Short Performance Assessment (SPA)

Performance Expectation: **HS-PS1-8**

Grade Level: **High School**

Adapted from SNAP[1]

Title	**The Evolution of Nuclear Weapons**		
Designed by	**Jordan Pekor, Judith Lemire, Bob Colascione, Amanda LaComb**	Course(s)	**Chemistry, Physics**

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 Boundary**: 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 Ideas	**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.

Student Performance	1. Components of the model 2. Relationships 3. Connections

[1] The Short Performance Assessment (SPA) and the Assessment Rubric adapted from the Stanford NGSS Assessment Project http://snapgse.stanford.edu/

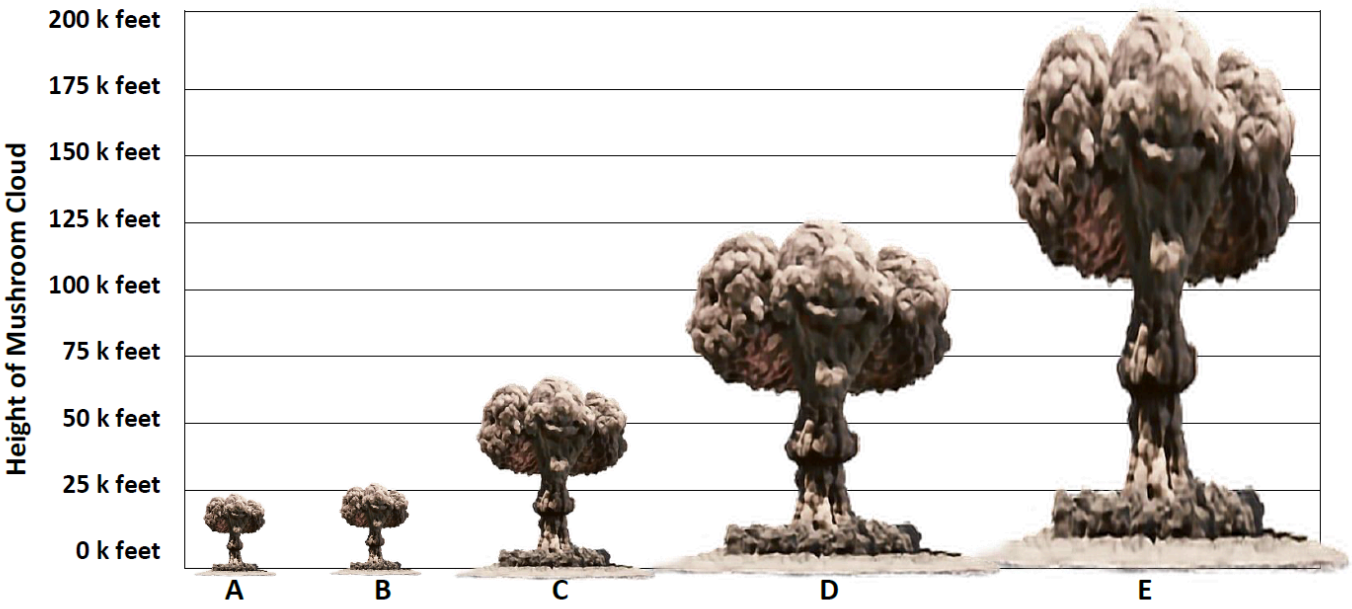
Short Performance Assessment

Phenomenon

During World War II, fission bombs were developed and dropped on Japan. Since this time, hydrogen (fusion) bombs have been created and improved upon. A comparison of some of these weapons are shown below:

Stimulus

The Evolution of Nuclear Weapons



A – Hiroshima, Japan, 1945

B – Nagasaki, Japan, 1945

C – French Test, 1970

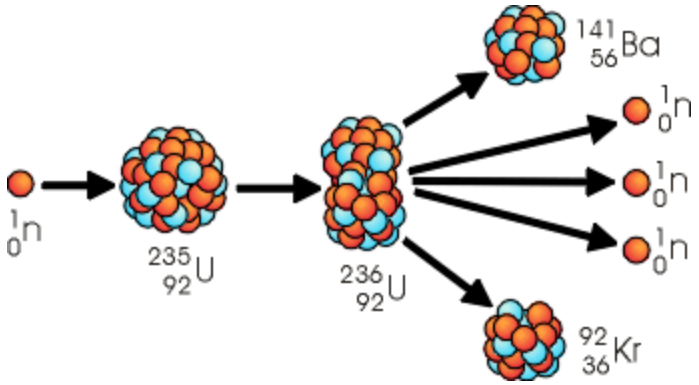
D – US Test, 1951

E – Soviet Test, 1961

Prompt

1. What pattern or patterns do you notice in the chart between fission and fusion bombs and the amounts of energy they release? Justify your response with evidence from the chart.
2. Compare and contrast the relationship between matter and energy in a fission versus a fusion bomb.

3. A model of the mechanism involved in a nuclear reaction is given:



https://commons.wikimedia.org/wiki/File:Nuclear_fission_reaction.svg

Is this a fusion or fission reaction? What evidence from the model made you come to this conclusion?

4. Using the model given in question 3, how do the outputs of this system contribute to a chain reaction?

Name_____

The Evolution of Nuclear Weapons

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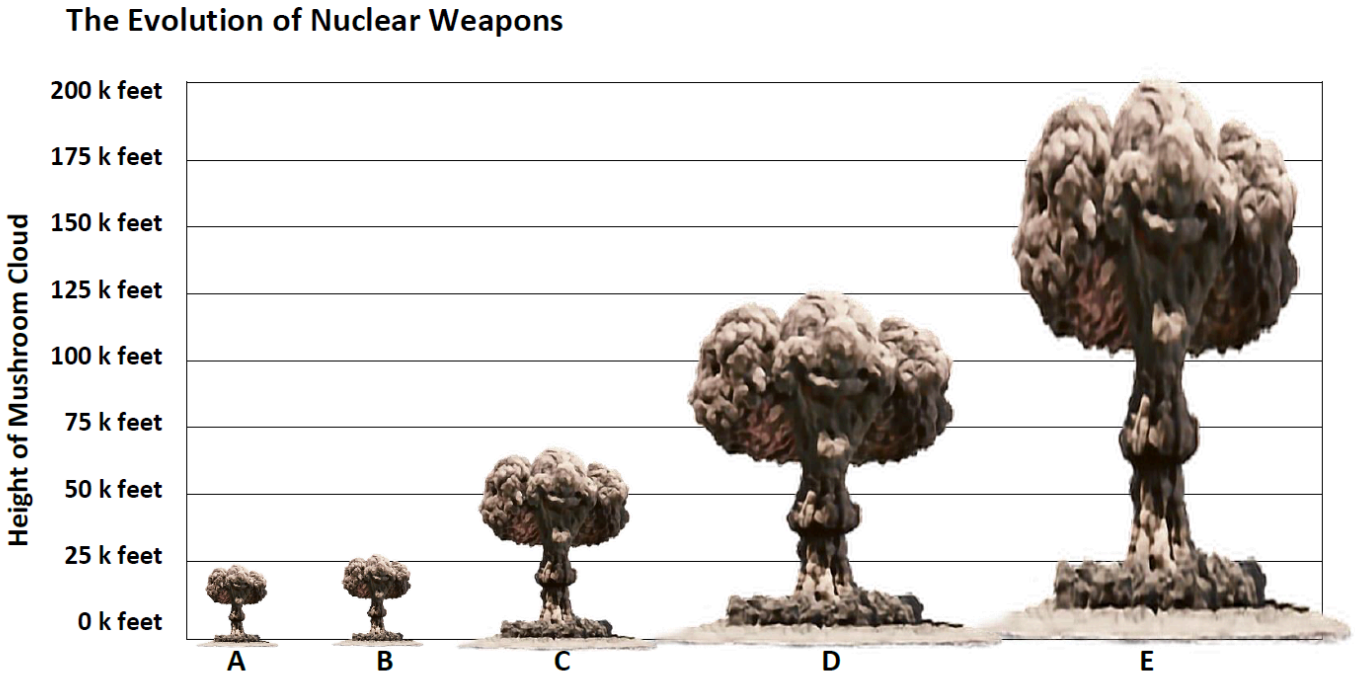

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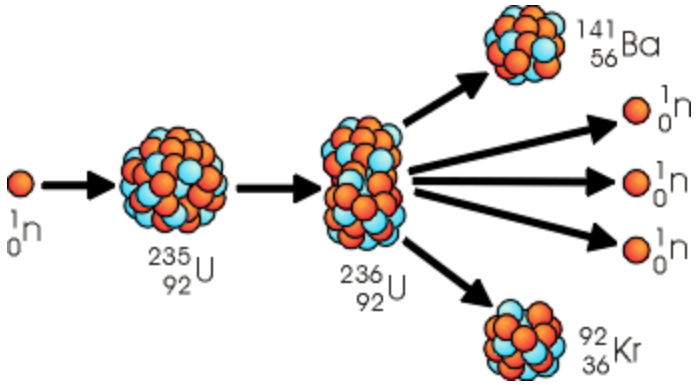

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Assessment Rubric* - Question 1				
	Emerging	Developing	Approaching Proficiency	Excelling
Description of performance	Fails to or incorrectly identifies the pattern.	Identifies the pattern but does not include a justification.	Identifies the pattern but has an incomplete or incorrect justification	Properly identifies the pattern and provides a correct justification for the pattern.
Sample student responses	A fission bomb produces more energy than a fusion bomb. It is greater.	The fusion bomb produces more energy than a fission bomb.	The fusion bomb produces more energy than a fission bomb because they were developed after the fission bombs.	The fusion bomb produces more energy than a fission bomb as indicated by the height of the blast (higher blasts would require greater energy

Assessment Rubric* - Question 2				
	Emerging	Developing	Approaching Proficiency	Excelling
Description of performance	Fails to identify a similarity and difference in the relationship between matter and energy for both fusion and fission.	Fail to show a relationship between fission and fusion, but show a similarity or difference between the reactions.	Identifies only a similarity or difference between fusion and fission, but does show the relationship between matter and energy.	Identifies both a similarity and difference in the relationship between matter and energy for both fusion and fission
Sample student responses	More energy is produced in fission.	Matter is converted to energy. OR More energy is produced during fusion.	Matter is converted to energy in both fusion and fission. OR More energy is produced during fusion because more matter is converted.	Matter is converted to energy in both fusion and fission. However, more energy is produced during fusion because more matter is converted.

Assessment Rubric* - Question 3				
	Emerging	Developing	Approaching Proficiency	Excelling
Description of performance	Student misidentifies the reaction as a fusion reaction, and does not provide the splitting of a larger nucleus into smaller fission products as evidence.	Student identifies the reaction as a fusion reaction, but does not provide the splitting of a larger nucleus into smaller fission products as evidence.	Student misidentifies the reaction as a fusion reaction, but provides the splitting of a larger nucleus into smaller fission products as evidence.	Student identifies the reaction as a fission reaction, and provides the splitting of a larger nucleus into smaller fission products as evidence.
Sample student responses	This is a fusion reaction.	This is a fission reaction.	This is a fusion reaction. I can tell this because the larger nucleus is splitting into smaller nuclei.	This is a fission reaction. I can tell this because the larger nucleus is splitting into smaller nuclei.

Assessment Rubric* - Question 4				
	Emerging	Developing	Approaching Proficiency	Excelling
Description of performance	Student neither demonstrates an understanding of a chain reaction, or how the outputs of the model contribute to the mechanism driving the chain reaction.	Student demonstrates understanding of the definition of a chain reaction, but not how the outputs of the model contribute to the mechanism driving the chain reaction.	Identifies the three neutrons ejected from the nucleus serve and the incident neutrons for the fission of three more uranium atoms, but fails to explain that a chain reaction results in an increasing rate of reaction.	Identifies the three neutrons ejected from the nucleus serve and the incident neutrons for the fission of three more uranium atoms. Student demonstrates that this results in exponential growth in the rate of this reaction.
Sample student responses	A chain reaction is a nuclear reaction.	As time goes on, the reaction involves more and more atoms.	The three neutrons on the products side of the reaction go on to strike three more uranium atoms, resulting in their fission.	The three neutrons on the products side of the reaction go on to strike three more uranium atoms, resulting in their fission. Each of these emit three more neutrons for a total of nine. As time goes on, this increase in number of ejected neutrons results in a reaction that grows at an exponential rate.

Insert additional Assessment Rubrics (if needed) here.