

Inquiry Into Nuclear Decay:

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**MONTAGUE AREA
PUBLIC SCHOOLS**

EDUCATION IN THE RIGHT DIRECTION

- Montague, Michigan
- Rural Public High School – 400 students
- Introductory Chemistry Class
- All students required to take the same chemistry class, no tracking.



Rationale

- New K-12 framework, NGSS, MI “HSCE”
- Comfortable with graphing/experimental design
- Introduce common applications for nuclear isotopes
- Eliminate some misconceptions/myths/fears of nuclear radiation

Safety

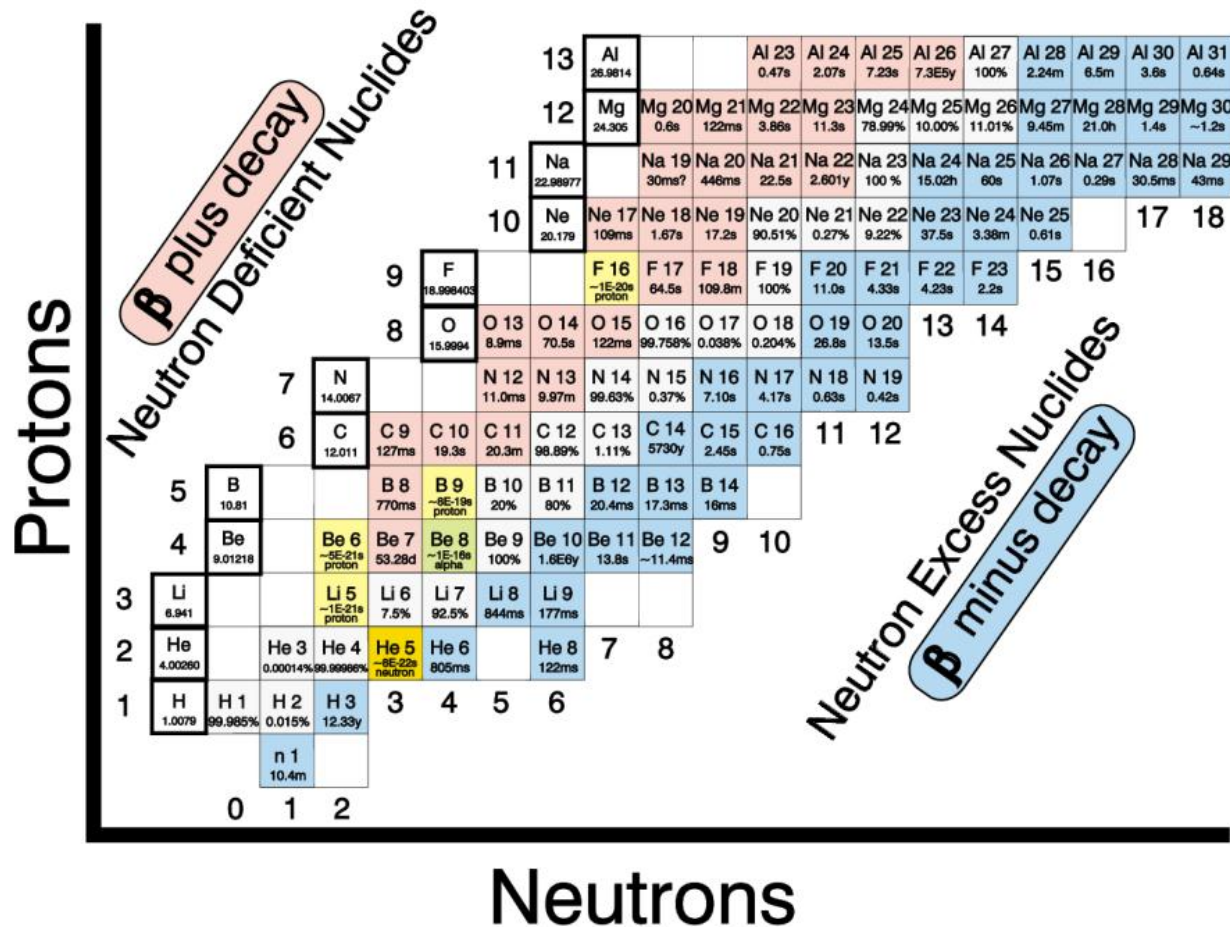
- All materials meet
 - Nuclear Regulatory Commission Definition of Exempt Quantities (from the Introduction to Exempt Consumer Product Uses, NRC 10 CFR 30):

Summary of Necessary Actions for Exempt Sources

- Obtain concurrence for use of radioactive sources from supervision.
- Provide a copy of “General Handling Procedures” to students.
- Handle all sources with care:
- Pick up sources by the sides.
- Do not touch the top of alpha and beta sources.
- Place sources “label side up” when not in use.
- Lock up all sources when not in use.
- Take an inventory:
 - . After every class.
 - . At the end of each semester.

Background

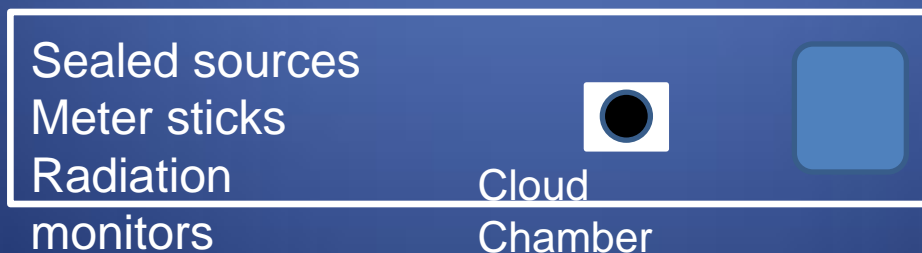
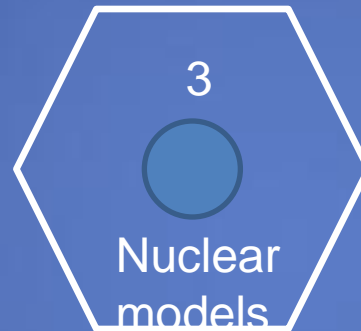
CHART OF THE NUCLIDES



Station Round Robin

- <http://www.gvsu.edu/targetinquiry/>
- Description: Introduces students to nuclear chemistry concepts .
 - Introductory guided inquiry activity
 - Five activities that focus on nuclear chemistry

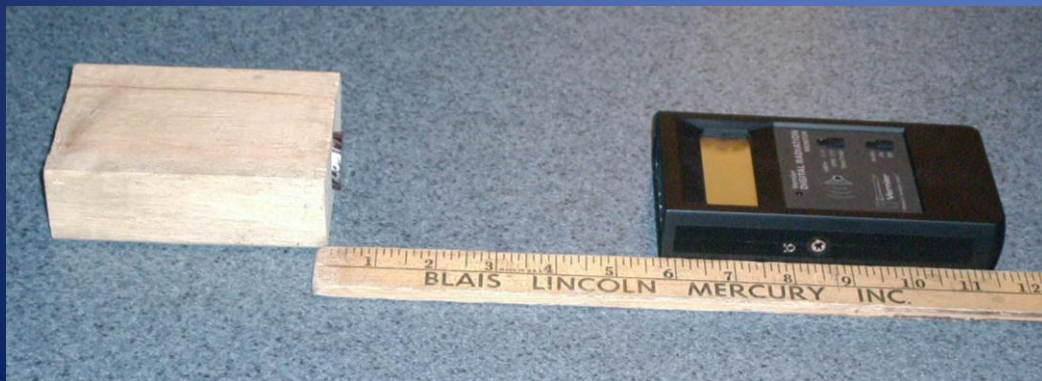
Classroom Layout



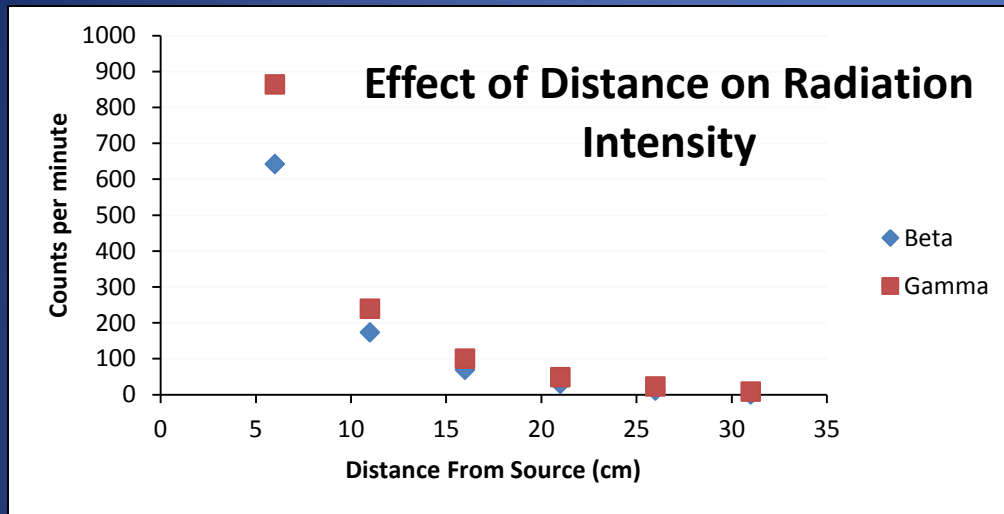
Activity I: Counts vs Distance.

How does distance impact radiation

- Materials: Sealed Source, 2x4 block, meter stick, radiation detector, stopwatch
 - Determine the relationship between distance and radiation
 - Impact on daily life: safe distance, x-ray technician



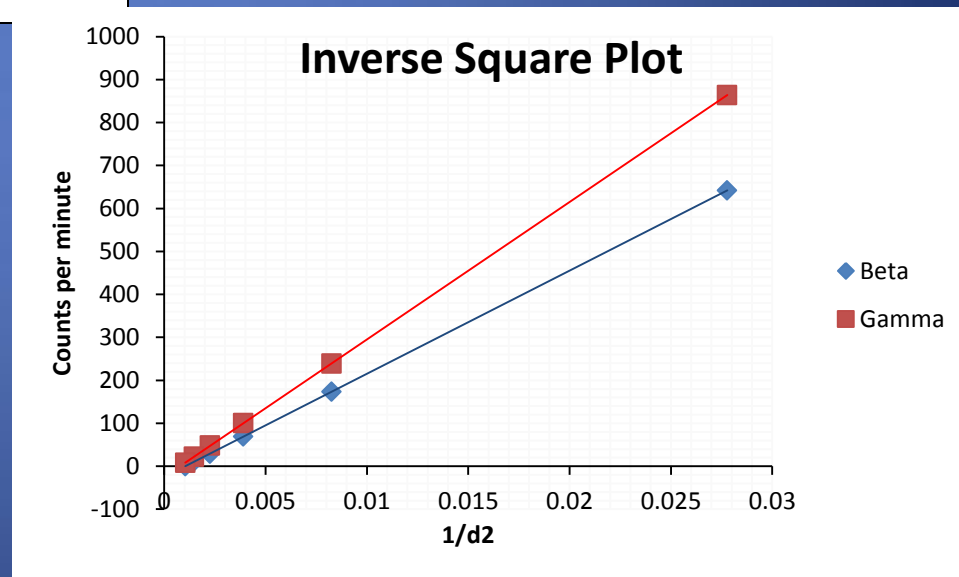
Sample Graphs



$$F = k \frac{q_1 q_2}{d^2}$$

$$F = G \frac{m_1 m_2}{d^2}$$

$$I \propto \frac{1}{d^2}$$



Activity II: Counts vs Shielding.

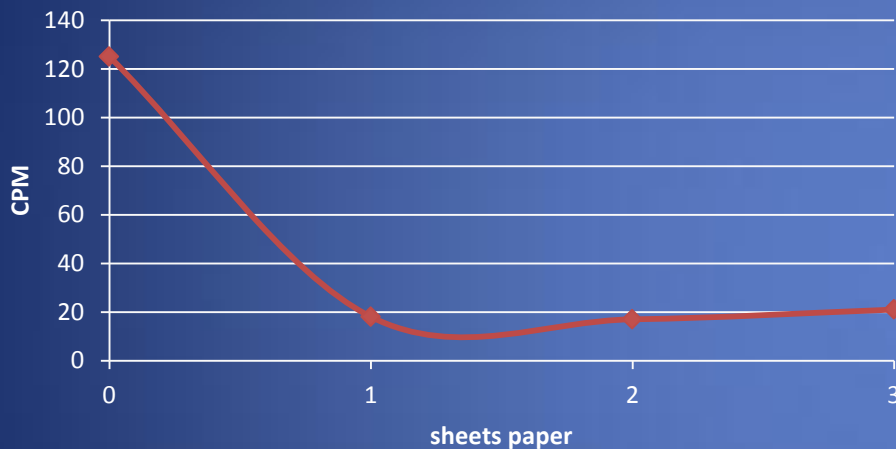
What is the different penetrating ability of the types of radiation?

- Materials: Sealed Source, 2x4 block, meter stick, radiation detector, stopwatch, shielding material ie Al squares
 - Determine the relationship between type of radiation and shielding material
 - Impact on daily life: protective material, x-ray technician

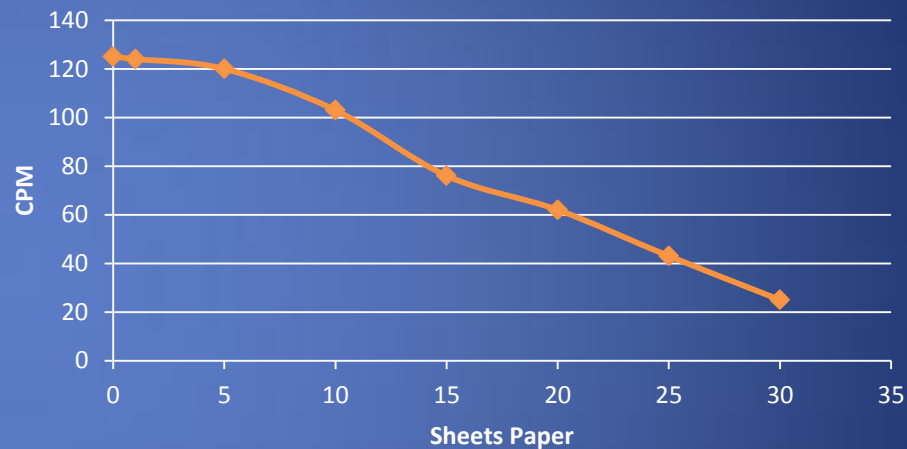


Sample Data

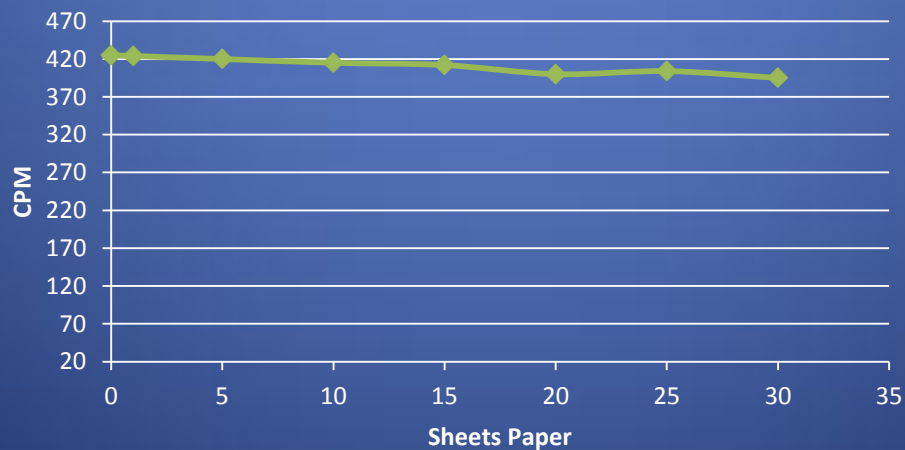
Alpha source



Beta Source



Gamma Source



Activity III: Nuclear Marbles.

What is changed in the nucleus?

- Materials: magnetic marble set of C-12 nuclei



https://shop.nd.edu/C21688_ustores/web/store_cat.jsp?STOREID=34&CATID=444&SINGLESTORE=true

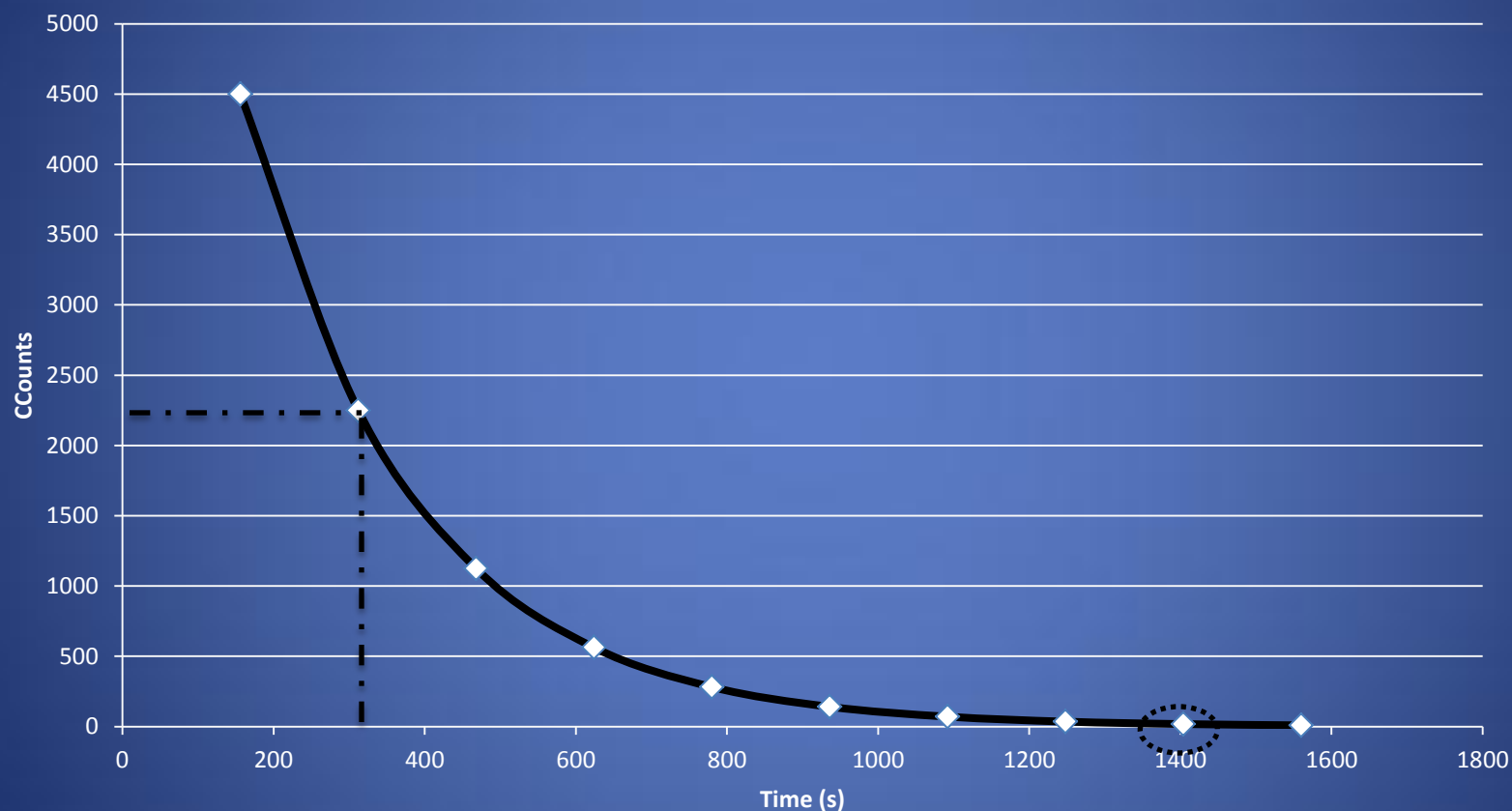
Activity IV: Exponential Decay

How can we determine half-life from a graph?

- Materials: plastic bag, tissue paper, Cs/Ba generator, CBL/Calculator, radiation detector,



Sample Data

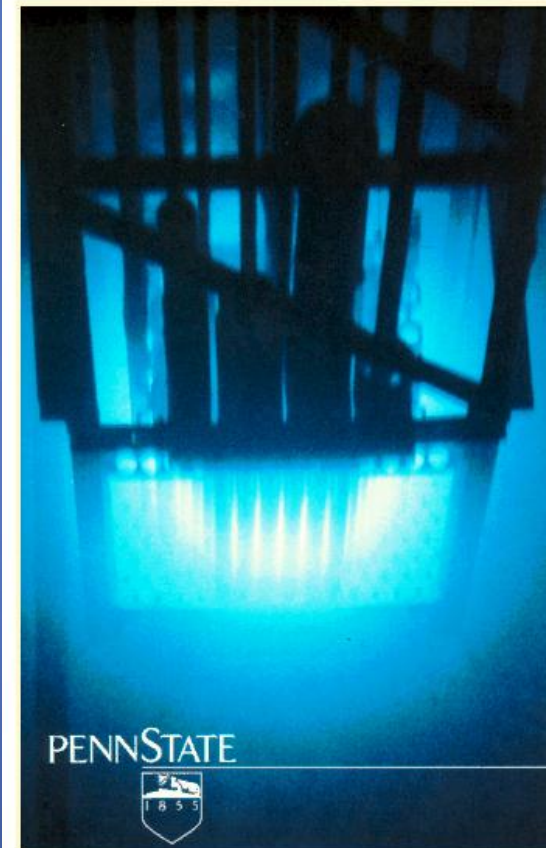


300 s
~2.5 min

18 cpm
~24 min
background

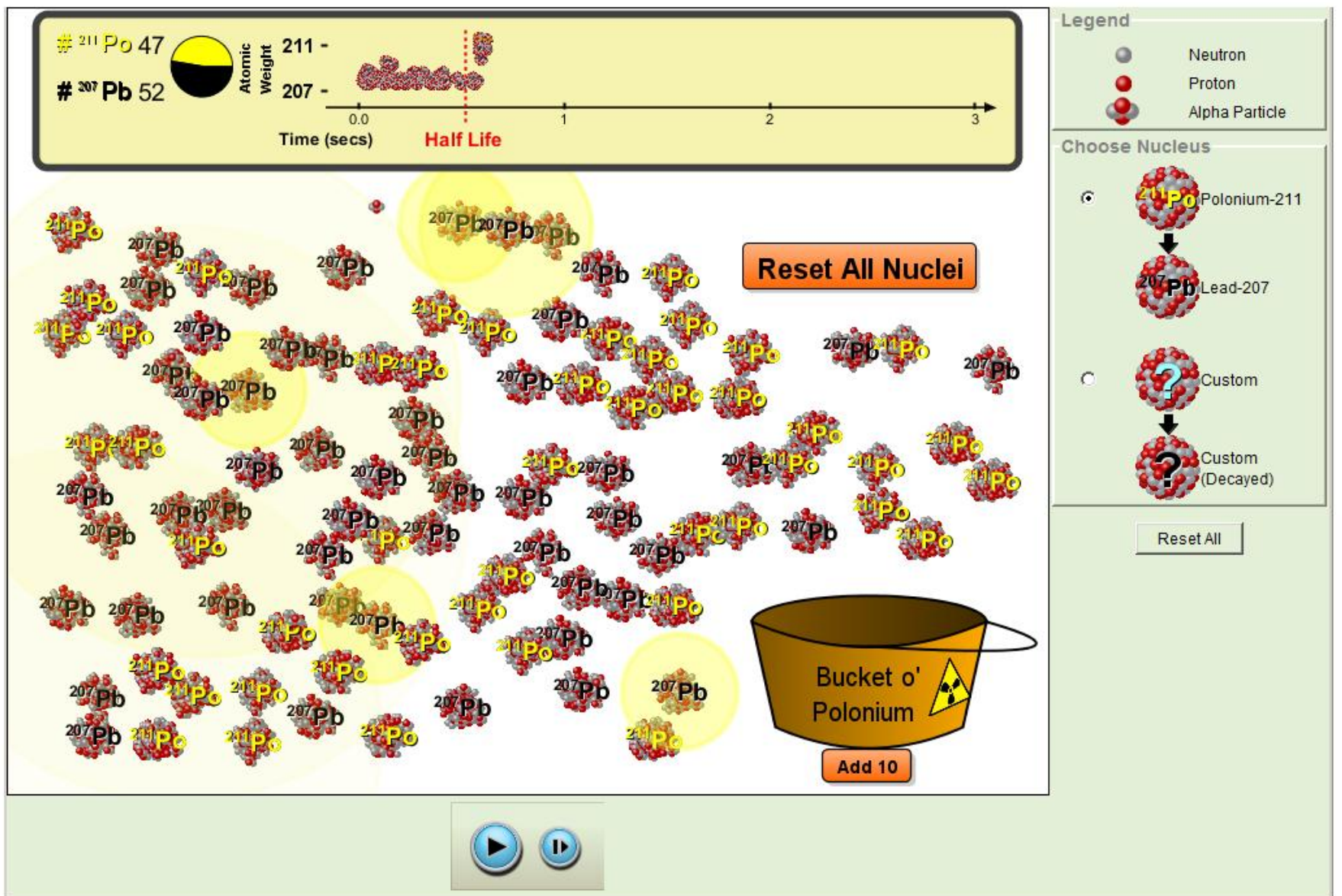
Activity V: PHET simulations

- Materials: computer with internet connection
 - Alpha Decay
 - Beta Decay
 - Nuclear Fission



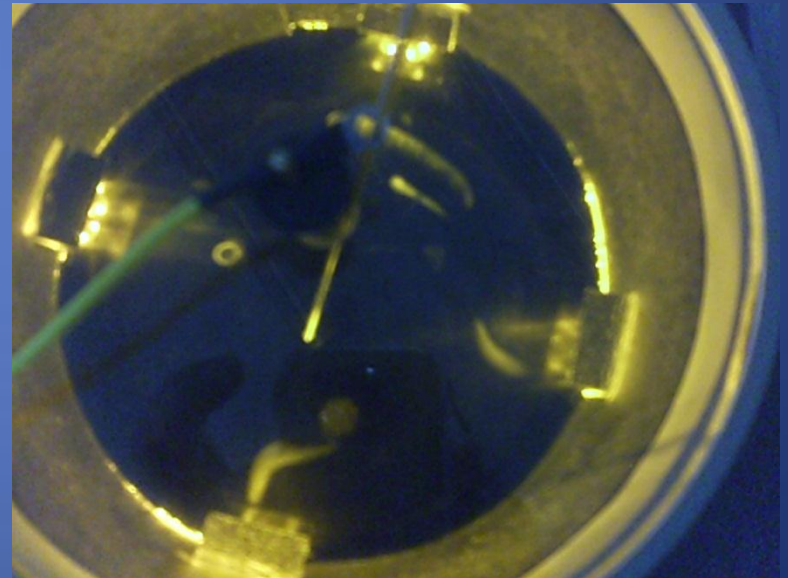
The core of the Penn State Breazeale Reactor is shown in this photo. The Breazeale Reactor is part of the Penn State Radiation Science and Engineering Center.

Alpha Decay sim



Activity VI: Cloud Chamber

- Materials: Ice water bath, cloud chamber, source, ethanol



Extension Discussion

Fukushima plant disaster; why was KI important? Why not in MI?

How do X-ray technicians protect themselves? Why?

What is your annual exposure, NRC website.

<http://www.nrc.gov/about-nrc/radiation/around-us/doses-daily-lives.html>

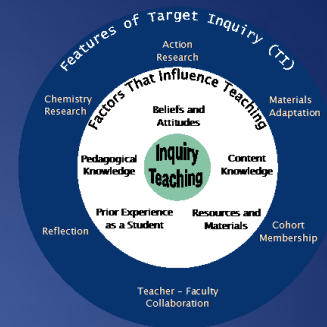
<http://www.nrc.gov/about-nrc/radiation/around-us/doses-daily-lives.html>

To access materials

<http://www.gvsu.edu/targetinquiry/>

- Password required to obtain materials (data collection only)
- Free teacher and student guides
 - Facilitation notes
 - Student misconceptions
 - Teacher set-up
 - Assessment questions

Acknowledgements



- Target Inquiry Professors and colleagues
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- ACS-Hach grant



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 - www.gvsu.edu/targetinquiry
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