In a chemical process, chemical reactions occur. For instance, propane gas burns, a chemical reaction occurs. In this chemical reaction, propane and oxygen react to form carbon dioxide and water. The model shows that mass is conserved during the reaction. We describe a systematic approach to designing rubrics for scoring equitable physical science assessment items. Rubric design for assessment task design involves unpacking learning performances (designed in previous project phase) aligned to NGSS performance expectations (PES) and designating Focal Knowledge, Skills, and Abilities (FKSAs) that evaluate various dimensions of an item response. The assessment items measure student proficiency related to chemical reactions and energy at the middle school grade band.

### FKSAs [J: atoms conserved in a model]
**Ability to support model use, development, or evaluation by explaining that a chemical reaction conserves atoms and/or mass**

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| 0     | One or more of the following:  
- Missing or incorrect statement about atom conservation in the reaction  
- Student refers only to representational elements (e.g. black/red/grey circles) without referring to atoms  
- General statement about the same number of atoms, without referring to specific elements |
| 1     | States one or two of the following:  
- Both sides have 10 oxygen atoms  
- Both sides have 8 hydrogen atoms  
- Both sides have 3 carbon atoms AND/OR  
- Student states that there are the same number of oxygen atoms AND hydrogen atoms AND carbon atoms on each side, without stating the numbers |
| 2     | Both sides have 10 oxygen atoms  
Both sides have 8 hydrogen atoms  
Both sides have 3 carbon atoms  
Student states all of the following:  
- Both sides have 10 oxygen atoms  
- Both sides have 8 hydrogen atoms  
- Both sides have 3 carbon atoms |

**Sample Task**

Many people use a propane gas stove to cook when camping. When propane burns, a chemical reaction occurs. In this chemical reaction, propane will react with oxygen to form carbon dioxide and water. The model below represents what happens during the chemical reaction. Use the model and what you know about chemical reactions to answer the questions below.

Support your answers using the model to describe what occurs with the atoms that make up propane, oxygen, carbon dioxide, and water. Be sure to include the number and/or types of atoms for each molecule before and after the reaction.

1. What is the balanced chemical equation for this reaction?
2. How do you know a chemical reaction occurred?
3. Discuss the phenomena using the model elements. Describe interactions among appropriate specific elements.
4. What are the products of this reaction?
5. What was conserved in this reaction?
6. Describe the regrouping or rearrangement of atoms in the model.

**Exemplar Responses**

A. A chemical reaction occurs when atoms of the original substances (propane and oxygen) regroup to form new substances (carbon dioxide and water). The model shows that carbon dioxide and water are made of oxygen, carbon, and hydrogen atoms. These atoms are the same as the atoms that make up propane and oxygen. This means carbon dioxide and water are produced by the regrouping of the atoms of propane and oxygen.

B. In the model, one molecule of propane and five molecules of oxygen have a total of ten oxygen atoms, three carbon atoms, and eight hydrogen atoms. After the reaction, the three carbon dioxide molecules and four water molecules also have a total of ten oxygen atoms, three carbon atoms, and eight hydrogen atoms. The total number of each type of atom before and after the reaction has not changed. Therefore, the mass stays the same.