Educational Resources from *Phenomenon Science Education*

Student Proficiency Goals for Performance Expectation **HS-PS1-8**

Information about Performance Expectation HS-PS1-8

Performance Expectation HS-PS1-8.

Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay.

Clarification Statement.

Emphasis is on simple qualitative models, such as pictures or diagrams, and on the scale of energy released in nuclear processes relative to other kinds of transformations.

Assessment Limits.

Assessment does not include quantitative calculation of energy released. Assessment is limited to alpha, beta, and gamma radioactive decays.

Science and Engineering Practice (Developing and Using Models)

- Develop a model based on evidence to illustrate the relationships between systems or between components of a system.

Disciplinary Core Idea (PS1.C: Nuclear Processes

- Nuclear processes, including fusion, fission, and radioactive decays of unstable nuclei, involve release or absorption of energy. The total number of neutrons plus protons does not change in any nuclear process.

Crosscutting Concept (Energy and Matter)

- In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved.

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SEP (Developing and Using Models):

- Students use evidence to identify and assign roles for the components required for their models.
- Students use evidence to identify the systems that their models are required to illustrate.
- Students develop models that can address phenomena related to the nuclear processes of nuclear fission, nuclear fusion, alpha radioactive decay, beta radioactive decay, and gamma radioactive decay.
- Students develop models that can illustrate the changes in total particle identity and count during nuclear processes.
- Students use models to illustrate the release or absorption of energy during nuclear processes.
- Students use models to illustrate the similarities and differences in the nuclear processes of nuclear fission, nuclear fusion, alpha radioactive decay, beta radioactive decay, and gamma radioactive decay.

DCI (PS1.C Nuclear Processes):

- Students know that nuclear fusion is the process of two or more atomic nuclei combining into a single atom.
- Students know that nuclear fission is the process of a neutron slamming into the nucleus of a larger atom causing it to split into smaller atoms.
- Students know that alpha, beta, and gamma radioactive decay are processes during which unstable atomic nuclei release energy and sometimes particles.
- Students know that energy is required for some nuclear processes.
- Students know that energy is released during most nuclear processes.
- Students know that the total number of neutrons plus protons in a nuclear process does not change even though the total number of neutrons and the total number of protons can change.

CCC (Energy and Matter):

- Students consider the flow of energy into, within, and out of a system undergoing a nuclear process.
- Students consider the flow of matter into, within, and out of a system undergoing a nuclear process.
- Students consider that total energy is conserved, meaning no energy is lost or gained during the process.
- Students consider that atoms are not conserved during nuclear processes but that the total number of protons plus neutrons is conserved.