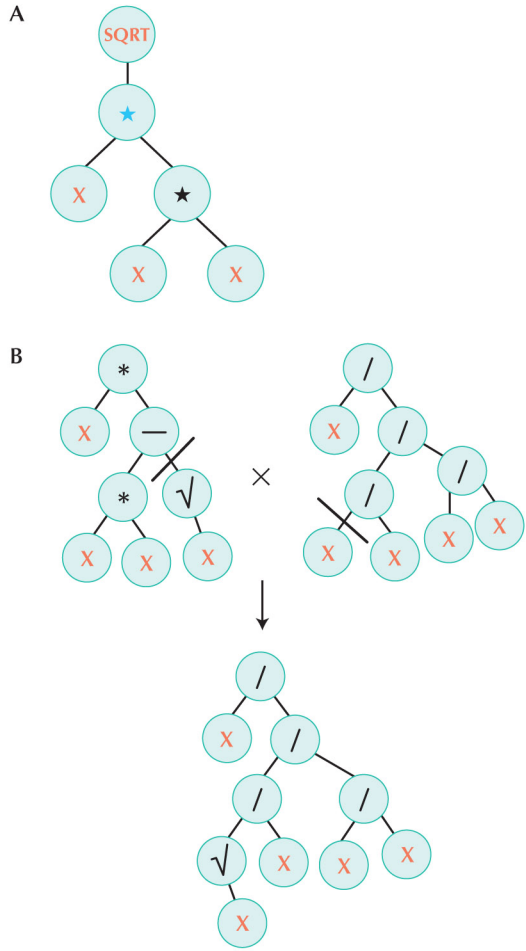

FIGURE 24.27. Kepler's third law states that the square of the orbital period of a planet P is proportional to the cube of its average distance from the sun, X, to within a constant: $P = X^{3/2}$. In a conventional programming language such as Fortran, this relation would appear as a string of characters, P = SQRT(X*X*X). Making random changes to each character (e.g., changing SQRT to SRT or deleting a parenthesis) would produce uninterpretable code. However, the relation also can be represented as a tree, with each node representing a computation on the two descendant branches. Now, random changes between legitimate values at the nodes (e.g., from * to +) or recombinations that splice together different trees will still make sense. (*B*) For example, how recombination between expressions representing $X*(X^2 - X)$ and $X/((X/X)/(X/X))$ gives an "offspring" representing $X/((X/X)/(X/X))$. If fitness increases as the expression becomes closer to the correct function (*A*), then selection, mutation, and recombination will cause a population of initially random trees to approach the solution shown in *A*.

24.27, modified from Mitchell M., *An Introduction to Genetic Algorithms*, pp. 36–39, © 1998 MIT Press