Math Diversion 1050

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March 4, 2026

The law is what we live with, Inspector.
Justice is sometimes harder to achieve
— Sherlock Holmes (Jeremy Brett)
[Episode *The Red Circle*]

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Source: https://www.algebra.com/algebra
Title:  Solution by tree (Question 10300)
 Presenter: Patrick
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1 Problem

Mary bought some donuts. She gave 1/2 her donuts and 1/2 a donut to her mom. Then she gave away 1/2 her remaining donuts and 1/2 a donut to her aunt. Then she gave 1/2 of her remaining donuts and 1/2 a donut to her sister, Kathy. This left her with 1/4 of a dozen donuts. How many doughnuts had she bought? [Ans. 31]

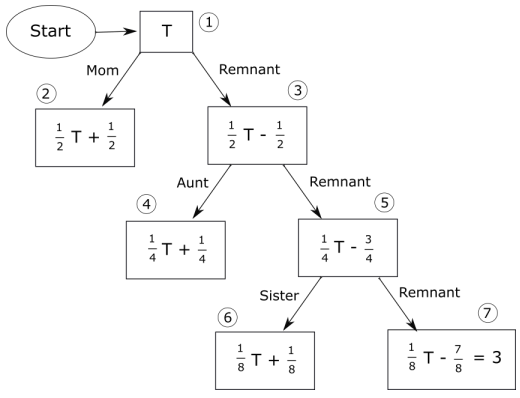

Figure 1. The donut tree.

2 Solution

Let's look at the graphic in Figure 1. We start with an unknown amount of T donuts and use the given information to work our way down the tree structure. At each level below the top level, we first compute the amount given to a relative and then the remnant is given by

$$\text{Remnant} = (\text{Amount in previous node}) - (\text{Amount given to relative})\,. \quad (1)$$

For example: To compute the first remnant at Point 3, we first compute the amount given to Mom, which is $\frac{1}{2}T + \frac{1}{2}$, and then subtract that amount from the previous node in the tree, which is

$$\text{Remnant at Point } 3 = T - (\tfrac{1}{2}T + \tfrac{1}{2}) = \tfrac{1}{2}T - \tfrac{1}{2}\,. \quad (2)$$

So, we keep giving out donuts to appreciative relatives, computing the remnant as we go, until we run out of relatives. That final remnant is calculated and set equal to three. From the remnant node at Point 7 in the figure, we see that $\frac{1}{8}T - \frac{7}{8} = 3$. Solving for T, we find that Mary started with 31 donuts.