

13.4: Linear Equations

Linear regression for two variables is based on a linear equation with one independent variable. The equation has the form:

$$y = a + bx \quad (13.4.1)$$

where a and b are constant numbers.

The **variable x is the independent variable, and y is the dependent variable**. Another way to think about this equation is a statement of cause and effect. The X variable is the cause and the Y variable is the hypothesized effect. Typically, you choose a value to substitute for the independent variable and then solve for the dependent variable.

? Exercise 13.4.1

The following examples are linear equations.

$$\begin{aligned} y &= 3 + 2x \\ y &= -0.01 + 1.2x \end{aligned} \quad (13.4.2)$$

Try It 13.4.1

Is the following an example of a linear equation?

$$y = -0.125 - 3.5x \quad (13.4.3)$$

The graph of a linear equation of the form $y = a + bx$ is a **straight line**. Any line that is not vertical can be described by this equation.

? Exercise 13.4.2

Graph the equation $y = -1 + 2x$.

Answer

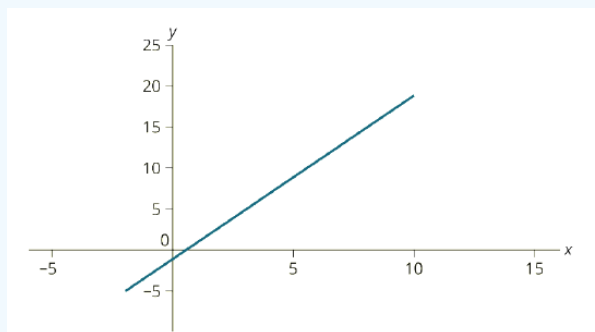


Figure \(\backslash\PageIndex{1}\backslash\)

Try It 13.4.2

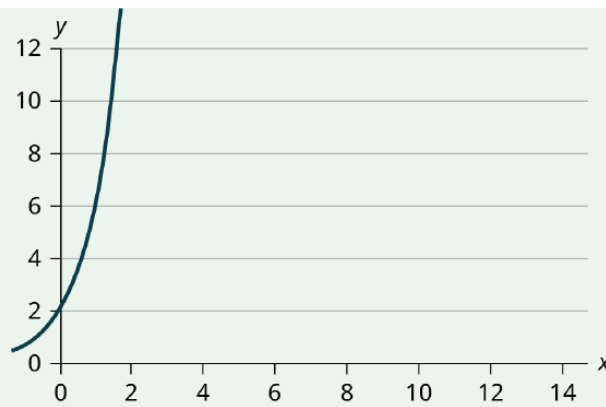


Figure 13.4.2: Is the following an example of a linear equation? Why or why not?

? Exercise 13.4.3

A local small business completes federal tax returns for customers. The rate for services is \$32 per hour plus a \$31.50 one-time charge. The total cost to a customer depends on the number of hours it takes to complete the job.

Problem

Find the equation that expresses the **total cost** in terms of the **number of hours** required to complete the job.

Answer

Let x = the number of hours it takes to get the job done.

Let y = the total cost to the customer.

The \$31.50 is a fixed cost. If it takes x hours to complete the job, then $(32)(x)$ is the cost of the tax return processing only. The total cost is: $y = 31.50 + 32x$

Try It 13.4.3

Emma's Extreme Sports hires hang-gliding instructors and pays them a fee of \$50 per class as well as \$20 per student in the class. The total cost Emma pays depends on the number of students in a class. Find the equation that expresses the total cost in terms of the number of students in a class.

For the linear equation $y = a + bx$, b = slope and a = y -intercept. From algebra recall that the slope is a number that describes the steepness of a line, and the y -intercept is the y coordinate of the point $(0, a)$ where the line crosses the y -axis. From calculus the slope is the first derivative of the function. For a linear function the slope is $dy/dx = b$ where we can read the mathematical expression as "the change in $y(dy)$ that results from a change in $x(dx) = b * dx$ ".

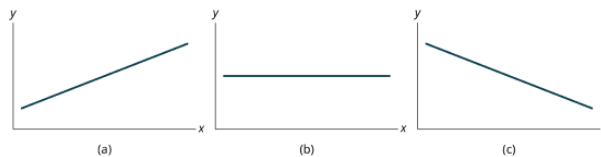


Figure 13.4.3: Three possible graphs of $y = a + bx$. (a) If $b > 0$, the line slopes upward to the right. (b) If $b = 0$, the line is horizontal. (c) If $b < 0$, the line slopes downward to the right.

? Exercise 13.4.4

Svetlana tutors to make extra money for college. For each tutoring session, she charges a one-time fee of \$25 plus \$15 per hour of tutoring. A linear equation that expresses the total amount of money Svetlana earns for each session she tutors is $y = 25 + 15x$.

Problem

What are the independent and dependent variables? What is the y -intercept and what is the slope? Interpret them using complete sentences.

Answer

The independent variable (x) is the number of hours Svetlana tutors each session. The dependent variable (y) is the amount, in dollars, Svetlana earns for each session.

The y -intercept is 25 ($a = 25$). At the start of the tutoring session, Svetlana charges a one-time fee of \$25 (this is when $x = 0$). The slope is 15 ($b = 15$). For each session, Svetlana earns \$15 for each hour she tutors.

Try It 13.4.3

Ethan repairs household appliances like dishwashers and refrigerators. For each visit, he charges \$25 plus \$20 per hour of work. A linear equation that expresses the total amount of money Ethan earns per visit is $y = 25 + 20x$.

What are the independent and dependent variables? What is the y -intercept and what is the slope? Interpret them using complete sentences.

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