What Is Calculus?
It is a branch of mathematical analysis developed during the 17th-19th centuries that develops computational techniques for the study of changing quantities. In modern formulations, these quantities are described in terms of functions.

Calculus consists of two parallel theories:
• the differential calculus develops the concept of the derivative, which measures the way in which functions change;
• the integral calculus develops the concept of the integral, which measures the way in which changes in quantities accumulate.

The Fundamental Theorem of Calculus (formulated around 1700 by Isaac Newton and Gottfried Leibniz) describes a deep connection between these concepts.
Mathematical Modeling
mathematical tools for describing, explaining, and predicting real phenomena by abstracting relevant features we wish to quantify in tables, graphs and formulas

Functions
• the fundamental objects that calculus operates with
• extremely versatile concept for mathematical modeling, especially for describing quantifiable change over time

A function is a rule that associates to every possible value of one variable quantity, called the input (or independent) variable, a unique value of another variable quantity, the output (or dependent) variable.

The Function “Machine”
Functions can be represented in four basic forms:

- **verbally**: by describing (in language) what output value is to be associated to each input value
- **numerically**: in the form of a two-column table that displays inputs and associated outputs
- **graphically**: on a coordinate plane in which the horizontal axis measures input values and the vertical axis measures output values; the \((x, y)\)-coordinate values of each of the finitely many points in a scatter plot, or of a line or curve (containing infinitely many points) displays every possible pair of inputs \((x)\) and associated outputs \((y)\) of the function
- **symbolically**: by means of a formula, having the general form \(y = f(x)\), where \(f(x)\) stands for an algebraic expression (or possibly a number of expressions) that tells one how to compute an output \(y\) for each input \(x\).
Function tables (numerical representation) are common models of real phenomena. Take care to always include appropriate units of measure when dealing with such numbers. The units of measure capture the important meaning of the mathematics (and sometimes indicate the appropriate methods for dealing with them).

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When displaying graphs of functions (graphical representation) as models of real phenomena, always label axes with a description of what that variable measures and include a scale appropriate to the model. This conveys the meaning of the plot.

[TI-83: blue keys (Y=, STATPLOT, WINDOW, ZOOM, TRACE, GRAPH) are for creating and using graphs]

A graph describes a function when every input has only one output (Vertical Line Test).

A function is
- **increasing** when the graph rises left-to-right,
- **decreasing** when the graph falls left-to-right,
- **constant** when the graph is horizontally flat.
When representing a function symbolically, we use notation like

$$A(t) = 128.57(1.035^t)$$

to indicate that outputs $A(t)$ are computed from inputs $t$ by using the formula on the right side of the equation.