Prince William County Schools, Virginia

Active Physics - Unit topic: Scientific Thinking

Lesson: Use of Isotopes in Archeology

Big Idea/Big Question:

- **<u>Our knowledge of atomic structure (nuclear reactions) is used to understand history of humankind.</u>**

Secondary ideas (prior knowledge):

- **The identity of an atom depends on the number of protons.**
- **Individual atoms for an element may have different mass due to variations in the number of neutrons, creating isotopes.**

Key Vocabulary:
isotope, half-life, decay, nucleus, proton, electron, neutron, carbon, radioactive, archeology

Lesson Objective(s):
VA SOL PH.3 The student will investigate and understand how to demonstrate scientific reasoning and logic. Key concepts include: b***<u>) analysis of how science explains and predicts relationships</u>***; and c) evaluation of evidence for scientific theories.

VA SOL PH.14 The student will investigate and understand that *extremely large and extremely small quantities are not necessarily described by the same laws as those studied in Newtonian physics*. Key concepts include: c) matter/energy equivalence; f) ***<u>nuclear physics; and i) radioactivity</u>***.

Engage (10 mins):
Warm-up questions:

- How can we tell the age of ancient artifacts?
- How certain are we of the age of a civilization?

(think-pair-share) Students will reflect on these questions and write a short explanation on their journal. They will share with a partner, listing the differences on their journal. The teacher will circulate the room to monitor the exchanges and pick a couple of pairs to share with the group key points that lead into the discussion; either misconceptions or prior knowledge.

Explore – Part I (30 mins):
Frame (Teacher):
Students will be presented with a short video about carbon dating:
http://science.howstuffworks.com/environmental/29401-assignment-discovery-carbon-dating-artifacts-video.htm
If this was part of their answers during warm-up questions, the teacher will ask them to explain the process before showing the video and write their impression after the video.
The teacher will present to the class a marble model of C-12 and C-14 nuclei to distinguish the two structures and emphasize that the number of protons is the same for both.
Do-It-Now (DIN, Students):
Part I – Students will be provided with a sample of “C-14” nuclei (100 M&M’s) and will record how many of the atoms are still carbon after shaking the container, remove the ones that have decayed, and repeat the process until all atoms have decayed. Each student will create a graph of their data. Students will gather in small groups to compare their graphs. The graph will be used to illustrate half-life, where shaking the

Formative Assessment:
Part I – Solve the “debate”: Scenario: Two archeologists are convinced that the artifacts found at their excavation site belong to different civilizations that occupied that region at different times.

Students will be provided information regarding multiple artifacts found at an excavation site to estimate their age and determine which of the archeologist is right.
Extend: Are all artifacts from the same time period?

box is equivalent to one half-life period. (The challenge is to emphasize the idea of a ratio of C-12 to C-14 in a living organism, and explain that in reality the atoms that decay remain in the sample – they don't disappear or escape.) **Explain – Part I (10 mins):** The teacher will present the half-life for C-14 and apply it to determine the age of various artifacts used as examples. **Explore - Part II (10 mins):** Students will be asked to explain how C-12 becomes C-14, based on their knowledge of atoms. They can use pictures, models, or words in their explanation. The teacher will prompt students, as appropriate, in regards to conservation laws (conservation of mass, energy, charge). They will write their explanations on whiteboards and bring them to the front of the classroom to share. **Explain – Part II (20 mins):** The teacher will model the decay process using a magnetic model of the nucleus as an example of beta decay and show the path of that decay on the chart of nuclei. Students will be asked to identify other isotopes that may have similar behavior. The teacher will emphasize that this is one of multiple nuclear reactions that result in isotopes or new elements. This will serve as the lead into further lessons on other radioactive materials and their use in medicine or technology. **Evaluate (10 mins):** Students will be asked to reflect why carbon is the element selected for dating ancient remains and artifacts. They will answer the following questions on an *exit slip*. ● What makes it the optimum element for this purpose? ● What other methods could we use if carbon dating was unknown? ● What points of the lessons where unclear?	
Support: ● Students will be provided both verbal and written instructions. ● English language learners will be provided a translation of instructions (Spanish), if requested. A bilingual dictionary is also available for their use. ● Teacher will model steps of the activity, as needed.	**Formative Assessment:**
Summarize the lesson:	**Formal Assessment:** -To be determined-
Differentiation: Student responses to warm-up questions will be used to distinguish those students that require additional information/prompts to complete the task. They may be a) paired with a student that has prior knowledge of the topic; or b) grouped together so that the teacher can provide an alternate version of the activity. To assist students that have trouble with multi-step procedures (identified as part of their accommodations), the group will be	

provided with a template for their data collection table and graph.	
Homework: Students will research (library/ online) when carbon dating was invented and find if prior techniques were available. Were there political/medical/social issues from this discovery?	
Follow Up: Subsequent lessons may relate to other decay mechanisms, or discoveries of radioactive substances. The focus will be on the modern day application of that discovery and/or the risks and sacrifices made by the scientists involved.	