PhET Tips for Teachers

Alpha Decay

The Alpha Decay simulation allows students to explore the process of alpha decay and investigate the concept of half-life.

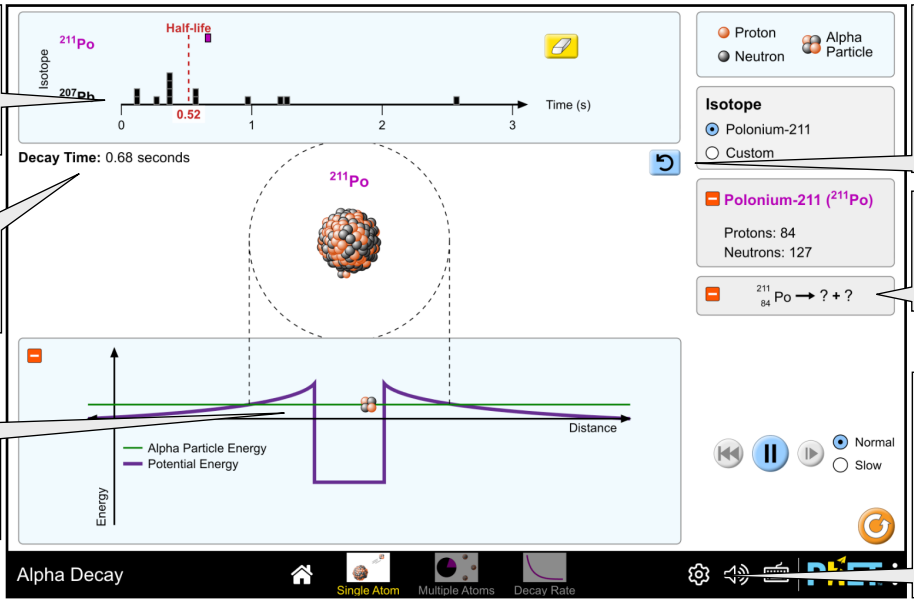
Single Atom Screen (Polonium Selected)

In the Single Atom screen, students observe how a nucleus changes during alpha decay and explore how the alpha particle's energy relative to the potential energy barrier determines half-life.

COMPARE individual decay times to half-life.

RECORD time to decay.

OBSERVE alpha particle tunneling.



RESET atom to repeat experiment.

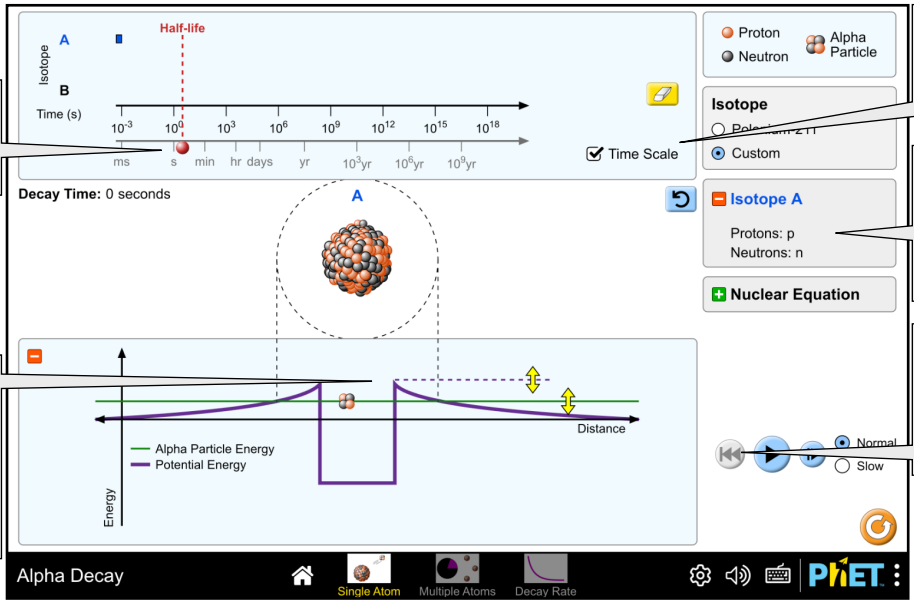
PREDICT decay products.

TURN OFF advanced quantum physics in preferences menu.

Single Atom Screen (Custom Selected)

SET half-life value.

ADJUST alpha particle energy and barrier height.



SHOW half-life in everyday units.

TRACK changes to particle counts.

REPLAY most recent decay event.

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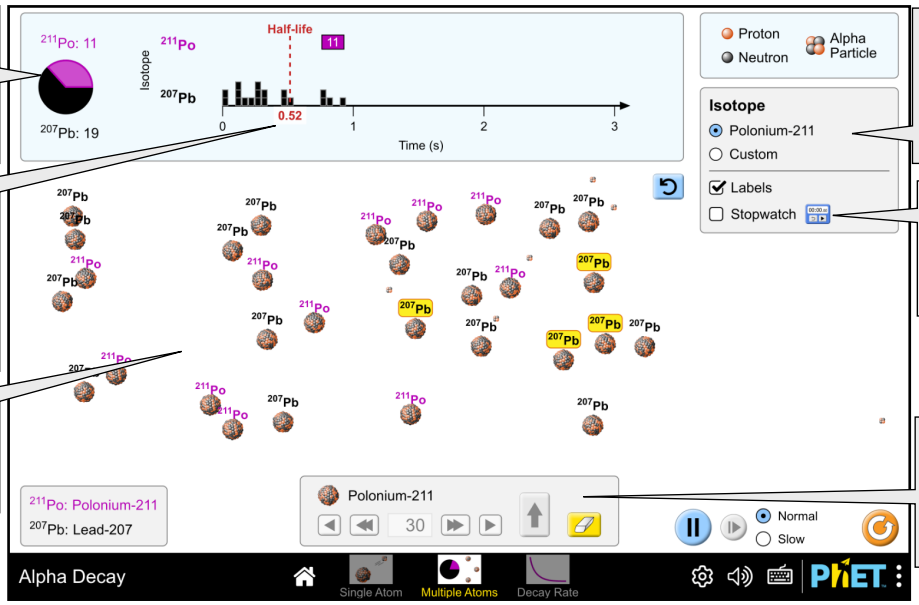
Multiple Atoms Screen

In the Multiple Atoms screen, students will explore the meaning of half-life.

COMPARE isotope amounts as time passes.

DETERMINE what fraction remains at half-life.

OBSERVE sample decay.



SELECT custom to adjust half-life value.

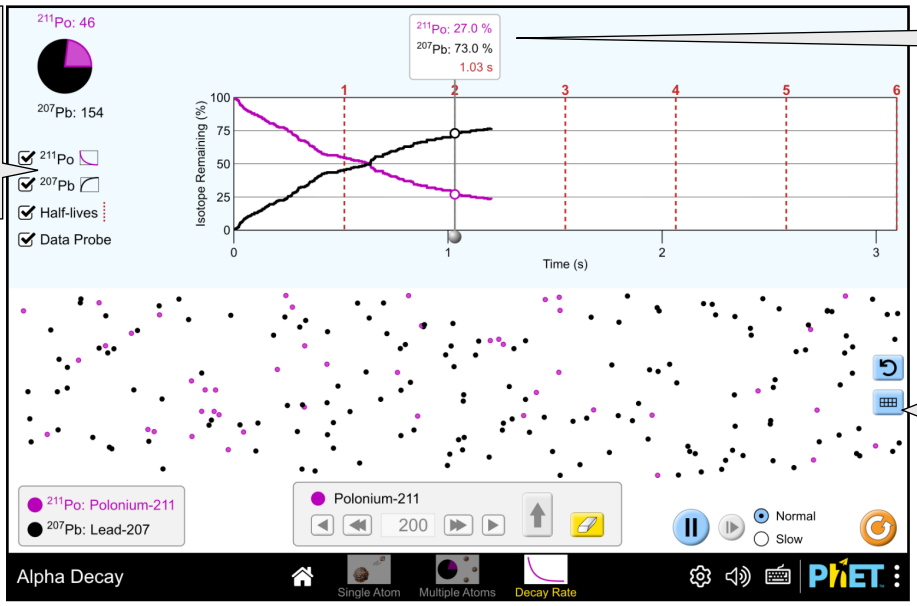
TIME the decay process.

CHOOSE number of atoms and **SET** sample.

Decay Rate Screen

In the Decay Rate screen, students investigate the exponential pattern of radioactive decay.

VISUALIZE isotope curves and half-life markers.



COMPARE percentages at each half-life.

SORT particles to see fraction remaining.

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Insights into Student Use

- On the Single Atom screen, students may think the dashed circle represents the nuclear boundary rather than the alpha particle escape distance.
- On the Single Atom screen, students may need support to recognize that the alpha particle tunnels through the potential energy barrier.
- On the Single Atom screen, students may not immediately know what is draggable with the custom isotope.
- On the Decay Rate screen, students may need support connecting the sorted view to the fraction of isotope remaining.

Complex Controls

- When the custom isotope is selected, adjusting the half-life will also change the alpha particle energy. Adjusting either the potential energy or alpha particle energy will cause the half-life to change.
- The replay decay button rewinds to the time just before the last decay. Users are encouraged to use the step forward button afterwards to view tunneling more easily.



- The stopwatch will begin playing once atoms are added to the play area and stop once all atoms are decayed. Use the play/pause button to pause at half-life times rather than the pause button on the stopwatch.
- The spinner's arrows set the number of atoms to add: the single arrow changes it by one, the double arrow by 10 on the Multiple Atoms screen or 100 on the Decay Rate screen. Pressing the orange set sample button places that number in the play area and disables both controls. Pressing erase clears the sample and re-enables them.



- The sort button arranges atoms to more easily visualize the fraction remaining. The number of rows and columns and distance between particles will vary depending on sample size.



Suggestions for Use

See all published activities for Alpha Decay.

Sample Challenge Prompts

- On the Single Atom screen, design an experiment to determine the relationship between half-life, potential energy, and alpha particle energy.
- On the Single Atom screen, describe how an alpha particle can escape the nucleus when its energy is below the PE barrier.
- On the Multiple Atoms screen, how much of a radioactive sample remains after one half-life? Use your observations to construct a definition of half-life.
- On the Multiple Atoms screen, experiment with different amounts of atoms to determine the effect of sample size on the half-life.
- On the Decay Rate screen, examine the percent of atoms remaining at each half-life marker. What pattern do you notice?

Sample Prediction Questions

- On the Single Atom screen, predict how the atomic number, mass number, and element present will change after decay. Run the simulation to test your prediction.

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- On the Single Atom screen, predict when a single atom will decay relative to the half-life time across several trials. What does this tell you about the nature of decay?

Simulation Details

See this sim's Model Documentation for more details.

- On the Single Atom screen, the energy level diagram has been simplified:
  - The forbidden zone for polonium-211 is exaggerated to better visualize tunneling.
  - The amount the well drops after a decay is equal to the alpha particle energy.
  - A single representative energy is used for emitted alpha particles, as real alpha emissions have a narrow distribution of energies centered around a characteristic value.
- On the Single and Multiple Atoms screens electron clouds are omitted to focus on nuclear changes.
- On the Decay Rate screen atoms are shown as solid spheres to optimize performance for large sample sizes.
- The positioning of atoms on the Multiple Atoms and Decay Rate screens is for visual clarity and does not represent a physical state.

Inclusive Features

See the simulation page for all supported inclusive features.

Alternative Input

- This simulation supports custom alternative input interactions, including hotkeys to play or pause the simulation. See the Keyboard Shortcuts dialog in the simulation for more information.

Sound and Sonification

- This simulation includes Basic Sounds, which provides audible confirmatory feedback to indicate successful interaction, such as when pressing a button or checking a checkbox.
- In addition, a unique sound is played when each atom decays. How often this sound occurs should help low or no vision users determine how the rate of decay changes over time.

Interactive Description (Core)

Core description is a subset of a fully described interactive experience.

- Teachers can access the Accessibility (A11y) View to see the descriptions available to screen reader users to decide if the sim's description meets their instructional needs. *Please note: A11y View is not intended for student use and will not provide a good experience for learners using screen reader software.*

Customization Options

Option 1: Use PhET Studio to configure a sim exactly how you want students to see it, save your preset, then send the preset link to your students. This is a premium product. Start a free trial today!

Option 2: Query parameters allow for customization of the simulation, and can be added by appending a '`?`' to the sim URL, and separating each query parameter with a '`&`'. The general URL pattern is:
`…html?queryParameter1&queryParameter2&queryParameter3`
For example, in Alpha Decay if you only want to include the 1st and 2nd screens (`screens=1,2`), with the 2nd screen open by default (`initialScreen=2`) use: https://phet.colorado.edu/sims/html/alpha-decay/latest/alpha-decay_all.html?screens=1,2&initialScreen=2

- To run this simulation in Spanish (`locale=es`), the URL would become:
  https://phet.colorado.edu/sims/html/alpha-decay/latest/alpha-decay_all.html?locale=es
- All available query parameters are shown in the table.

⚙ Indicates this customization can be accessed from the Preferences menu within the simulation.

Query Parameter and Description	Example Links
⚙ `advancedQuantumPhysics` - when `false`, hides the energy diagram accordion box. Default is `true`.	`advancedQuantumPhysics=false`

`screens` - specifies which screens are included in the sim and their order. Each screen should be separated by a comma. For more information, visit the Help Center.	`screens=1`
	
	`screens=2,1`

`initialScreen` - opens the sim directly to the specified screen, bypassing the home screen.	`initialScreen=3`
⚙ `locale` - specify the language of the simulation using ISO 639-1 codes. Available locales can be found on the simulation page on the Translations tab. Note: this only works if the simulation URL ends in "_all.html".	`locale=es` (Spanish) `locale=fr` (French)
`audio` - if muted, audio is muted by default. If disabled, all audio is permanently turned off.	`audio=muted` `audio=disabled`
⚙ `interactiveHighlightsInitiallyEnabled` - opens simulation with interactive highlights enabled	`interactiveHighlightsInitiallyEnabled`
`allowLinks` - when `false`, disables links that take students to an external URL. Default is `true`.	`allowLinks=false`
`supportsPanAndZoom` - when `false`, disables panning and zooming using pinch-to-zoom or browser zoom controls. Default is `true`.	`supportsPanAndZoom=false`

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Additional PhET Resources

See PhET's Inclusive Features page to learn more about each Inclusive Feature and how to use them with your students.
For more tips on using PhET sims with your students, see Teaching with PhET.
To learn more about ways to create and facilitate sim-based lessons, visit our free Virtual Workshops.