**PhET Tips for Teachers: Isotopes and Atomic Mass**

We made the Isotope sim to follow the Build an Atom sim. The Build an Atom sim allows students to make isotopes, but the Isotope sim shows the abundance and how it relates to the average atomic mass of an element. For *applications* of isotopes, see our suite of nuclear chemistry sims: Nuclear Fission, Alpha Decay, Beta Decay or Radioactive Dating Game.

## Tips for controls:

**Make Isotopes Tab** (Isotopes atoms with same # of protons and different # of neutrons.)

- Select an element in the first **2** rows of the periodic table; the most abundant isotope of that element appears on the scale.
- Add *or remove* neutrons, but select element on periodic table to change the number of protons.
- The scale shows the mass number or the atomic mass.

**Second Tab: Mix Isotopes**

- Select an element in the first **3** rows of the periodic table; the stable isotopes of that element appear in buckets (the unstable isotopes $^{3}H$ and $^{14}C$ are not included).
- Add isotopes to the chamber in two ways: you can drag in the isotopes (up to 10 of each) or click the **More** button to use sliders (up to 100 of each isotope); the **Less** button returns the buckets.
- Select **Nature's mix** to see the actual composition and average atomic mass. The ratio of isotopes is represented by 1000 isotopes in the chamber.

## Insights into student use / thinking:

- The mass number is the sum of the protons and neutrons in the atom. If students need review of this use Build an Atom
- In college interviews, students wanted to select other common elements, like gold; you could add more elements in an activity.
- In middle school interviews, students liked to draw pictures with the isotopes.
- In all interviews, students try to match Nature's mix using **My mix**; this is not always possible.

## Important modeling notes / simplifications:

- If you make an isotope that is not listed as stable in the NIST table, the nucleus shakes and the word "**Unstable**" appears under the nucleus.
- The atomic mass is relative to $^{12}C$, which is defined as 12 amu. The sim only shows the atomic mass for stable isotopes (the exceptions are $^{3}H$ and $^{14}C$).
- The sim computes the average atomic mass of the isotopes in the chamber (shown on a line chart), and the percentage of each isotope (shown as a pie chart).
- The sim is not able to show the exact ratio for some elements (for example, the exact ratio for helium would take 1 $^{3}He$ isotope and 999,999 $^{4}H$ isotopes).
- While the size of different atoms is not a main learning goal, the sim shows the relative electron cloud size for each element.

## Suggestions for sim use:

- For tips on using PhET sims with your students see: **Guidelines for Inquiry Contributions** and **Using PhET Sims**
- The simulations have been used successfully with homework, lectures, in-class activities, or lab activities. Use them for introduction to concepts, learning new concepts, reinforcement of concepts, as visual aids for interactive demonstrations, or with in-class clicker questions. To read more, see **Teaching Physics using PhET Simulations**
- For activities and lesson plans written by the PhET team and other teachers, see: **Teacher Ideas & Activities**

Authors: Kelly Lancaster, Trish Loeblein Updated: May 2011