1 Functions and Models

1.4 Graphing Calculators and Computers

Graphing Calculators and Computers

Graphing calculators and computers can give very accurate graphs of functions.

A graphing calculator or computer displays a rectangular portion of the graph of a function in a **display window** or **viewing screen**, which we refer to as a **viewing rectangle**.

The default screen often gives an incomplete or misleading picture, so it is important to choose the viewing rectangle with care.

Graphing Calculators and Computers

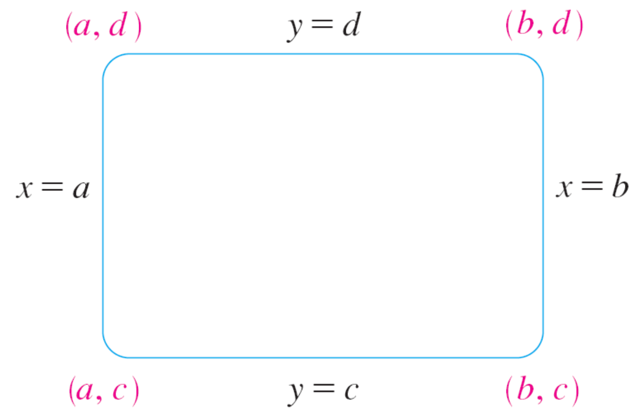
If we choose the x-values to range from a minimum value of $X min = a$ to a maximum value of $X max = b$ and the y-values to range from a minimum of $Y min = c$ to a maximum of $Y max = d$, then the visible portion of the graph lies in the rectangle

$$[a, b] \times [c, d] = \{(x, y) \mid a \leq x \leq b, c \leq y \leq d\}$$

shown in Figure 1.

We refer to this rectangle as the

[a, b] by [c, d] viewing recta



The viewing rectangle [a, b] by [c, d]

Figure 1

Graphing Calculators and Computers

The machine draws the graph of a function *f* much as you would.

It plots points of the form $(x, f(x))$ for a certain number of equally spaced values of *x* between *a* and *b*.

If an *x*-value is not in the domain of *f*, or if $f(x)$ lies outside the viewing rectangle, it moves on to the next *x*-value.

The machine connects each point to the preceding plotted point to form a representation of the graph of *f*.

Example 1

Draw the graph of the function $f(x) = x^2 + 3$ in each of the following viewing rectangles.

(a) [–2, 2] by [–2, 2]

(b)(b) [–4, 4] by [–4, 4]

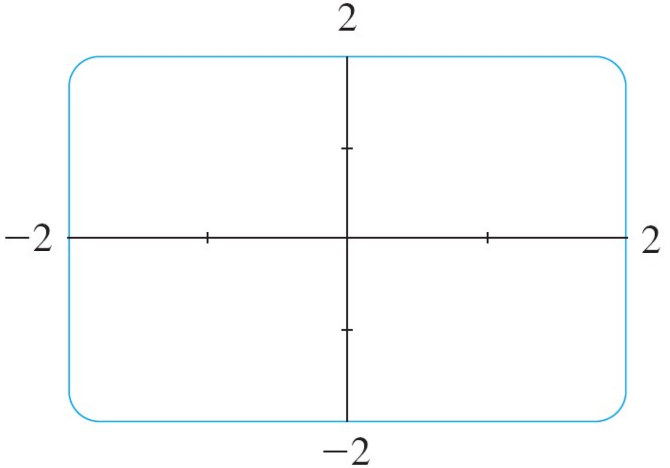
(c) [–10, 10] by [–5, 30]

(d) [–50, 50] by [–100, 1000]

Example 1 – *Solution*

For part (a) we select the range by setting $X\,min = -2$, $X\,max = 2$, $Y\,min = -2$, and $Y\,max = 2$.

The resulting graph is shown in Figure 2(a). The display window is blank!



[–2, 2] by [–2, 2]

Graph of $f(x) = x^2 + 3$

Figure 2(a)

Example 1 – *Solution*

A moment's thought provides the explanation: Notice that $x^2 \geq 0$ for all x, so $x^2 + 3 \geq 3$ for all x.

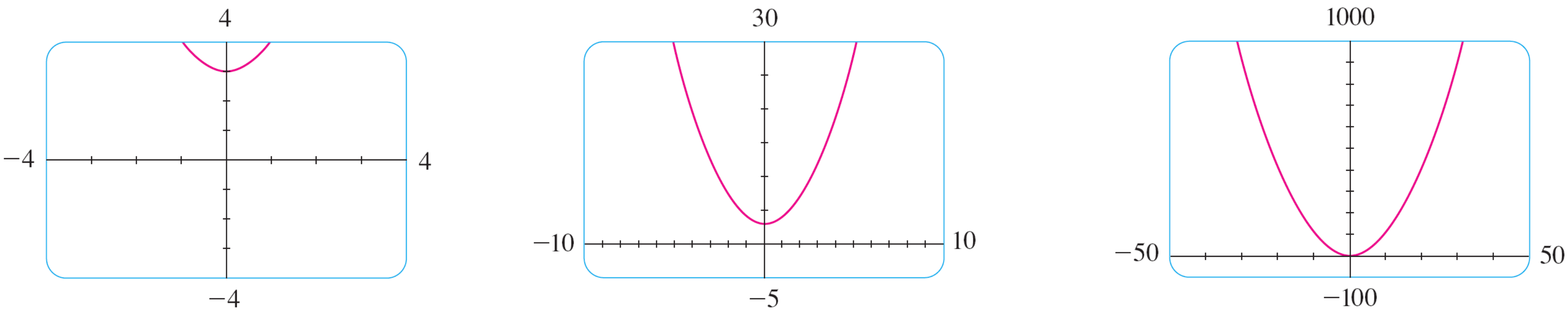
Thus the range of the function $f(x) = x^2 + 3$ is $[3, \infty)$.

This means that the graph of f lies entirely outside the viewing rectangle [–2, 2] by [–2, 2].

Example 1 – *Solution*

cont'd

The graphs for the viewing rectangles in parts (b), (c), and (d) are also shown in Figure 2.



(b) [–4, 4] by [–4, 4]

(c) [–10, 10] by [–5, 30]

(d) [–50, 50] by [–100, 1000]

Graphs of $f(x) = x^2 + 3$

Figure 2

Observe that we get a more complete picture in parts (c) and (d), but in part (d) it is not clear that the *y*-intercept is 3.

Graphing Calculators and Computers

To understand how the expression for a function relates to its graph, it’s helpful to graph a **family of functions**, that is, a collection of functions whose equations are related.

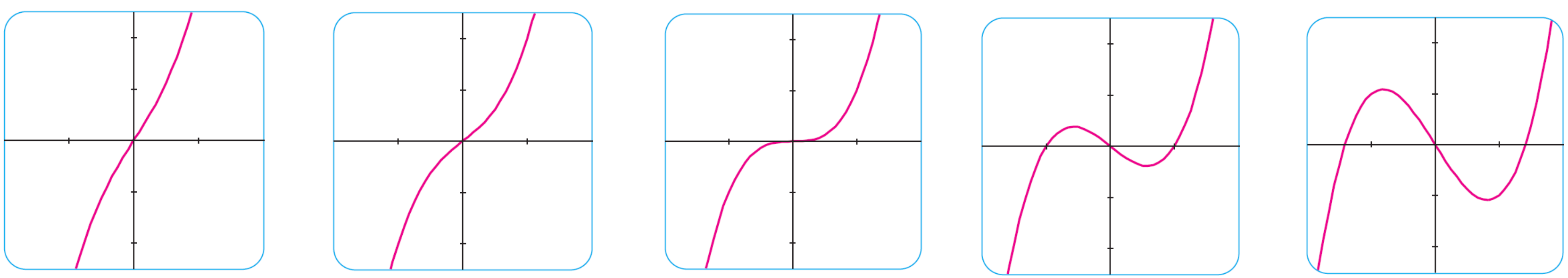
In the next example we graph members of a family of cubic polynomials.

Example 8

Graph the function $y = x^3 + cx$ for various values of the number c. How does the graph change when c is changed?

Solution:

Figure 13 shows the graphs of $y = x^3 + cx$ for $c = 2, 1, 0, -1$, and -2.



(a) $y = x^3 + 2x$ (b) $y = x^3 + x$ (c) $y = x^3$ (d) $y = x^3 - x$ (e) $y = x^3 - 2x$

Several members of the family of functions $y = x^3 + cx$, all graphed in the viewing rectangle $[-2, 2]$ by $[-2.5, 2.5]$

Figure 13

Example 8 – *Solution*

cont'd

We see that, for positive values of c, the graph increases from left to right with no maximum or minimum points (peaks or valleys).

When $c = 0$, the curve is flat at the origin.

When c is negative, the curve has a maximum point and a minimum point.

As c decreases, the maximum point becomes higher and the minimum point lower.