

Chemical Reactions

Science Grade-Level Expectations

The exercises in this instructional task address content related to the following science grade-level expectation:

PS-M-A7 Compare the masses of reactants and products of a chemical reaction (GLE 11)

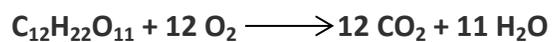
PS-M-A8 Determine the effect of particle size of the same reactants on the rate of chemical reactions during a lab activity (e.g., powdered vs. solid forms) (GLE 12)

	Objectives
Task	<ul style="list-style-type: none"> - Evaluate a reaction equation to draw a conclusion - Cite evidence to support conclusion - Analyze models of a closed system - Explain changes in mass throughout changes in a system
<u>Sample Student Exemplar Response</u>	

Implementation Tips:

- This task is intended to be integrated into a larger unit that contains hands-on science opportunities, student-led investigations, non-fiction reading, and a variety of other instructional strategies.
- Teachers may choose to use or modify the task as part of an instructional lesson or as a formative or summative assessment.
- Strategic instructional decisions will need to be determined prior to implementation such as:
 - Should the provided text be read aloud to students or read independently by students?
 - Will students work collaboratively or individually to complete the task?
 - What content knowledge and skills will students need to have prior to attempting the task?
 - Does the task need to be modified based on the needs of the students at the time of implementation?

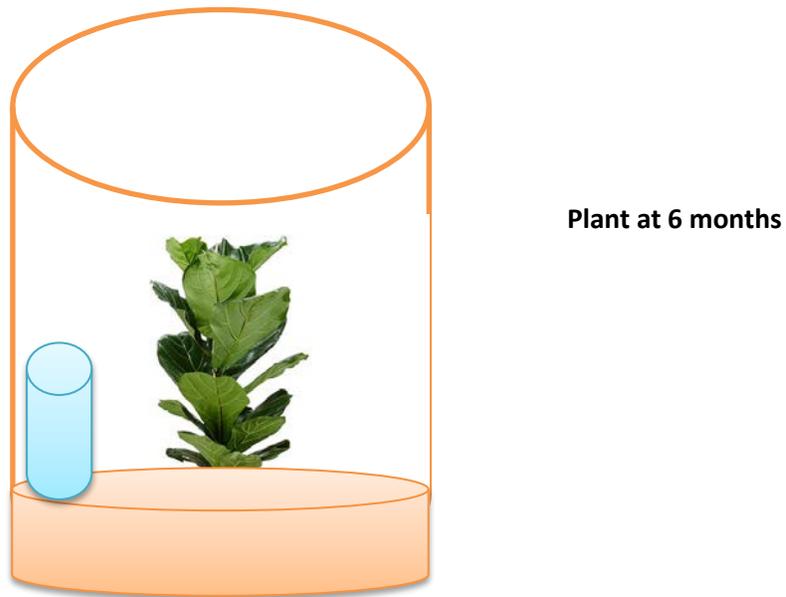
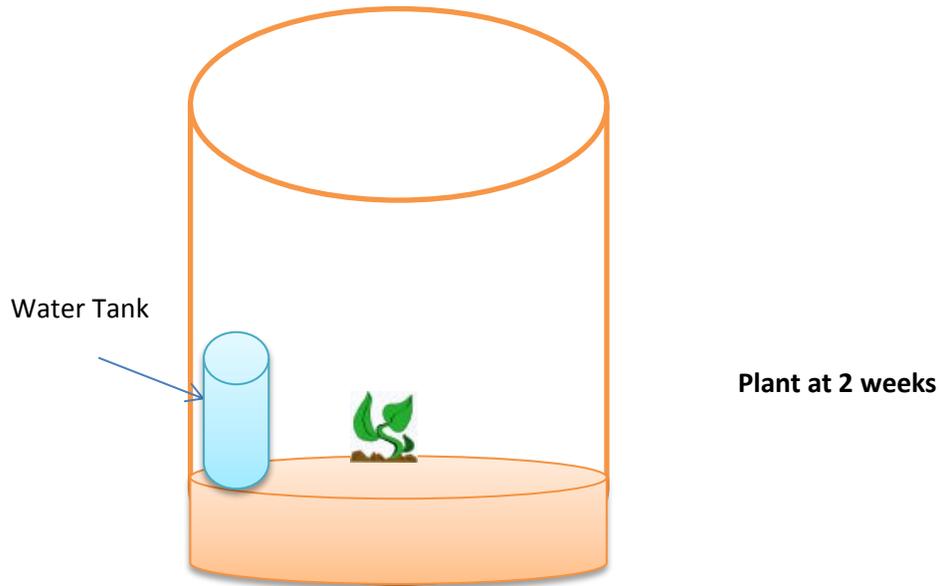
- Read [Sugar, an Unusual Explosive](#), a news article featuring a dynamic chemical reaction.
- Analyze the equation for the chemical reaction when sugar burns.



Task Part 1: Evaluate the equation above. Draw a conclusion as to how this equation relates to the law conservation of matter. Cite evidence from the equation to support your conclusion.

Task Part 2: Describe why sugar, a product that is found in virtually all kitchens, became a dangerous substance at the Savannah, Georgia plant.

- Inside a large **sealed** glass container is moist soil, a cycling irrigation system, and a seed just planted. The container with soil, seed, and water are massed. The container is placed in the sunlight and observed.



Eventually, the plant is allowed to die and dry up. The entire container with its contents is massed again.

Task Part 3: Explain what will happen to the total mass inside the sealed container during this process and when massed at the end.

Sample Student Exemplar Response

Part 1

The number of carbon, oxygen, and hydrogen atoms is the same on both sides of the equation. There are a total of 12 carbon atoms, 35 oxygen atoms, and 22 hydrogen atoms on the left side of the equation (reactants) and the same number of the right side of the equation (products), so the quantities are equal before and after the reaction.

Mass and matter are conserved because the mass of each atom, the total number of each atom, and the total mass remains the same before and after the reaction. If you have the same number and mass of each atom in the reactants and the products, the conservation of matter is justified by the balanced equation.

Part 2

Explosive reactions are influenced by several factors. One of those factors is the surface area of the substance. When a substance is finely divided, it will normally produce a faster reaction than if the same mass is present as a single lump. A sugar cube has a specific surface area, but, when it is split or crushed, the surface area of all of the pieces combined is significantly higher than the original sugar cube.

The sugar plant in Savannah, Georgia, had finite particles of sugar coating the floor, the machinery, and floating in the air. The overall surface area of the sugar dust was significant. Because there was a source of ignition, each dust particle in the air and the sugar dust covering the surfaces became a potential target for combustion.

Considerably smaller amounts of sugar are found in individual homes than was found in the sugar plant. Additionally, sugar found in homes is typically stored in containers, further reducing the chance of an explosive reaction. The surface area of sugar in people's homes is minimal when compared to the surface area of the sugar dust found at the sugar plant in Georgia.

Part 3

The total mass inside the sealed, closed system will not change. Matter will change in form and composition as the plant changes and dies, but the total mass will not change. Plants use the atoms in water, carbon dioxide and minerals (nitrogen and phosphorus) from soil to chemically create all it needs for growth. Through photosynthesis, $(6\text{CO}_2 + 12\text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2 + 6\text{H}_2\text{O})$ the plant takes in light energy, carbon, and water to produce sugar, water, and oxygen. Through respiration, the plant uses the sugar produced from photosynthesis to unlock energy needed for the plant. At some point, the rate at which stems and leaves die begins to equal the rate of new growth. When the plant dies, decomposition yields the same atoms in the same amounts back to the soil and air, so the total mass inside the sealed container will remain exactly the same throughout growth and death. The mass will exist in different forms.