# Passive Pasta

Workshop

*This demonstration is based off a workshop Carla Ramsdell gave at 2019 Physics Congress. All figures were taken from resources provided by Carla Ramsdell. More information is available on her blog, referenced below in the "Additional Resources" section. Participants learn about an energy-efficient way of making a meal.*

**Number of Participants:** As many as you like!
**Audience:** All ages
**Duration:** 20 Minutes
**Difficulty:** Level 2
**Materials Required:**

- Hot water maker or coffee maker
- Well insulated travel mug with lid
- Spaghetti - thinner the better!
- Boiling or near boiling water
- Sink or bucket for dumping used water
- Salt
- Optional: Seasonings, olive oil, parmesan, or red pepper flakes

Figure 1 – insulated travel mug and spaghetti noodles during initial setup

## Setup:

1. Give an insulated travel mug to all participants, or for a large group, divide into groups and place a mug with each group.
2. Select a 1 cm (dime-sized or nickel-sized) bundle of spaghetti. Break bundle in half and put both halves into the travel mug. Ensure the pasta fits inside the travel mug with the lid on.
3. Add a pinch of salt to the mug.
4. Pour boiling water into the mug until it just covers the pasta.
5. Put the lid on the mug and swirl the mug around.
6. Let sit for approximately 12 minutes. *This is a good time to stop and explain the science behind the activity.*
7. Uncover the mug and try a piece of pasta. If the pasta is a bit tough, cover it again and leave for a couple more minutes. If the pasta tastes good, cover it again. Open the drinking tab and pour out the water.
8. Add seasonings if desired and dig in!

Figure 2 – illustrations taken throughout the workshop

## Presenter Brief:

Be familiar with basic thermodynamic properties and particularly conservation of energy. Understand what an isolated system is in terms of thermodynamics. Be able to explain why an isolated system is preferred to maintain a theoretical constant temperature. Understand why the experiment is energy efficient and know how to explain the connection between an isolated system and conservation of energy. Understand why the walls of travel mug has relatively low thermal conductivity. Be able to explain why the lid is necessary. Basic understanding of why hot water is necessary to cook the pasta. Basic understanding of what ingredients make up pasta.

**Vocabulary:**

Conservation of energy – the law that states that energy cannot be created or destroyed, only changed from one form to another.

Energy transfer – when energy flows from one form to another.

Heat – a form of energy that transfers from a warm object to a cooler object

Insulation – material used to keep an area or object hot or cold.

Isolated System – a closed system with a form of insulation.

Temperature – an average measure of how fast atoms or molecules are moving that tells us how something is hot or cold.

Specific Heat – the heat required to increase the temperature of a certain amount of material by one degree.

Pasta – substance made up of carbohydrates become squishy when soaked in water.

## Physics and Explanation:

**Elementary:**

**As the pasta is being soaked in the hot water inside of the travel mug, begin the following discussion.**

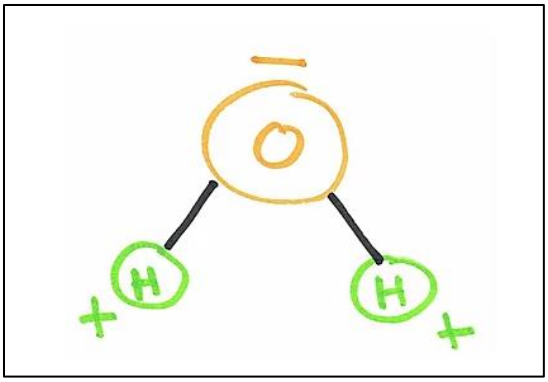


Figure 3 – Water molecule diagram

Water is a molecule made up of one oxygen atom and two hydrogen atoms. Atoms are the smallest units of matter. The oxygen atom has a negative charge while the hydrogen atoms have a positive charge and opposite charges attract. Atoms that have opposite charges, like oxygen (orange) and hydrogen (green), attract and connect to each other. When different types of atoms connect, a molecule is created (fig. 3).

Water is a molecule. Molecules are a combination of different types of elements.

Water exists at many temperatures. Temperature is an average measure of how fast molecules are moving. As temperature increases in the mug, the water molecules get excited with energy and begin to move faster; as temperature decreases, the water molecules will lose energy and move slower. Since the travel mug is insulated, energy in the form of heat is prevented from leaving the mug. The hot water added to the mug will stay hot and the water molecules will continue moving fast.

When hot water is added to the travel mug, the water molecules get excited and begin to move around the mug very quickly. The hot water remains hot in the mug because of insulation.

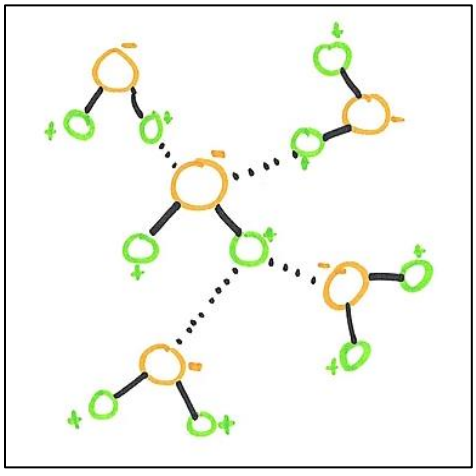

Figure 4 – Water molecules diagram

A lot of energy is used to increase the temperature of water. However, once water is hot, like the water in the mug, the energy is stored in the water molecules. This stored energy in the water is used to cook the noodles! The noodles cook faster in the travel mug because the water molecules have energy stored in them for a longer amount of time. Imagine a cup of hot chocolate. The cup that holds the hot chocolate is not insulated and does not have a lid, unlike the travel mug used for the noodles. The hot chocolate becomes cold faster than the water cooking the noodles, which means the hot chocolate loses its stored energy faster.

**Will the pasta become soft in cold water?**

- The insulated travel mug prevents stored energy in the form of heat from escaping and the noodles can cook faster. Cold water can also be used to cook noodles, but water molecules have less energy and move slower in cold water and the noodles would cook slower.

**Challenge students to explain what is happening while the pasta sits in the warm water. What would happen if you did not use the lid on the travel mug?**

**Middle School and General Public:**

**As the pasta is being soaked in the hot water inside of the travel mug, begin the following discussion.**

Water is made up of two different elements—oxygen and hydrogen—that exists in many different temperatures and states. Temperature is not only a quantitative expression of how something is hot or cold, but also the average kinetic energy of molecules or atoms in an object. As the temperature of an object increases, energy is transferred in the form of heat to that object.

- Water is a molecule that exists at many different temperatures. Heat is a form of energy that flows in or out of an object to increase or decrease the temperature of said object.

Water has a high specific heat, which means a lot of heat is used to increase the temperature of water. However, a high specific heat also means hot water has a lot of stored energy. This knowledge of water can be used to cook food, like noodles, with less energy! For example, heating a small pot of water on the stove and cooking noodles can take a lot of time and continuous heat. Instead, an isolated system like the insulated travel mug can utilize the stored energy in hot water to cook the noodles and help save money on energy bills and help the environment.

- Stored energy in water can be used to cook foods like noodles because water has a high specific heat. Cooking with low amounts of energy can help save money on energy bills and help the environment.

**Challenge students by discussing basic ways to save energy. How else can you save energy and minimize your carbon footprint using everyday household items?**

The travel mug is not a perfect isolated system. In other words, small amounts of heat will flow out of the travel mug and the temperature of the water will decrease approximately 10 º F. However, the water in the travel mug will remain hot enough to cook the noodles. The noodles cook faster in hot water than in cold water. Because the hot water molecules are excited from stored energy, and the insulated travel mug prevents the energy from escaping. The water molecules flow faster for longer in the travel mug and the carbohydrates in the noodles are hydrated faster. Noodles can be hydrated in cold water as well, but the slower flow of less excited water molecules will hydrate the noodles at a slower rate.

- An isolated system can be used to cook noodles, and noodles cook faster in hot water than in cold water.

## Additional Resources:

- Carla Ramsdell's Physics and Explanation on Passive Pasta: https://www.knowwattscooking.com/post/2019/11/16/travel-mug-pasta-fun-easy-fast-food-cooked-passively
- Crash Course, Polar and Nonpolar molecules: https://www.youtube.com/watch?v=PVL24HAesnc
- Crash Course, Temperature: https://www.youtube.com/watch?v=6BHbJ_gBOk0
- Schroeder, Daniel V. *An Introduction to Thermal Physics*. Pearson India Education Services, 2018.
- Thermodynamics Crash Course: https://www.youtube.com/watch?v=4i1MUWJoI0U