

## **Lesson Plan: Teenage Mutant Ninja Nuclei**

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**Subjects taught:** Regents, Honors, and AP Physics

**Grade level:** 11, 12

**TOPIC of lesson:** Nuclear processes: fusion, neutron absorption, radioactive decay, bombardment

**Preceding Lessons:** Students will have received lessons in nuclear physics: composition of the atom, binding energy, fission, fusion, decay, etc.

**Objective:** Students will be able to...

- build model nuclei representing various elements and isotopes
- identify baryon numbers associated with above nuclei
- understand and explain the various processes by which nuclei can 'mutate' to form new elements and isotopes
- explain/calculate how mass/energy, momentum, and charge are conserved during any nuclear process or interaction

### **State Curriculum Standards:**

**New York State Standard 4 – The Physical Setting:** Students will understand and apply scientific concepts, principles, and theories pertaining to the physical setting and living environment and recognize the historical development of ideas in science.

*Key Idea 5:*

Students can compare energy relationships within an atom's nucleus to those outside the nucleus.

**Performance Indicator 5.3:**

5.3f Among other things, mass-energy and charge are conserved at all levels (from subnuclear to cosmic).

5.3i The total of the fundamental interactions is responsible for the appearance and behavior of the objects in the universe.

5.3j The fundamental source of all energy in the universe is the conversion of mass into energy.\*

**Rationale:** This activity will allow students to explore the various possibilities for nuclear transformations and understand how protons and neutrons define an atom.

### **Instructional Strategies:**

*Cooperative Groups:* Students will work in groups of two to build/modify models of nuclei, and to answer follow-up questions and problems.

*Discussion:* Following completion of the activity, the class will discuss the results and tie them in with previous lessons on nuclear physics.

### **Resources:**

<http://www.jinaweb.org/outreach/marble/>

**Activities:**

1. The class will spend a few minutes reviewing nuclear processes (fission, fusion, neutron absorption, decay), and how they affect the baryon numbers of nuclei.
2. In groups of two, students will play the *Nucleosynthesis Game* described on <http://www.jinaweb.org/outreach/marble/> , and fill out a chart:

<u>Step #</u>	<u>Reaction Type</u>	<u>Reaction Equation</u>
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3. Students will work with their group to answer follow-up questions (see attached.)

**Extension:**

Given velocity of an ion moving through a magnetic field, and the strength of the magnetic field, students can calculate the mass:charge ratio.

Given the mass and charge of an ion, students can calculate its rate of acceleration in a defined electric field, and can calculate the final velocity after a defined distance of travel.

**Assessment:**

The activity/question packet

On-going assessment through labs and test questions