Lesson Title	What's My Age Again?
Length of Lesson	90 minutes
Created By	Erin Anderson
Subject	Chemistry
Grade Level	9-12
State Standards	1F, 3A, 3B, 3C
DOK Level	3: Develop a logical argument, Assess.
DOK Application	Identify research questions and design investigations for a scientific problem. Apply a concept in the other contexts.
National Standards	B. Physical Science
Graduate Research Element	Isotopic analysis is useful to determine recent climate changes, often preserved in sediments deposited in bays, the open ocean and within glacial ice. I work with sediments from 2 different Gulf Coast bays: Weeks Bay, AL and Tampa Bay, FL.

Student Learning Goal:
Students should be able to discuss the structure of an atom and the number and function of fundamental particles within the atom. Additionally, they should be able to identify situations where carbon dating would be an appropriate dating technique.

State Standards:
1F: Relate symbols to names of common chemical elements.
3A: Identify various theories of the atom, including Rutherford, Bohr, and electron cloud theories by matching the theory to its description.
3B: Identify the three fundamental particles of an atom when given the charge, mass, and location of the particle.
3C: Determine the number of protons, electrons, or neutrons in an element when given the atomic number and the atomic mass of the element, or vice versa.

National Standards: B. Physical Science: Structure of atoms:

- Radioactive isotopes are unstable and undergo spontaneous nuclear reactions, emitting particles and/or wavelike radiation. The decay of any one nucleus cannot be predicted, but a large group of identical nuclei decay at a predictable rate. This predictability can be used to estimate the age of materials that contain radioactive isotopes.

Materials Needed (supplies, hand-outs, resources): irradiated salt, Fossils (any), bones (non-fossilized), artifacts (pottery, cloth, etc.), rocks (extrusive and intrusive igneous, metamorphic), soil. Objects will be numbered and labeled. Each object will be surrounded by soil.

Lesson Performance Task/Assessment:
Match-Maker Dating Game:

- Students must decide which type of dating to use for different objects (uranium- or carbon-dating). Objects will be provided by the fellow. Students will handle volcanic rocks, sedimentary rocks, metamorphic rocks, soil, bone, cloth, and an ancient Roman ring. Some objects cannot be radioactively dated, but the soil around the objects can be carbon-dated. Students will decide whether or not to date the soil, the object, and what type of dating method to use. They will explain their choices.

Lesson Relevance to Performance Task and Students:
Understanding that different isotopes have different half-lives is important. Also, the objects that are being dated must contain the isotopes that are being analyzed. Would you use uranium dating on a cow skull? No.

Anticipatory Set/Capture Interest:

1. Irradiated salt demonstration:

Irradiated salt is red in color, because, when subjected to gamma radiation, the outer shell electrons of the salt molecule were excited to a higher state, changing the angle light reflects off and refracts through salt. When heated, the radioactive salt will glow, because heat releases the gamma rays, exciting the outer shell electrons as they absorb the radiation.

2. Radiation exposure sheet: How much radiation have you been exposed to? Students take a quiz and add up the numbers to determine the amount of radiation they've been subjected to.

Guided Practice:
The teacher will give a short lesson, describing different isotope dating techniques and their uses. In some cases, uranium-dating is better than carbon-dating and vice versa. Her reasoning will serve to guide the students when they make their own decisions during the Match-Maker game.

Independent Practice:
Students will explain why they chose the dating method they chose for each object.

Remediation and/or Enrichment:
IEP's will be supported. For remediation, the teacher will work with the students to help them determine which type of dating method is appropriate. For enrichment, specific decay types of U and C will be covered. Uranium-dating will be further discussed with an application to igneous

(volcanic and intrusive magma/lavas) and metamorphic (temperature and pressure-stressed rocks that have changed throughout time). Uranium-dating can give a date of formation for igneous rocks and a date of deformation (but NOT a date of formation) for metamorphic rocks.

Check(s) for Understanding:

1. What types of objects do you only use carbon dating for? *Organic objects within a certain time period.*
2. In the case of a rock, does uranium dating only provide the date of rock formation/crystallization? *No, in metamorphic rocks, uranium dating can be used to determine an ending date for deformation (the uranium "clock" began ticking when the rock cooled to a specific temperature (~900°C)).*
3. If I were trying to date a piece of lava, would I find the date of formation or the date of deformation? *Date of formation, because lava is frozen (crystallized) magma.*

Closure:
Students are aware of different dating methods used by geologists. Really, everything a geologist does is either chemistry or physics.

Possible Alternate Subject Integrations:
Geology, History, Physics

Teacher Notes:
All organic material should be carbon-dated. This includes cloth, twigs, roots, ash.
All inorganic material can be uranium-dated IF the object contains uranium and its daughter product. The object MUST be old enough to have undergone a measurable amount of uranium-decay.

Half lives:
carbon-14 (**half-life** of 5730 years)
uranium-238 (**half-life** of 4.47 billion years)
uranium-235 (**half-life** of 704 million years)

Irradiated salt activity: http://www.new.ans.org/pi/edu/teachers/reactions/docs/2006-03.pdf
Estimate Your Radiation Dose: American Nuclear Society, www.ans.org

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Student Learning Goal: Must correctly match chemistry vocabulary with clues read by the instructor.

State Standards: All Chemistry I

National Standards: B. Physical Science.

Materials Needed (supplies, hand-outs, resources): Teacher's Discovery Bingo Kit, poker chips, candy.

Lesson Performance Task/Assessment: Students must recall concepts and vocabulary that they have learned over the course of the semester. They must identify the correct clue with the vocabulary word on their Bingo sheet.

Lesson Relevance to Performance Task and Students: Students need to regularly review their chemistry concepts throughout the semester, so they will not forget. Also, reviewing concepts leads to a deeper understanding.

Anticipatory Set/Capture Interest: Chemistry crossword: a brief crossword puzzle will show the students what they know and what they don't know. We will immediately begin the Bingo game after spending a few minutes on the crossword puzzle.

Guided Practice: Instructor reads out concepts and clues to students during the Bingo game.
Independent Practice: Students must correctly match the clue with the vocabulary word on their Bingo sheet.
Remediation and/or Enrichment: All IEP's will be supported. For remediation, more clues will be given to help the students score Bingo. For enrichment, difficult concepts and experiments will be mentioned by the instructor, and students must correctly match these clues with the correct vocabulary word.
Check(s) for Understanding: Different students should score Bingo each time. If the same student scores Bingo over and over again, confusing concepts will be revisited and discussed before the period ends.
Closure:

- Will this game be helpful in preparation for the final?
- How did this game help you remember and understand concepts that we've already

studied?

Possible Alternate Subject Integrations:

Teacher Notes:

Teacher's Discovery Bingo Set printed by Teacher's Discovery. Available online for purchase.