# Lesson 1 | What is a System?

Student Name _____ Period _____ Date_____

Follow lab procedures as indicated. Use your science journal for the following:

- Record all observations
- Record answers to discussion questions
- Write down any additional questions you may have

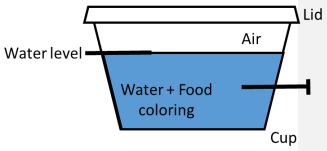
**Materials Needed**

- ❑ 3 plastic cups with lids
- ❑ 1 sharpie
- ❑ 1 nail
- ❑ 1 eye dropper
- ❑ 1 plastic catch dish (large enough for plastic cup to sit in, with low edges)
- ❑ Several drops of food coloring
- ❑ (optional) 2 pieces of masking or scotch tape

## Creating a model of a system

**Part 1 Procedures**

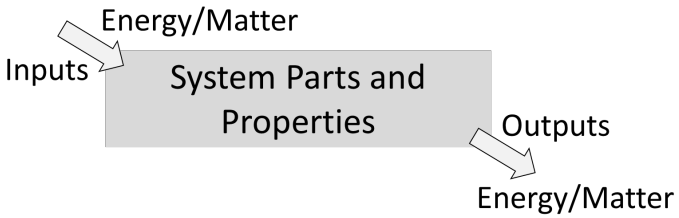
1. Fill a plastic cup half way with tap water, add a drop of food coloring, and snap the lid in place.
2. Carefully push a nail through the side of your cup below the water line. DO NOT remove the nail just yet.
3. Gently mark the water level with a marker.
4. Observe your cup and make a sketch in your science journal.




Add the following definitions and model to your science journal:

- A system is an organized group of interacting objects or components.
- Inputs are matter and energy that enter a system
- Outputs are matter and energy that exit a system

Write this on your lab notebook paper




When investigating or describing a system, the boundaries and initial conditions of the system need to be defined. A model can be used to analyze and describe inputs and outputs.

Write this on your lab notebook paper

Using your sketch as a model…

- Label the components
- Label the boundaries
- Describe the initial condition of your setup (inputs, outputs, water level, etc.)
- Indicate what can be measured in your setup

**Constructing a scientific argument**

On your own, write a brief scientific argument (use claim-evidence-reasoning) to answer the following:

- Why is this setup considered a system?

Discuss with your lab partner

- What was your claim?
- What was your evidence?
- What was your reasoning?

## Using a model to predict

Models can be used for understanding and predicting the behavior of systems. Your sketch is a model of the actual system.

- Use your model to predict what will happen to your system when you remove the nail.
- Write your prediction in your science journal.

Write this on your lab notebook paper

**Part 2 Procedures**

1. To prevent spills, place your cup in a tray. It may be useful to prop your cup on a second inverted cup to make observations.
2. Gently remove the nail.
3. Record your observations.
    a. What happens to the system?
    b. Does the system's behavior match your prediction?
4. Answer the following questions in your science journal.
    a. How did the nail removal impact your input and outputs?
    b. Are there any invisible components missing from your model?
5. Use a different colored pen to revise your sketch and improve your model.

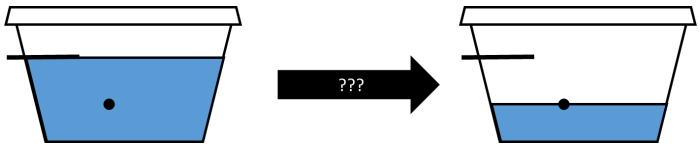
Write this on your lab notebook paper

## Lab Challenge

**Manipulating components within the system**

How can you manipulate your system to lower the water level to the nail hole?

- With your lab group, come up with as many ways to accomplish this task as possible.
- Whe n ready, present your ideas to your teacher.
- Your teacher will have you test one of your ideas.




**Test your solution**

- Sketch your proposed solution in your science journal and perform your experiment.
- Once all groups have conducted their tests, compare your ideas and results with other groups.

**Discussion**

Discuss the following in your lab group. Write a short summary in your science journal.
In your experiment, you changed something about your system.

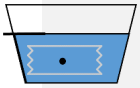
- Did the behavior of your system change?
- If so, how did the components interact to bring about a change in behavior of the system?
- Did the boundaries of your system change? If so, how?
- What was the output of your system?
- What was the input of your system?

Write this on your lab notebook paper

## Quantifying changes in the system

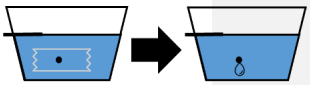
**Procedures**

1. Place your finger or a piece of tape over the nail hole in the original cup. Refill the cup with any of the colored water that has escaped.

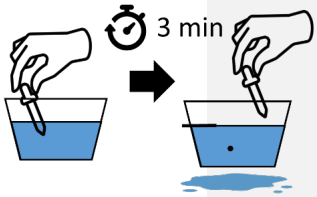


2. Fill a second cup with tap water, add a drop of food coloring.
    a. You will use water from this cup to replace water lost from the original cup.

3. Open up the hole once again and allow water to flow freely for 3 minutes.



4. Using an eye dropper or pipette, replace the water lost with water from the second cup in order to maintain the same water level.




5. Record how many drops are returned to the original cup during the 3 minutes in your journal.

6. Using the data you collected, calculate the rate of water loss in drops per minute.

## Defining stability and change in the system

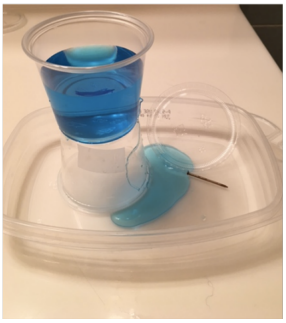
Write this on your lab notebook paper

- **Equilibrium** is a state of rest or balance due to equal action of inputs and outputs.
- Systems **not in equilibrium** are experiencing a state of imbalance between inputs and outputs. This imbalance results in unequal changes in the system.
- **Dynamic Equilibrium** is a state of balance when inputs and outputs are equally fluxing. In this case, a balanced system is the result of equal and opposite changes.

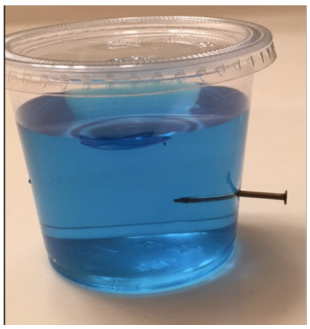
**Applying knowledge of stability and change**

**Directions**: In your science journal, label the following setups as:
**Equilibrium, Not in Equilibrium, and Dynamic Equilibrium**

Water Lost from System



Beginning system



Maintaining Water Level

## Comparing Inputs and Outputs

**Procedures**

1. Fill a plastic cup half way with tap water, add a drop of food coloring, and snap the lid in place.
2. Fill a second plastic cup to the same level with **very hot water**, add a drop of a different food coloring, and snap the lid in place.

**SAFETY NOTE**:
Do NOT use boiling water.

**Directions**:

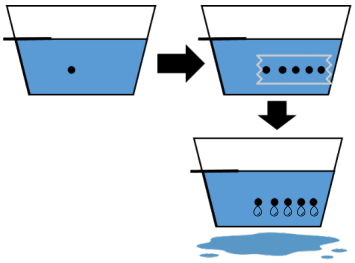
1. In your science journal, construct a Venn diagram to compare the two systems.
2. Write a scientific argument (using claim-evidence-reasoning structure) to answer the question:
   **Are both systems at equilibrium?**

Write this on your lab notebook paper

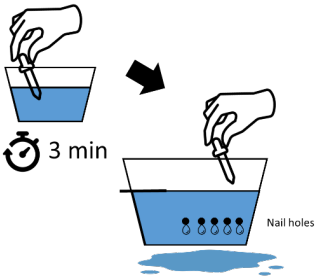
## Increasing water loss from the system

**Procedures**

1. Remove the water from your original cup and poke 4 holes at the same level as the first nail hole. Cover the holes with tape.
2. You will repeat the water loss experiment as done previously.
3. Remove the tape and allow water to flow freely for 3 minutes.

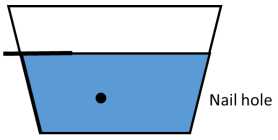


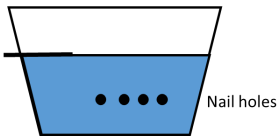
4. Using an eye dropper or pipette, try to replace the water lost with water from the second cup in order to maintain the same water level.
5. Record your answer to the following in your journal.
    - **What happened to the water loss rate when more holes were added?**
    - **Were you able to maintain equilibrium?**




**Comparing sustainability of two systems**

Would you consider either system to be "sustainable"?




**Directions**:

1. Write a scientific argument in your science journal using claim-evidence-reasoning structure to justify your answer. Be sure to include the scientific terms input, output, and equilibrium in your argument.

2. Write a proposed definition of "sustainability".