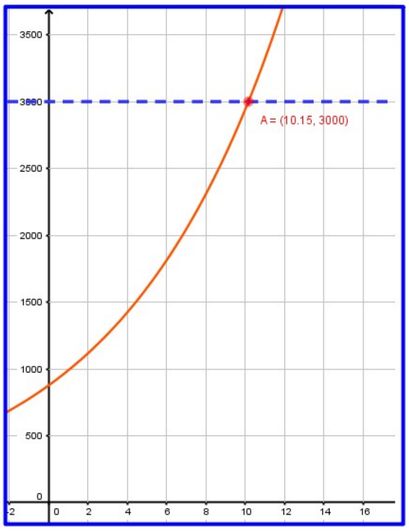
≈ 3664 Use a calculator. Round to the nearest dollar.

The amount in the account, to the nearest dollar, is $3664.
Write your answer, 3664 in the grid.

The Base e

Modeling with Exponential Functions Having Base e

The Dow Jones index is a stock market index for the New York Stock Exchange. The Dow Jones index for the period 1980-2000 can be modeled by $V_{DJ}(t) = 878e^{0.121t}$, where t is the number of years after 1980. Determine how many years after 1980 the Dow Jones index reached 3000.



$$3000 = 878\left(e^{0.121}\right)^t$$

The value of the function is about 3000 when $x \approx 10.2$. So, the Dow Jones index reached 3000 after 10.2 years, or after the year 1990.

The Base *e*

Any Questions ?

The Base *e*

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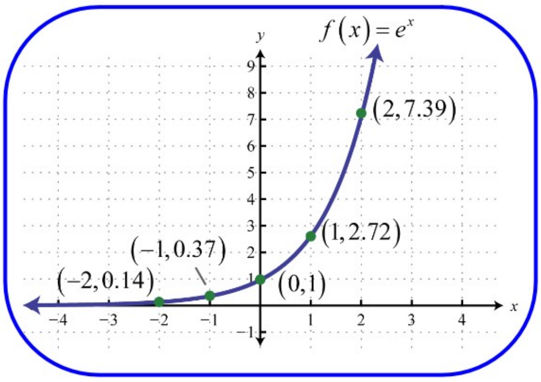

Classwork

Worksheet 13.3

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