# 3.1 EXPONENTIAL FUNCTIONS

**EXAMPLE A** Sketch the graph of the function $y = 3 - 2^x$ and determine its domain and range.

■ For a review of reflecting and shifting graphs, see Section 1.2.

**SOLUTION** First we reflect the graph of $y = 2^x$ [shown in Figure 1(a)] about the $x$-axis to get the graph of $y = -2^x$ in Figure 1(b). Then we shift the graph of $y = -2^x$ upward 3 units to obtain the graph of $y = 3 - 2^x$ in Figure 1(c). The domain is $\mathbb{R}$ and the range is $(-\infty, 3)$.

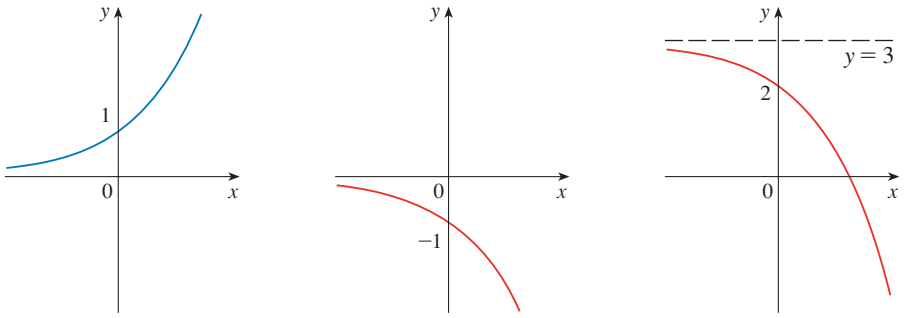


**FIGURE 1** (a) $y = 2^x$ (b) $y = -2^x$ (c) $y = 3 - 2^x$ ■

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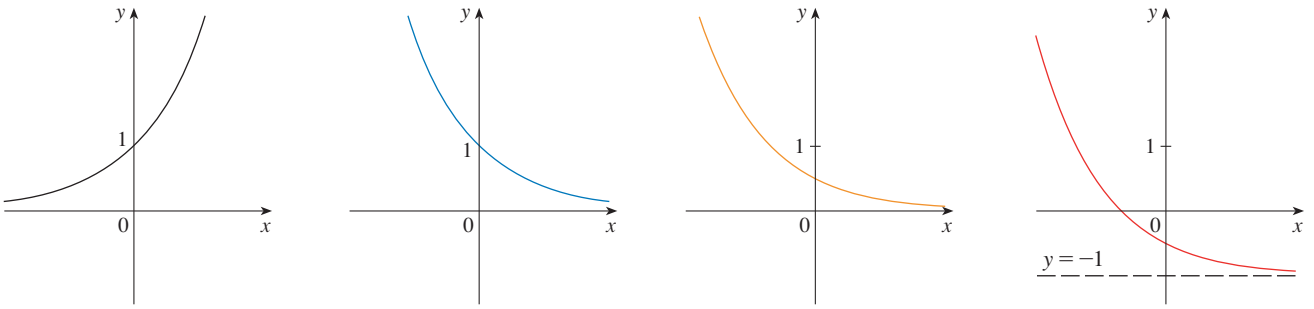
**EXAMPLE B** Graph the function $y = \frac{1}{2}e^{-x} - 1$ and state the domain and range.

**SOLUTION** We start with the graph of $y = e^x$ from Figure 2(a) and reflect about the $y$-axis to get the graph of $y = e^{-x}$ in Figure 2(b). (Notice that the graph crosses the $y$-axis with a slope of $-1$). Then we compress the graph vertically by a factor of 2 to obtain the graph of $y = \frac{1}{2}e^{-x}$ in Figure 2(c). Finally, we shift the graph downward one unit to get the desired graph in Figure 2(d). The domain is $\mathbb{R}$ and the range is $(-1, \infty)$.




(a) $y = e^x$ (b) $y = e^{-x}$ (c) $y = \frac{1}{2}e^{-x}$ (d) $y = \frac{1}{2}e^{-x} - 1$

**FIGURE 2** ■