EXPONENTIAL DECAY When a quantity decays exponentially, it decreases by the same percent over equal time periods. To find the amount of the quantity left after t time periods, use the following model.

KEY CONCEPT *For Your Notebook*

Exponential Decay Model

a is the **initial amount**. r is the **decay rate**.

$$y = a(1 - r)^t$$

$1 - r$ is the **decay factor**. t is the **time period**.

REWRITE EQUATIONS
Notice that you can rewrite $y = ab^x$ as $y = a(1 - r)^t$ by replacing b with $1 - r$ and x with t (for time).

The relationship between the decay rate r and the decay factor $1 - r$ is similar to the relationship between the growth rate and growth factor in an exponential growth model. You will explore this relationship in Exercise 45.

EXAMPLE 5 TAKS REASONING: Multi-Step Problem

FORESTRY The number of acres of Ponderosa pine forests decreased in the western United States from 1963 to 2002 by 0.5% annually. In 1963 there were about 41 million acres of Ponderosa pine forests.

a. Write a function that models the number of acres of Ponderosa pine forests in the western United States over time.

b. To the nearest tenth, about how many million acres of Ponderosa pine forests were there in 2002?

Solution

a. Let P be the number of acres (in millions), and let t be the time (in years) since 1963. The initial value is 41, and the decay rate is 0.005.

$P = a(1 - r)^t$ Write exponential decay model.

$= 41(1 - 0.005)^t$ Substitute 41 for a and 0.005 for r.

$= 41(0.995)^t$ Simplify.

AVOID ERRORS
The decay rate in this example is 0.5%, or 0.005. So, the decay factor is $1 - 0.005$, or 0.995, not 0.005.

b. To find the number of acres in 2002, 39 years after 1963, substitute 39 for t.

$P = 41(0.995)^{39} \approx 33.7$ Substitute 39 for t. Use a calculator.

▶ There were about 33.7 million acres of Ponderosa pine forests in 2002.

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GUIDED PRACTICE for Example 5

5. WHAT IF? In Example 5, suppose the decay rate of the forests remains the same beyond 2002. About how many acres will be left in 2010?