Lesson Summary

This unit on Fluid Mechanics is broken into three parts: Static Fluids, Viscosity, and Dynamic Fluids. This lesson is the third and final activity in the Static Fluids portion of the unit. The first two portions of the Static Fluids subunit deals with density and buoyant forces.

To start the third lesson, students are going to need a cardboard box (any type of cardboard), duct tape, and a ruler. They can work individually or in groups.

Students are going to design and construct a boat made out of cardboard and duct tape. It needs to be made in such a way that they can calculate the volume of the boat. The duct tape is to waterproof the outside of the boat. The boat is going to be placed in salt water, which will have a density greater than 1.00, which will make students calculate the amount of mass the boat can hold more difficult, as fresh water has a density of 1.00g/cm³ and thus that volume equals the mass it can hold. Using density, students have to determine the amount of mass the boat can hold to the Plimsoll line and also how much it will hold before it sinks. Students are introduced to the Plimsoll line and why that is important in shipping (http://oceanservice.noaa.gov/facts/plimsoll-line.html).

To make calculations easy, the Plimsoll line is going to be equal to 80% of the volume of the boat. That line is to be clearly marked on the outside of the boat on the duct tape. They should make a line on the front and back of the boat and on both sides (four lines total). This will indicate that the boat is being loaded with masses properly and will not flip or sink prematurely.

Once students have determined how much mass the boat holds at 80% capacity and how much before it sinks, they can perform their experiment and see how close they were to the calculations. Teachers can also have students explore why there are various lines for the Plimsoll line as well as the percent error for the ships at the Plimsoll line and when it sinks.
**Unit Storyline**

The Fluid Mechanics unit is broken up into three subunits: Static Fluids, Viscosity, and Dynamic Fluids. Each subunit has a set of activities that help support a driving question of the day.

**Static Fluids:** With static fluids, students learn about density, mass, and volume. They use this knowledge to understand buoyant forces, which allow them to then determine whether or not ships float or sink based on the cargo they carry.

- Will It float?
- Where is the missing weight?
- Can you sink your ship?

**Viscosity (Friction):** Students learn about viscosity so they have an idea of how moving fluids encounter internal friction.

- How does viscosity affect the terminal velocity of a marble?

**Dynamic Fluid Motion:** Students learn about pressure and Pascal’s Principle. They are also introduced to Bernoulli’s Principle and the idea of continuity.

- How fast can you get water to leave a hole in a bucket?
- Can you sink a floating object without touching it?
- Can you lift a car with your hands?
- How is possible to get water to travel uphill?

**Unit Project:** This project brings all the topics together.

Design a model of a water tower for a town based off cost constraints and fluid flow through pipes.

**Phenomena**

How is it possible to flush a toilet or get water out of the faucet when there is no electricity?

**Other Resources**

- Torricelli’s Theorem
- PhET Under Pressure
  - [https://phet.colorado.edu/en/simulation/under-pressure](https://phet.colorado.edu/en/simulation/under-pressure)
- PhET Fluid Pressure and Flow

**Science Partners**

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**Additional Unit Plan Information:**