

Using the Quarknet CRMD Lifetime Study to Reinforce Concepts of Exponential Decay

Jeremy Wegner, Winamac Community High School

Introduction

- HS Physics Teacher in small town rural Indiana for 20 years.
- Involved with Quarknet since 2013, Physics enthusiast since 1994!
- Disclaimer
 - I'm only presenting information about materials that other people have worked hard to produce. I take no credit for their work.
 - Any assertions or conclusions I make should be taken with a grain of salt and should immediately be superseded by all those who know more about the subject, which is quite possibly everyone else in this room.




Quarknet Activities

- [Quarknet.org](https://www.quarknet.org)
 - Data Portfolio - Scroll down to the bottom of the page. Lots of good stuff to explore.
 - Data strand - Cosmic Ray, Topic - Data Analysis, Apply
 - Mean Lifetime - Part 1
 - Mean Lifetime - Part 2



Preparation

What are the Big Ideas that you want your students to remember? Depends on the level of the course, teacher, and student.

- How quickly the amount of stuff changes depends on the amount of stuff there is. If there's less stuff it changes less quickly.
 - Exponential growth/decay models only give information about a large group of things, not about any one single thing.
 - Half-life and mean lifetime are two different ways to describe the same thing.
 - The mean lifetime doesn't tell you how long a particle will last.
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Mean Lifetime - Part 1

- Traditional Activities - Emandemium Lab
- Dice vs. Candy - less physically stimulating, but more stimulating Physics-ally
- Using google sheets to collect data sets - individual results vs. group results
- Exploring what is *really* happening on the graph
 - Connecting rolls to equivalent units of time.
 - Asking questions like, “How many dice took 4 rolls to come up as a 1?”
 - Using different starting points to show that it is arbitrary when finding decay constants.
 - Why is half-life always shorter and mean lifetime?



Mean Lifetime - Part 2

- Quarknet CRMD's - how they gather data
- Mean Lifetime study - how the data is analyzed
- Where to get data and analyze it
 - Quarknet.org, e-lab, cosmic ray, login as guest, student home, data, lifetime, search: let students find cool places
 - Run: Lifetime Study, print graph
- What to do with it
 - Canceling out the noise
 - Picking a starting point
- Similarities and differences with Part 1



Conclusions

- quarknet.org - Quarknet activities allow you to introduce Particle Physics concepts while at the same time reviewing traditional Physics topics. I also like:
 - Top Quark - momentum and vector addition
 - Quark Puzzle - standard model and looking for patterns
 - Rolling with Rutherford - data analysis, histograms
 - Did students retain Big Ideas?
 - Student questions:
 - Why use mean lifetime instead of half-life?
 - When am I ever going to use this?
 - Discussion/Questions
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