# Title Information

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Radioactive Decay Lab

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# Data and Observations / Calculations

## Exercise 1: Simulating Half-lives

### Data Table 1: Predicted vs. Observed Simulated Parent Isotopes

| **Number of Half-lives** | **Predicted # of Parents** | **Actual # of Parents**  **Trial 1** | **Actual # of Parents**  **Trial 2** | **Actual # of Parents**  **Trial 3** |
| --- | --- | --- | --- | --- |
| **0** | **50** | **50** | **50** | **50** |
| **1** | 25 | 20 | 31 | 24 |
| **2** | 12 | 11 | 18 | 12 |
| **3** | 6 | 5 | 8 | 7 |
| **4** | 3 | 4 | 6 | 6 |
| **5** | 1 | 3 | 2 | 3 |
| **6** | 0 | 2 | 1 | 1 |
| **7** | 0 | 0 | 0 | 0 |
| **8** | 0 | 0 | 0 | 0 |
| **9** | 0 | 0 | 0 | 0 |
| **10** | 0 | 0 | 0 | 0 |

### Graph of Data Table 1

## Exercise 2: Radioactive Decay Scheme

### Data Table 2: Radioactive Decay Research

| **Radiogenic Isotope** | **Rubidium-87** |
| --- | --- |
| **Daughter Isotope(s)** | Strontium-87 |
| **Decay Type** | Beta Decay |
| **Half-life** | 48.8 Billion Years |
| **Is the daughter isotope stable?** | Yes, Strontium-87 is a stable element |
| **Source(s)** | Steiger, F. (1996). Radioactive Dating. Retrieved June 17, 2020, from <https://chem.tufts.edu/science/FrankSteiger/radioact.htm> |

### Data Table 3: Parent Isotopes over Predicted Time

| **Half-life** | **Time (billions of years)** | **Parent Isotopes Remaining (%)** |
| --- | --- | --- |
| **0** | **0** | **100** |
| **1** | 48.8 | 50 |
| **2** | 97.6 | 25 |
| **3** | 195.2 | 12 |
| **4** | 390.4 | 6 |

### Graph of Data Table 3

A close up of a map

Description automatically generated

## Photo Requirements

### Exercise 1 Documentation

A close up of a piece of paper

Description automatically generated

### Graph of Data Table 1 Screenshot

A screenshot of a computer

Description automatically generated

### Graph of Data Table 3 Screenshot

A screen shot of a computer

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# Lab Question Answers

## Exercise 1 Questions

1. **How did the predicted values compare to the actual values in Data Table 1 and Graph 1? Explain sources of variability in the outcomes of this experiment.**

The predicted values in Data Table 1 and Graph 1 were very similar to the actual values. The predicted values line on Graph 1 fell right between the plotted Trial 1 and Trial 2 data sets. Trial 1, generally speaking, has fewer parent isotopes left per half-life. Trial 2, generally speaking, had more parent isotopes left per half-life. Trial 3 had the most similar results to the predicted values. Sources of variability could be seen in the way each penny hit the carpet flooring when flipped. Another source of variability is between rounding errors where in my predicted data, as I halved each of the parent isotopes during the half-life, I rounded down when I received a decimal value. I expect generally random errors to occur in this experiment, as compared to systematic errors.

1. **What would Graph 1 look like if only 5 pennies were used in this experiment? What if 10,000 pennies were used? Based on your responses, what might be inferred about the relationship of half-life and sample size?**

I believe that the Graph 1 on half-life would be fairly variable if there were only 5 pennies. Especially given my experiment, in each trial when I only had a few pennies left, I would see a more liner trend in half-life. For example, in Trial 1 the last few half -live counted had 4, 3, 2 then zero parent isotopes remaining. This proves to be more linear. However, Trial 3 differentiates this by depicting a similar exponential decrease. Trial 3 had parent isotopes going from 6, 3, 1, then 0. If there were 10,000 pennies used, I think the data would look even more like the expected half-life trend where exactly 50% of the pennies remain parent isotopes per round. Having 10,000 pennies decreases the random error that is expected in our experiment because it substantially increases the sample size. As the sample size increased the half-life trend will become more exponential.

## Exercise 2 Questions

1. **Explain the difference between alpha, beta, and gamma decay?**

Alpha decay “occurs with the emission of 2 protons and 2 neutrons” (GEY 111 HOL lab manual, 2020). Beta decay occurs when there is an imbalance in the number of protons and neutrons in the nucleus of an atom” (GEY 111 HOL lab manual, 2020). Gamma decay is where gamma emission occurs by a nuclei dissipating energy. The primary difference between each decay type is the resultant of the decay type and the intensity of that resultant. Alpha decay results in the least intense alpha particle. Beta decay creates a product of a more intense beta particle. The most intense product is form gamma decay which creates a gamma ray. Each decay type, along with its respective resultant, produces a daughter isotope as well.

1. **What percentage of daughter isotope would be present after 5 half-lives have passed for 87Rb?**

97% of daughter isotope would be present after 5 half-lives have passed for Rubidium-87. In 5 half-lives there would be 3% of Rubidium-87 meaning 97% of the initial sample has decayed into Strontium-87.

Calculations:

6%/2 = 3% Parent Isotope Remaining

100% - 3% = 97% Daughter Isotope

1. **Use Graph 2 to determine the percentage of parent isotopes that would remain after 2 billion years have passed.**

97.2% of the parent isotopes that would remain after 2 billion years have passed.

Calculations:

Q: Quantity of Substance Remaining

I: Initial Quantity

t: Time Elapsed

h: Rubidium-87 Half-Life

1. **List the uses for 87Rb.**

Rubidium-87 is used to determine the age of rocks. This isotope is used as a “frequency standard in high-accuracy timing equipment such as GPS receivers”. It is also used in laser cooling. (Rubidium, 2012)

# Conclusions

From this activity I have come to better understand radioactive decay. I have come to understand through the various graphing activities that radioactive decay has an exponential trend. Each isotopic element used has its own decay timeline and type of decay. I read about the different types of decay and matched the radioactive decay of Rubidium-87 to beta decay. In researching Rubuiduim-87 I have learned how each isotope and its respective daughter isotope produced can be leveraged in different industries. Rubidium-87 is very important to determining the age of rocks.

# References

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