Decay Lab

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1 Introduction

Radioactive decay, also known as nuclear decay or radioactivity, is the process by which a nucleus of an unstable atom loses energy by emitting radiation.

Many real world phenomena can be modeled by functions that describe how things grow or decay as time passes. Examples of such phenomena include the studies of populations, bacteria, the AIDS virus, radioactive substances, electricity, temperatures and credit payments, to mention a few. Any quantity that grows or decays by a fixed percent at regular intervals is said to possess exponential growth or exponential decay.

2 Objective

Explore the behavior of radioactive decay. Specifically we look at exponential decay of different quantities of atoms. The procedure involves the analysis of the time it takes for their maximum points to reach their minimum points. We obtain the number of time steps for each quantity by estimating the probability of decay for each trial.

3 Definitions

Exponential growth - this occurs when the growth rate of the value of a mathematical function is proportional to the function's current value, resulting in its growth with time being an exponential function. Exponential decay occurs in the same way when the growth rate is negative. In the case of a discrete domain of definition with equal intervals, it is also called geometric growth or geometric decay, the function values forming a geometric progression.

4 Data Analysis

Initial Number of Atoms	Probability of Decay	Number of Time Steps
1000	0.4	17
1000	0.35	15
1000	0.3	20
1000	0.25	27
1000	0.2	41
1000	0.15	43
1000	0.1	59

Table 1: Data used to produce the decay graphs

From the table above, it can be seen that the constant value in the experiment is the initial number of atoms. That is because we want to have a degree of consistency throughout the trials so that the results can be interpreted more cohesively.

In the first trial (along with the rest), the number of atoms used is 1000. The probability of decay, however, was 4/10 or 0.4 Below is the data that gives out the points for a decay graph. 1000 591 346 218 130 80 54 33 21 15 9 4 2 1 1 1 1 0 The number of time steps was 17.

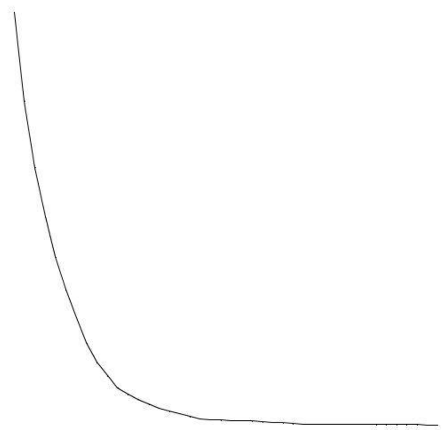

Figure 1: Graph of trial 1

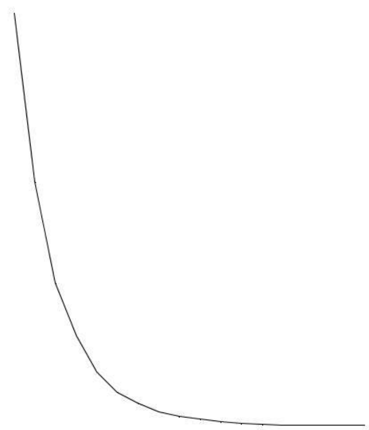

Figure 2: Graph of trial 2

In trial 2, the number of atoms used is 1000; the probability of decay is 0.35, and the number of time steps is 15. 1000 631 390 243 169 113 67 47 33 29 16 9 7 5 2 0

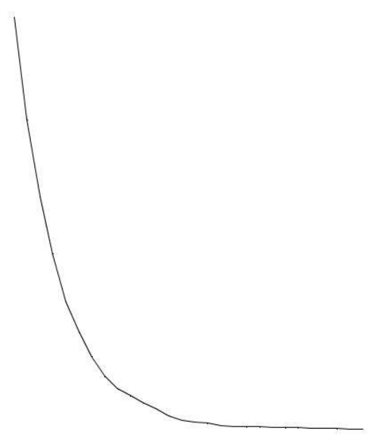

Figure 3: Graph of trial 3

In trial 3, the number of atoms used is 1000; the probability of decay is 0.3, and the number of time steps is 20. input P, the probability of decay. 1000 708 484 344 237 158 107 68 51 37 27 24 18 14 10 8 8 2 2 2 0

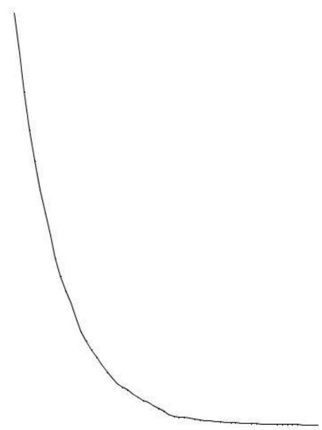

Figure 4: Graph of trial 4

In trial 4, the number of atoms used is 1000; the probability of decay is 0.25, and the number of time steps is 27. input P, the probability of decay. 1000 752 565 426 310 236 177 129 99 82 64 50 33 23 18 15 10 8 6 6 5 4 4 3 3 2 1 0

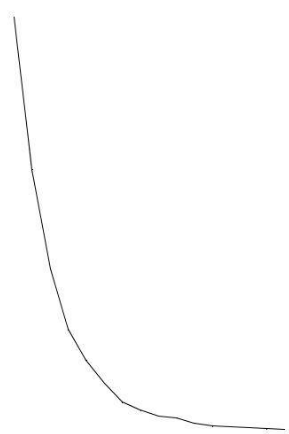

Figure 5: Graph of trial 5

In trial 5, the number of atoms used is 1000; the probability of decay is 0.2, and the number of time steps is 41. input P, the probability of decay. 1000 785 624 505 408 329 261 200 152 120 91 75 63 52 42 34 29 21 16 14 13 12 12 11 9 7 6 4 3 3 3 3 3 3 3 3 2 2 2 2 2 2 1 0

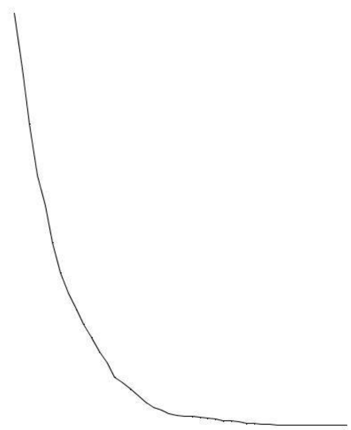

Figure 6: Graph of trial 6

In trial 6, the number of atoms used is 1000; the probability of decay is 0.15, and the number of time steps is 43. input P, the probability of decay. 1000 866 732 607 533 444 371 321 281 246 214 178 151 117 104 88 73 56 44 38 29 25 22 21 19 17 15 11 11 10 4 4 3 3 1 1 1 1 1 1 1 1 1 1 0

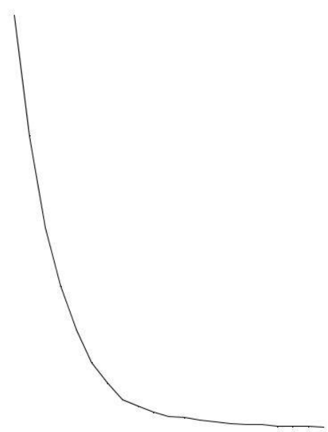

Figure 7: Graph of trial 7

In trial 7, the number of atoms used is 1000; the probability of decay is 0.1, and the number of time steps is 59. 1000 902 810 718 642 571 516 461 406 362 326 298 259 228 205 184 165 147 129 116 101 92 86 76 69 60 56 48 41 34 27 21 19 19 18 15 13 12 12 10 9 8 6 6 5 5 4 4 3 3 3 2 2 2 2 2 2 1 1 1 0

5 Discussion

As it can be seen from the data and graphs above, the batch of values and numbers for each trial produces a comprehensive graph of exponential decay. Although none of the graphs above are exactly the same, what they have in

common is that they start from a maximum point (1000) and rapidly descend to a certain point. At that specific point in the graph, the decrease (decay) decelerates significantly but does not stop. Instead the decay continues at a much slower rate until it reaches zero.
However, because the end value is zero, the trials do not abide by the theoretical definition of exponential decay. This is because, in exponential decay the population number continuously decreases without a definitive end. When graphed, the population starts out high but decreases in a non-linear fashion until the line reaches the x-axis and seemingly reaches zero. Hence, the line asymptotic. Despite that, it should not reach zero but keep lowering; nonetheless, a graph cannot convey this property of exponential decay, which is why we see zero as the end point of the population decay when in truth decay keeps occurring.

6 Conclusion

What the experiment and the theory help realize here is that exponential decay can be represented through visual means, such as a graph, but they are done so inaccurately due to the technical limitations and errors involved in the process. This conveys that exponential decay is difficult to be interpreted visually and thus, it requires explanation from theory.

7 References

`http://www.regentsprep.org/regents/math/algebra/ae7/expdecayl.htm`