Determining the half life of beer

Introduction
Beer foam is in essence a large number of bubbles that support each other and thus have a certain volume that over time 'pop'. As a result the foam volume decreases over time

This beer foam therefore 'decays' over a period of time after the beer has been poured, but what is the **trend** of decay?

In this experiment, you will be measuring the rate of decay of beer foam by measuring the height of the foam with respect to time.

Equipment
- 200ml beer (less is required but allows for repetition)
- 100ml measuring cylinder
- Ruler (optional)
- Stop watch

Method
1. Pour ~40ml of beer into the measuring cylinder. (You need to ensure the top of the foam does not extend beyond the 100ml mark. Therefore the amount may vary due to pouring technique and temperature of the beer)
2. Measure both the top and bottom reading of the foam, and immediately record the difference for t = 0 s
3. Measure both the top and bottom every 30s until the foam is for practical purpose, gone, and record in a table
4. Draw a graph of the foam height vs time.

Part 1

1. From the graph what does the trend show?
2. There are some uncertainties in the data collected. What factors contributed to these uncertainties?
3. From the graph determine the time taken for half of the initial foam to decay.
4. Double the time you have just recorded. What is this the volume amount at this time
5. Triple the time from Q3. What is the amount left. What trend do you see?
6. What is therefore time taken for half the sample to decay over the full period of time?

Part 2

The decay of the beer foam follows a a negative exponential decay

$$N = N_0\, e^{-\lambda t} \qquad \lambda = \frac{ln2}{t_{1/2}}$$

where

N = the amount remaining
N_0 = the original amount
t = time
λ = decay constant

You will determining the half life from the graph by calculating the decay constant

1. Modify your data table to include $\frac{N}{N_0}$

2. Since $\frac{N}{N_0} = e^{-\lambda t}$, then $\ln(\frac{N}{N_0}) = -\lambda t$

3. Now graph $\ln(\frac{N}{N_0})$ vs time, and determine the slope
4. From the slope determine the half life.
5. How does this compare to the value you determined in part 1?
   Discuss some reasons for any differences.

Final questions

1. How does this model radioactive decay?
2. Discuss some limitations to this model.
3. What are some further inquiry questions that can be addressed using this technique?

Some references

- PhysicsHigh Half Life of beer video - www.physicshigh.com/nuclear.html#8
- A Leike - 2002 Ig Nobel prize for beer decay
  https://www.tf.uni-kiel.de/matwis/amat/iss/kap_2/articles/beer_article.pdf