UC Irvine FOCUS!
5 E Lesson Plan

Title: M&M Radioactive Isotope Half-life
Grade Level and Course: 8th Grade Physical Science, 9-12 High School Chemistry
Materials: M&M™ candy pieces Re-sealable bag graph paper
Instructional Resources Used: (concept maps, websites, think-pair-share, video clips, random selection of students etc.) http://www.youtube.com/watch?v=l9HXAXXyU0U&feature=related http://lectureonline.cl.msu.edu/~mmp/applist/decay/decay.htm http://www.youtube.com/watch?v=tQa4LONy9XM http://www.colorado.edu/physics/2000/isotopes/radioactive_decay3.html • Think-pair-share - Students will watch videos, record all thoughts and perceptions, share with another student and then share out to class. Teacher will record all thoughts on the board.
California State Standards: (written out) 8th Grade Physical Science 7. The organization of the periodic table is based on the properties of the elements and reflects the structure of atoms. As a basis for understanding this concept: b. Students know each element has a specific number of protons in the nucleus (the atomic number) and each isotope of the element has a different but specific number of neutrons in the nucleus. Investigation and Experimentation 9. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other three strands, students should develop their own questions and perform investigations. Students will: e. Construct appropriate graphs from data and develop quantitative statements about the relationships between variables. 9-12 High School Chemistry 11. Nuclear processes are those in which an atomic nucleus changes, including radioactive decay of naturally occurring and human-made isotopes, nuclear fission, and nuclear fusion. As a basis for understanding this concept: c. Students know some naturally occurring isotopes of elements are radioactive, as are isotopes formed in nuclear reactions. f. * Students know how to calculate the amount of a radioactive substance remaining after an integral number of half-lives have passed.
Lesson Objectives: a. Students will successfully follow directions and complete the lab. b. Students will recognize half-life graph is non-linear. c. Students will be able to calculate the half-life of an isotope. d. Students will be able to calculate the mass of remaining substance based

on half-life and time passed.

Differentiation Strategies to meet the needs of diverse learners:

- English Learners: Place students into pre-arranged in lab groups that have been designed to maximize student time on task and understanding. Prior to lab, students will define the terms “isotope” (and give examples) and “radioactive”.
  http://www.colorado.edu/physics/2000/isotopes/radioactive_decay3.html
  Students watch video as teacher slowly reviews the terms and concepts. Teacher solicits student responses to ensure understanding.
- Special Education: Students watch
  http://lectureonline.cl.msu.edu/~mmp/applist/decay/decay.htm
  As video is playing, teacher asks “What do you see as changing?” Teacher explains that even though some are changing, the number changing is decreasing over time.
- GATE: Students will calculate the half-life based on the speed they do their experiment.

ENGAGE

- Describe how the teacher will capture the students’ interest.
  Show the following two clips
  http://www.youtube.com/watch?v=tQa4LONy9XM
  http://www.youtube.com/watch?v=l9HXAXXyU0U&feature=related
  Both clips show changing the atomic number of the nucleus, one by fusion and on by fission.
- What kind of questions should the students ask themselves after the engagement?
  a. What changes in the video?
  b. Is/are new elements created?
  c. How do you know?

EXPLORE

- Describe the hands-on laboratory activity that the students will be doing.
  Students will explore a third way that new atoms can be created - the radioactive decay of unstable isotopes. Students will simulate the half-life of decay by starting with a set number of m&ms in a bag, pouring out the m&ms and sorting out the ones that do not land with the “m” facing up. They will record the number left, as these represent the undecayed atoms.
  They will then put the undecayed m&ms back into the bag, shake and pour them back out, repeating the procedure until no more m&ms remain undecayed.
- List the “big idea” conceptual questions that the teacher will ask to focus the student exploration.
  Nuclear decay is the changing of the number of protons (and neutrons) a nucleus contains.
  a. Does this decay happen in a regular repeating pattern?
  b. Does the decay happen in a regular time period?

EXPLAIN

- What is the “big idea” concept that students should have internalized from doing the exploration?

Unstable nuclei undergo change in a regular repeating process called nuclear decay. This involves the nucleus changing in any number of different methods to include alpha decay and beta decay. Both change the number of protons and neutrons in the nucleus. While the half-life is a constant, the number of atoms available for decay is cut in half each time; thereby making the graph of half-life non-linear.

- List the higher order questions that the teacher will ask to solicit student explanations for their laboratory outcomes, and justify their explanations.
  - a. If the number of protons and neutrons are changed in the nucleus, how does that affect the ratio of protons and neutrons?
  - b. Does the ratio of protons and neutrons of a nucleus determine stability of a nucleus? Why or why not?
  - c. Does the same element exist after nuclear decay? Explain.
  - d. Can there ever be no atoms left to decay? Explain.

EXTEND

- Explain how students will develop a more sophisticated understanding of the concept.

  Students will research a radioactive isotope of an element, build and then present by power point or (to differentiate, by poster) the decay process of an isotope of their choosing. They must include the half-life.
- How is this knowledge applied in our daily lives?

  Students will articulate in the power point or poster on how their isotope is used to enhance humankind's knowledge of our world. This might include medical treatment, pollution control, diagnosis or history of our universe. The half-life of their isotope needs to be considered in the application.

EVALUATE

- How will the student demonstrate their new understanding and/or skill?
  - a. Successful completion of the lab to include answering the questions and graphing the results.
  - b. Correctly answering questions at end of chapter tests and benchmark exams.
- What is the learning product for the lesson?
  - a. Completion of the lab.
  - b. Correctly answering lab questions.
  - c. Power point/poster.

Background Knowledge for the Teacher:

The radioactive half-life for a given radioisotope is a measure of the tendency of the nucleus to "decay" or "disintegrate" and as such is based purely upon that probability. The tiny nuclear size compared to the atom and the enormities of the forces that act within it make it almost totally impervious to the outside world. The half-life is independent of the physical state (solid, liquid, gas), temperature, pressure, the chemical compound in which the nucleus finds itself, and essentially any other outside influence. It is independent of the chemistry of the atomic surface, and independent of the ordinary physical factors of the outside world. Radioactive decay is a statistical process which depends upon the instability of the particular radioisotope, but which for any given nucleus in a sample is completely unpredictable. The decay process and the observed half-life dependence of radioactivity can be predicted by assuming that individual nuclear decays are purely random events. The radioactive half-life for a given radioisotope is the time for half the radioactive nuclei in any sample to undergo radioactive decay. After two half-lives, there will be one-fourth the original sample, after three half-lives one-eighth the original sample, and so forth.

Source: http://hyperphysics.phy-astr.gsu.edu

Student pages are attached.

Radioactive M&Ms

Pre-Lab Questions:

1. On the periodic table, the number for carbon is ______, and the atomic mass is ________. What do each of these numbers tell us?

2. Give the term for an element that has the same atomic number, but different atomic mass: ________________________.

3. What particle in the nucleus is responsible for this difference in mass?

4. Some isotopes are stable. What does this mean?

5. Some isotopes are unstable. What does this mean?

6. What is the atomic mass number for the stable isotope of carbon?

7. What is the atomic mass number for the unstable isotope of carbon?

8. What is given off by unstable isotopes?

9. During radioactive decay, the __________ isotope decays into a ____________ isotope that has a different ___________________ number.

Materials:
M&M™ candy pieces
resealable bag
graph paper

Procedures:

1. Place 50 atoms of candium (pieces of candy) in the bag.
2. Seal the bag and gently shake for 10 seconds.
3. Gently pour out candy.
4. Count the number of pieces with the print side up—and record the data. These atoms have "decayed".
5. Return only the pieces with the print side down to the bag. Reseal the bag.
6. Consume the "decayed atoms”.
7. Gently shake the sealed bag for 10 seconds.
8. Continue shaking, counting, and consuming until all the atoms have decayed.
9. Graph the number of undecayed atoms vs. time.

Trial	Number of Atoms Decayed	Number of undecayed atoms remaining	Class Total	Class Average
0				
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				

Graph:

Conclusion:

1. What is a half-life?

2. In the experiment, what was the half-life of the element candium?

3. At the end of two half-lives, what fraction of the atoms had not decayed?

4. Describe the shape of the curve drawn. Repeat the experiment three more times, starting with 30 atoms, 80 atoms, and 100 atoms of candium. Compare the resulting graphs.

5. Repeat the experiment using half-lives of 5 seconds, 20 seconds, and 1 minute. Compare the resulting graphs.