7.PS1.5 How Many Atoms?

Pattern Analysis of Student Thinking (PAST)

Performance Expectation (PE)

Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved.

Targeted Disciplinary Core Idea (DCI) | Chemical Reactions

- Substances react chemically in characteristic ways.
- In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants.
- The total number of each type of atom is conserved, and thus the mass does not change.

Task 1

Use a model to explain how oxygen and iron react.

Purpose	Student Response Themes	Examples of Student Responses	Possible Teacher Instructional Moves
In this task, questions 1a and 1b are designed to determine how students define the red dirt system. Students define the boundaries of the system and evaluate the usefulness of each component to illustrate the process of red dirt formation. Question 1c is designed so that students identify how iron and oxygen interact within the defined system. Student answers may vary but should indicate at least that the iron and oxygen bond together.	**Question 1A** Student identifies the components (air, soil, oxygen molecules, iron molecules, and iron oxide (Fe_2O_3) in the modeled system. **Question 1B** Student lists the system components important in the formation of red dirt such as iron and oxygen. **Question 1C** Student describes that iron and oxygen combine during a chemical change to form rust. Student may describe the proportions of iron and	• The parts of the system are air, soil, oxygen and iron before it becomes "red dirt". After it is air, soil, and rust in the dirt. • Air, soil, oxygen, iron, iron oxide • The important parts of the "red dirt" are oxygen and iron and it shows that iron interacts with oxygen in the soil to make iron oxide that causes the soil to be red. • Our dirt is red because iron in the soil combines with oxygen to oxidize to form rust which is red. • Every 2 irons and 3 oxygens combine	Give students other examples of modeled systems and have them identify the components of the system. Model identifying the components for the students if needed. Have students physically act out rearrangement of materials in a chemical reaction in small groups and/or with the whole class. Facilitate small group discussions with manipulatives to discuss what occurs in chemical reactions. Pair a student who understands with a student who does not in order to facilitate peer tutoring. Have students explain and model their thought process to a peer.

	oxygen before, during, and/or after the chemical change.	to form Fe2O3 (rust). • Oxygen and iron combine to form iron oxide or rust. • They are making rust.	

Focus SEP/CCC: Students use a model of Oklahoma "red dirt" to describe the unobservable mechanism of oxidation, as oxygen molecules in the atmosphere are conserved when they chemically react with iron in the soil.

Task 2

Support a given claim about the mass of red dirt with evidence and reasoning.

Purpose	Student Response Themes	Examples of Student Responses	Possible Teacher Instructional Moves
This task is designed to elicit student understanding of conservation of matter and their concept of the mechanism of conservation in a chemical reaction. Students utilize the "red dirt" model to provide evidence for what happens in the oxidation reaction. In choosing responses, students will reveal how they define the system (e.g. the air and the soil, or just the soil). Answers may be internally inconsistent. If they choose b, the student should have defined the system as the soil only and the teacher may need to clarify how the conservation of matter still	**Question 2** • Student describes chemical change and resulting mass change. Student description may differ depending on how the student defined the system. • Student defines only the soil as the system. The student describes that oxidized soil will weigh more due to the added oxygen. • Student defines air and soil as the system. The student communicates that the number of molecules after the formation of "red dirt" equals	• Claim B — "Red dirt" weighs more than original dirt because the weight of the oxygen is added to it in the reaction. • I chose claim B because red dirt has more mass because it takes the oxygen away from the air. • Claim c because the Law of Conservation of Matter says all the atoms before the reaction are still present after. • I choose claim c because it is only a physical change in appearance. It's still	Have students discuss the three viewpoints and/or the different ways the system can be defined. Facilitate the discussions so that students have the opportunity to see how the definition of the system can alter the answer. Show the soil system to the students and draw a box or circle around the system as it could be defined in different ways. Give students the opportunity to see how in all cases the conservation of matter can be applied. Give students other opportunities to see the conservation of matter, such as the steel wool burning investigation, to help students understand where "extra mass" is entering the system. If students struggle with the

applies. If they choose c, the student should have defined the system as both the atmosphere (air) and geosphere (soil). Inaccurate claims may be paired with evidence and explanations that demonstrate conceptual understanding (in part or in full).	the number of molecules before the "red dirt" formed.	dirt, just a different color. (Incorrect)	idea of gas having mass, have students measure the masses of different gasses in closed systems.

Focus SEP/CCC: Students apply the scientific idea of conservation of matter to a model of chemical reaction occurring in soil to explain why Oklahoma "red dirt" has more mass after the oxidation of iron in the soil system.