Pasta Cooking

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1 Concepts and Usage

Separable first-order differential equations, best for Math 125 weeks 8 or 9

2 Introduction

The equation $\frac{dh}{dt} = kh(1 - \frac{h}{K})$ can be used to represent pasta density over time in minutes, where h is equal to the mass in grams divided by the length of pasta in centimeters. The following values were determined for the density of the pasta initially, at 7 minutes, and the value as t approaches infinity (K).

h(0) = 1.4, h(7) = 0.59, K = 0.5

3 Questions

1. Write an equation h(t) to represent the density of the pasta at any given time in the cooking process.
2. If the pasta is fully cooked at 8 minutes, at what time is the pasta half cooked?
3.If the K value of a different pasta was found to be 0.4 instead of 0.5, how long should it be cooked to achieve the same density of the original cooked pasta?

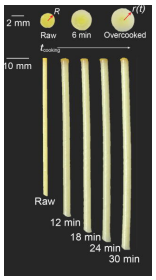

Figure 1: Image taken from the article "Swelling, softening, and elastocapillary adhesion of cooked pasta" 2022 by Hwang et. al.

4 Solution to Question 1

$\frac{dh}{dt} = kh(1 - \frac{h}{K})$
$\frac{dh}{h(1-\frac{h}{K})} = (k)dt$
$\ln \frac{h}{K-h} = kt + C$
$\frac{h}{K-h} = e^C e^{kt}$
$e^C = A$
$\frac{h}{K-h} = Ae^{kt}$
$h = \frac{AKe^{kt}}{1+Ae^{kt}}$
$A = \frac{h(0)}{K-h(0)} \approx -1.56$
$0.59 = \frac{(-1.56)(0.5)e^{k(7)}}{1-1.56e^{k(7)}}$
$k \approx 0.206$
$h(t) = \frac{-0.78e^{0.206t}}{1-1.56e^{0.206t}}$