

# Newtonian vs. Non-Newtonian Fluids

Teacher Facilitation Guide | Science, Physics Grades 11–12

Essential Question	Learning Goals	Standards
What is the key difference between Newtonian and non-Newtonian fluids?	Students will be able to: <ul style="list-style-type: none"> <li>compare and contrast Newtonian and non-Newtonian fluids.</li> <li>reflect on practical and industrial applications of non-Newtonian fluids.</li> </ul>	NGSS HS-PS2-6 Motion and Stability: Forces and Interactions

## Preparation

1. Review this Teacher Facilitation Guide. Edit the lesson to accommodate the needs of your students and the limits of your classroom. Consider which activities lend themselves best to teacher facilitation, group collaboration, and/or independent practice
2. Review and make a copy of the [Newtonian vs. non-Newtonian Fluids Slide Deck](#). Edit as needed.
3. Review the [Newtonian and non-Newtonian Activity Sheet](#), including all resources and links. Edit as needed and decide if you want to assign a digital or physical copy.
4. Review the learning artifact options and make a plan for which choice(s) you will offer.
5. [Gather materials needed for students to design an oobleck investigation in Activity 2.](#)

### Learning Artifact

Students will create an infographic, or other visual of their choice, to demonstrate their understanding of the differences between Newtonian and non-Newtonian fluids and answer the essential question.

Other options include:

- Composing a written response to the essential question.
- Participating in a group discussion regarding the essential question.

## Overview

This lesson is designed to be facilitated with a group. It introduces students to the concept that fluids can behave like both liquids and solids under certain conditions. In order to understand this, students investigate the differences between Newtonian and non-Newtonian fluids. The lesson concludes with students researching how scientists apply an understanding of non-Newtonian liquids to solve problems.


### Jump to:

- [Activity 1: Viscosity, Stress, and Strain \(Slides 2–3\)](#)
  - [Slide 2](#)
  - [Slide 3](#)
- [Activity 2: Solid or Liquid? \(Slides 4–8\)](#)
  - [Slide 4](#)
  - [Slide 5](#)
  - [Slide 6](#)
  - [Slide 7](#)
  - [Slide 8](#)
- [Activity 3: Applications \(Slide 9\)](#)
  - [Slide 9](#)
- [Activity 4: Infographic \(Slides 10-11\)](#)
  - [Slide 10](#)
  - [Slide 11](#)


## Activity 1: Viscosity, Stress, and Strain (Slides 2–3)

**Student Goal:** Research the role of viscosity and shear stress on the behavior of fluids.

### Slide 2

<p>Activity 1: Viscosity, Stress, and Strain</p> <p>What is the role of viscosity and shear stress on the behavior of fluids?</p> <p>Independently, look up the definitions to the key terms on your <a href="#">Newtonian and non-Newtonian Fluids Activity Sheet</a>.</p>	<p>This activity begins with students defining the key terms for the lesson. Make sure each student has either a digital or physical copy of the <a href="#">Newtonian and non-Newtonian Activity</a> sheet.</p> <p>Students can use <a href="#">RheoSence</a> (includes webinar) and/or the <a href="#">Central States Industrial</a> websites as starting resources. These are linked on the activity sheet.</p> <p> <b>DIFFERENTIATE</b></p> <p>Consider differentiating the process by adapting how the students access resources or write definitions.</p> <ul style="list-style-type: none"> <li>• Provide the definitions directly to students</li> <li>• Share your course text/materials to find concise or clearly identified definitions (rather than more open-ended research)</li> </ul>
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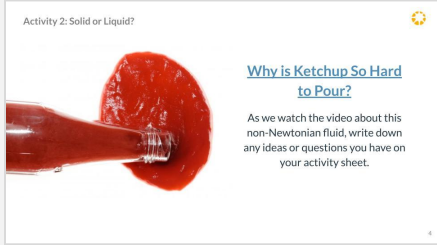
### Slide 3

<p>Activity 1: Viscosity, Stress, and Strain</p> <p>Collaborate with a partner. Use your definitions to answer the Activity 1 questions.</p> <p>Be specific and include examples. Be ready to share!</p>	<p> <b>ACTIVE LEARNING PRO-TIP</b></p> <p>Structure this activity as a think-pair-share, with students briefly reflecting on the questions individually before collaborating in pairs or small groups and sharing with the whole group. Each student should fill out their own answers on their activity sheet.</p> <p>You may also structure this as a <a href="#">jigsaw</a> if time allows. Edit the instructions as necessary.</p>
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## Activity 2: Solid or Liquid? (Slides 4–8)


**Student Goal:** Design and conduct an oobleck investigation.

### Slide 4



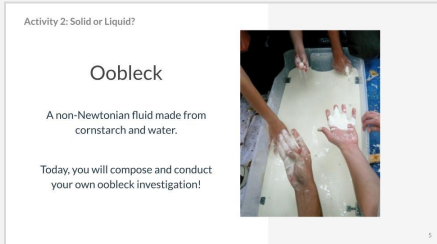
Students record their ideas or questions in the [Activity 2](#) section of their activity sheets as they watch the video [Why is Ketchup So Hard to Pour?](#)

Students should include ideas about how common fluids, like water, respond to force and examples of non-Newtonian fluids and their response to force. They should specifically describe what happens the harder you push and what the key is for releasing ketchup from a bottle.


 **TEACHER TALK**

*Ketchup is an everyday example of a non-Newtonian fluid. Record any ideas or questions you have while you watch the video. Be ready to share with your partner and the class.*

### Slide 5



Introduce your students to oobleck with the picture. Allow time for them to share their prior oobleck experiences, if any, with the class. Share that they will be working with oobleck today and designing their own investigations.

 **TEACHER TALK**

*Oobleck is another example of a non-Newtonian fluid and today you will get to compose AND conduct your own oobleck investigation. Has anyone made oobleck before? Anyone want to share what they already know about oobleck?*


**Optional:** You can introduce this oobleck investigation by having students read the story of *Bartholomew and the*

*Oobleck*, written by Dr. Seuss (1949). This story follows the adventures of a young boy, Bartholomew Cubbins, who must rescue his kingdom from a sticky green substance called "oobleck." The story is also available as [a Read-Aloud video](#) (19:26).

**Slide 6**

<p>Compose and conduct an oobleck investigation.</p> <p>Compose a research question and a hypothesis about the behavior of oobleck under different kinds of applied stress.</p>	<p>Divide students into partner or lab groups (of 3 or 4) to brainstorm a research question about the behavior of oobleck under different kinds of applied stress that they want to investigate. This research question will be the start of their investigations, so the group needs to be in agreement.</p>
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**Slide 7**

<div style="border: 1px solid #ccc; padding: 5px;"> <p style="font-size: small;">Activity 2: Solid or Liquid?</p> <div style="display: flex; justify-content: space-between;"> <div style="width: 40%; text-align: center;"> <p><b>Ask Questions</b></p> </div> <div style="width: 55%;"> <p style="font-size: x-small;">For example:</p> <ul style="list-style-type: none"> <li>• What do you think would happen if you hit the oobleck with a hammer?</li> <li>• How does the behavior of oobleck compare to that of other fluids?</li> <li>• How is oobleck behavior different with different ratios of ingredients?</li> </ul> </div> </div> </div>	<p>Allow time for groups to thoroughly research the question they want to investigate about the behavior of oobleck under different kinds of applied stress. Have them record their work on the <a href="#">Oobleck Investigation</a> page of their activity sheets.</p> <p> <b>DIFFERENTIATE</b></p> <ul style="list-style-type: none"> <li>• Consider having each lab group work on investigating a different question and hypothesis.</li> <li>• Each lab group can then share their results with the class in order to compose ideas regarding the key difference between Newtonian and Non-Newtonian fluids.</li> </ul>
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## Slide 8

Activity 2: Solid or Liquid? ☀

**In Your Lab Group**

- Design a procedure to investigate your research question.
- Gather materials and conduct your investigation.
- Document your observations in writing, photos, and/or video.
- Compose a list of possible explanations.

**Make sure you have enough materials for the number of groups you have.**

Investigation materials include:


- cornstarch
- water
- bowls or bins for mixing
- spoons
- beakers or measuring cups for measuring
- food coloring (optional)
- camera for photos/video

If students will be coloring their oobleck, let them know to add the food coloring to the water first and then mix with the cornstarch.

Additional materials may be needed depending on the research question being investigated. Check in with groups frequently to make sure you have what they need on hand or they will need to revise their experimental design.

Rotate to each group to support students in drafting their investigations on their [activity sheets](#). **Check in with each group and give them the go-ahead when you have looked over their experimental design and feel they are ready to get started.** Continue to rotate groups and assist students as they are working. Remind them to use their cameras to take photos/videos of their observations and to clean their areas when they are done.

**Check in with each group again** and discuss the results of their investigations with them, before proceeding.

 **TEACHER TALK**

*As a group, start drafting your investigation on your activity sheets. Each member of the group is responsible for their own work. When you think you are ready to get started, call me over so I can look at your work and give you the green light.*

*Do not start using the materials until I have given you permission.*

 **DIFFERENTIATE**

Scaffolding: If students are struggling to get started, share that the easiest way to make oobleck is to start by mixing ~ 475 ml ( 2 cups) of cornstarch to ~ 237 ml (1 cup) of water in a bowl. Mix the cornstarch and water until the oobleck is formed.

### Activity 3: Applications (Slide 9)

Student Goal: Research applications of non-Newtonian fluids.

[Slide 9](#)

Activity 3: Applications	
<p><b>What are some real-world applications of non-Newtonian fluids?</b></p>	<p>Investigate <b>one or two examples</b> and <b>summarize</b> them on your activity sheet.</p> <p>Share <b>why</b> you chose these applications and <b>why</b> you found them interesting.</p>

 **ACTIVE LEARNING PRO-TIP**

#### Mini-Research Project Options

1. Direct students to conduct research on applications of non-Newtonian fluids individually and then use the Think-Pair-Share (TPS) strategy to summarize and share their findings with the class.
2. Alternatively, assign a specific application of non-Newtonian fluids for each lab group to research and then explain to their class.

Examples of applications include drag reducing agents, printing technology, damping and braking devices, personal protective equipment, and food products.

Research tips:

- Encourage students to use primary sources for their research (rather than secondary sources).

- If doing a Google search, they should be sure to use boolean operators (AND, OR, and NOT), to help focus their search and connect various pieces of information to find exactly what they're looking for (non-Newtonian fluids AND personal protective equipment).

## Activity 4: Infographic (Slides 10-11)

**Student Goal:** Create and share an infographic that answers the essential question: What is the key difference between Newtonian and non-Newtonian fluids?

### Slide 10

Create an infographic.

Answer the essential question:  
What is the key difference between Newtonian and non-Newtonian fluids?

Students will create an infographic, or other visual of their choice, to demonstrate their understanding of the differences between Newtonian and non-Newtonian fluids and answer the essential question: *What is the key difference between Newtonian and non-Newtonian fluids?*

### DIFFERENTIATE

This final activity can be tailored or changed entirely to fit the needs of your students. Other options include:

- Compose a written response to the question.
- Participate in a group discussion regarding the essential question.

### Slide 11

Activity 4: Infographic

#### Things to Include

- Newtonian fluid, non-Newtonian fluid, shear-thinning fluid and shear-thickening fluid.
- Definitions for each type of fluid in terms of shear stress, strain rate, and viscosity.
- Examples of each type of fluid.
- Descriptions of real-world applications of non-Newtonian fluids.
- Observations and images from your investigation to help describe some of these fluid types.

Edit the infographic requirements as needed for your students.

Get more resources like this at [www.opportunityeducation.org/resources](http://www.opportunityeducation.org/resources)