

# Conservation of Mass

## Conservation Series

### *Instructor's Guide*

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DEVELOPED BY THE TEACHING AND LEARNING LABORATORY AT MIT  
FOR THE SINGAPORE UNIVERSITY OF TECHNOLOGY AND DESIGN

# Introduction

## When to Use this Video

- In Chem 101, at home or in recitation, before Lecture #3: Stoichiometry
- Prior knowledge: basic stoichiometry

## Learning Objective

After watching this video, students will be able to apply the law of conservation of mass to real-world scenarios.

## Motivation

- Many students have a hard time using the law of conservation of mass correctly when reasoning about real-world phenomena, or neglect to use it entirely.
- Emphasizing conservation of mass early in the curriculum will provide scaffolding for future engineering courses.

## Student Experience

It is highly recommended that the video is paused when prompted so that students are able to attempt the activities on their own and then check their solutions against the video.

During the video, students will:

- Select a control volume to aid their calculations.
- Identify the mass entering, exiting, and accumulating in the control volume.
- Calculate unknown quantities using stoichiometry.
- Check their solutions against the video.

## Key Information

*Duration:* 10:39

*Narrator:* Prof. Mark Bathe

*Materials Needed:*

- Paper
- Pen/pencil

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## Video Highlights

This table outlines a collection of activities and important ideas from the video.

Time	Feature	Comments
0:37	Prerequisite Knowledge and Learning Objectives	
1:05	Time lapse video of a plant growing	
1:22	Students are introduced to the concept of a control volume.	This may be a new concept for your students.
3:33	Students apply conservation of mass to an example of a growing plant.	After selecting a control volume, students use the law of mass conservation to determine the amount of reactants and products that must have entered and exited the control volume given a certain increase in mass of the plant.
6:55	Students apply conservation of mass to a rusty car.	After selecting a control volume, students use the law of mass conservation to determine the amount of reactants and products that must have entered and exited the control volume given a certain decrease in mass of a rusty car.

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### Video Summary

This video reviews the law of conservation of mass and basic stoichiometry. Students are introduced to control volumes as a conceptual tool to aid in problem solving. Students use the concepts of mass conservation and control volumes to find unknown information in examples about a growing plant (photosynthesis) and a rusting car (iron oxidation).

# Chem 101 Materials

When appropriate, this guide is accompanied by additional materials to aid in the delivery of some of the following activities and discussions.

## Pre-Video Materials



1. To motivate the importance of using conservation laws to explain real-world phenomena, watch a brief video clip from the “Lessons from Thin Air” video, part of the “Minds of Our Own” video series produced by the Harvard-Smithsonian Center for Astrophysics. This video clip can be found online at [http://www.learner.org/vod/vod\\_window.html?pid=77](http://www.learner.org/vod/vod_window.html?pid=77).



During minutes 4:00-5:47, Harvard graduates are asked about the origin of mass in trees. When asked whether  $\text{CO}_2$  could be a primary source of the mass, students react with disbelief that a gas could be the source of a tree’s mass. Play the video clip and then ask your students what they think. Where do they think a tree’s mass comes from?



2. Because many students do think of gases as “massless” continue to discuss this topic with your students. Ask your students, “In a reaction where a gas is produced, is mass still conserved? Why or why not?”

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## Post-Video Materials

Use the following activities to reinforce and extend the concepts in the video.



**1.** Have students form groups of two or three. Each group should come up with an example or scenario where people might consider mass to have been “lost”. Groups should then present their example to the rest of the class along with an analysis of why the mass wasn’t lost after all. For example, students might think of composting. What happens to biomass in a compost pile? Or students might think of a human that has lost “weight”? Where did that mass go?

Note: Students may have questions about the equivalency of mass and energy ( $E=mc^2$ ). In chemical reactions, the amount of mass that might be converted into another form of energy (and vice versa) is so small that mass and energy can be thought of as separately conserved. In nuclear reactions, however, a significant conversion of mass to energy may occur. Thus, the law of conservation of mass can no longer be applied separately from conservation of energy.

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## Additional Resources

### Going Further

Your students will use the law of conservation of mass throughout their undergraduate experience, but will most likely see it in differential form. Have students derive the differential form of the mass conservation law by shrinking the control volume to the size of a differential volume element.

### References

The following MIT Open CourseWare lecture discusses Lavoisier's experiment.

- Cummins, Christopher, and Sylvia Ceyer. 5.112 *Principles of Chemical Science, Fall 2005*. (Massachusetts Institute of Technology: MIT OpenCourseWare), <http://ocw.mit.edu> (Accessed 22 Dec, 2011). License: Creative Commons BY-NC-SA  
–Video Lecture #1 discusses Lavoisier's experiment.

The following resources discuss students' conceptions of conservation of mass, particularly as applied to real-world scenarios.

- Schneps, M., Sahiner, A., Jones, W., Arterberry, M. (Producers), (1997). *Minds of Our Own* [DVD]. Available from [http://www.learner.org/vod/vod\\_window.html?pid=77](http://www.learner.org/vod/vod_window.html?pid=77)
- Hartley, L., Wilke, B., Schramm, J., D'Avanzo, C., Anderson, C. (2011). College Students' Understanding of the Carbon Cycle: Contrasting Principle-based and Informal Reasoning. *Bioscience*, 61(1), 65-75.

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<http://ocw.mit.edu>

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Fall 2013

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