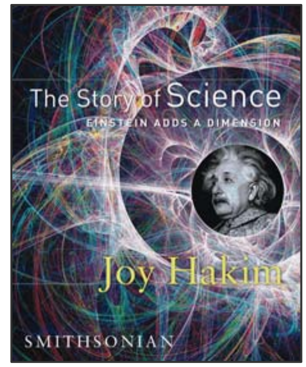
The Fission Vision



Fission Simulation

With the help of your teacher, you can model nuclear fission with your class. Each student will represent a uranium atom, either U-235 (which is fissile) or U-238 (which is nonfissile). Your teacher will mimic the neutron.

First, take a card from your teacher, but don't tell the other students what role you've drawn. Then, in a wide, open space arrange yourselves in a matrix; make sure you stand about 1 meter from one another. As you take your places, consider how the "structure" you're creating compares to a crystal.

Once everyone is ready, your teacher initiates the reaction by walking into the formation in a straight line and touching a student at random. If you are touched and you're a nonfissile atom, remain totally still. If you are touched and you're a fissile atom, silently count, "One tomato, two tomato, three tomato," then shout, "Bang," and quickly (but gently) tag all the other students within arms' reach. With the help of an audio or video recorder, log the number of generations of bangs that occur until the process stops.

Complete this process three times, and each time draw a new role. At the end of the three rounds, summarize your data in this chart:

% Fissionable	# of Generations of Reactions
25%	
50%	
75%	

1. What percentage of fissile atoms produced the longest/strongest chain reaction?

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2. Why? ____

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Also consider the following questions:

3. On the news you often hear the term "enriched uranium." Why do scientists enrich uranium before fission can occur?

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Next, grab a calculator and look carefully at the diagram on page 217 of the reader. It represents a chain reaction. Note that when the first neutron hits the Uranium-235, two neutrons are released *in addition to* the original one. In the next reaction, potentially nine neutrons are released. Complete the table showing the reaction number and number of free neutrons:

Reaction	# Free Neutrons
1	3
2	
3	
4	
5	
6	
7	
•	
•	
•	
▼	
n	> 1 million

4. How many reactions are required to release at least a million free neutrons? _________

5. Graph the number of free neutrons in each reaction. What is the shape? ____________

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6. If each reaction takes about 10^{-7} second, how long will this process take?

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7. In fission reactors, rods are sometimes used to slow reactions. If a rod absorbed one of every three released neutrons, how would the shape of the graph change? ____________

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Science Objects, Applets, and Animations
Chain Reaction: Mouse Trap Model
http://www.physics.umd.edu/lecdem/services/demos/demosp4/p4-62.htm

Nuclear Fission
http://www.lon-capa.org/~mmp/applist/chain/chain.htm

Evaluation

Physicists love to do rough, "back of the napkin" estimates. These are often called Fermi Questions after Enrico Fermi. Here's a Fermi Question for you: Look at the chart below. It shows the energy needed to get from Earth to the dwarf planet Pluto, at the edge of our solar system, if we were to harness the energy of a fission reaction. Compare that to the energy available in gasoline. If we could somehow create a gasoline-powered rocket, how much fuel would we need to get to Pluto? How much mass would that represent?

Fuel	Mass (g) per Molecule or Reaction	Energy Released per Molecule/Reaction (eV)	# of Reactants/Reactions needed to get to Pluto	Total Mass of Fuel needed
Fission	4×10^{-23}	2×10^{7}	3.5×10^{24}	680
Gasoline	1.9×10^{-22}	66		

*Adapted from NOVA, "A Trip to Pluto," http://www.pbs.org/wgbh/nova/teachers/activities/3213_einstein_05.html where complete answers, explanations, and extensions can be found.