



## Density

- Lesson Concept** Density is a property of matter that is temperature dependent.
- Link** In the previous lesson, students learned about humidity as a condition of the air. In this lesson, students explore density as a property of matter that is temperature dependent. In the next lesson, students will learn how the differential heating of water, soil, sand and air affect the density of air and contribute to the formation of convection currents that impact weather.
- Time** 50 minutes
- Materials**
- Whole class
- 1 Hairdryer
  - 1 Thin tissue paper or plastic bag
  - Masking or scotch tape
  - 1 Gallon size Ziploc bag with 10 cotton balls
  - 1 Gallon size Ziploc with 20 cotton balls
- Per Partner
- Quart size Ziploc bag with 5 cotton balls
  - Gallon size Ziploc bag with 5 cotton balls
- Individual
- Science Notebook
- Advance preparation**
1. Prepare Ziploc bags with cotton balls.
  2. Tape the bottom of the tissue paper or plastic bag so that it has just a very small opening that will fit around the nozzle of the hairdryer.
  3. Write the questions for Step 9 on a piece of paper for the document camera or on the board.
- Procedure:**
- Engage** (10 minutes) *Density is the amount of mass in a given volume.*
1. Write the word density on the board and ask students to think-pair-share what they think the word means.

*Teacher Note: If students have experienced the physical science unit, they learned that density is the amount of mass in a given volume (or the amount of stuff in a given space). Build on their responses to the prompt in Step 3. If the students have not experienced that unit, use Step 2 to build this definitional level of density.*

2. If students are unclear of what density means, perform the following demonstration:
  - a. Ask 10 students to come forward and stand in the front of the classroom in a pre-determined space (where they have room between them). Then ask them to get very close in a pre-determined place (where they are squished).
  - b. Ask the rest of the class to describe what they noticed: What stayed the same? What changed? The number of students (mass) was the same; the amount of space (volume) changed. Which situation was more tightly packed? Which was less?
  - c. Which was more dense? Which was less? Why?
3. Write a classroom definition of density: the amount of mass in a given volume.
4. Explain that today students will have an opportunity to explore more about density.

**Explore #1**                      **(15 minutes) Matter, including air, has different densities, depending on how much “stuff” is packed in its space.**

5. Explain that everything has density, even air. Ask student to make a square with their hands in the air. Based on what they did in Step 2, what does this represent (space/volume)? What would be in that volume? (Air). Based on what they did in Step 2, what does the air represent? (mass).
6. Explain that they will build a model to help them think about the density of air.
7. Distribute quart and gallon bags of cotton balls to partners.
8. Ask the students, based on their “square in the air,” what did their finger represent? (Space /volume). What do the bags represent? (space/volume). What do the cotton balls represent? (Air molecules/mass).
9. Have the students compare the two bags and answer the following questions in their science notebook:
  - What is the same about the models?
  - What is different about the models?
  - Which model has more molecules (mass)?
  - Which model has more volume (space)?
  - Which model is more dense? How can you tell?
10. Discuss the students’ ideas as a class. They should be able to identify that the bags have the same number of molecules but that the smaller bag has less volume and is therefore more dense because the molecules are more tightly packed.

11. Hold up both gallon sized bags with 10 cotton balls in one and 20 cotton balls in the other for the class to see. Ask partners to discuss which model is more dense and why.
12. Have several partners share their ideas. (The volume is the same; the amount of air molecules is different. The one with 30 is denser because more matter is packed into that space. So, density is not directly related to the size of the matter, but how many molecules are within whatever space it takes up).

*Teacher Note: Density is the relationship of mass to volume. In the student baggies (gallon and quart), the mass stayed the same, but the volume was different. In the class demonstration, the volume stayed the same, but the mass was different.*

**Explore #2 (15 minutes) Temperature affects the density of air**

13. Ask the students if they have ever seen a hot air balloon. Have a student or two share aloud how they think a hot air balloon works.
14. Turn on the hairdryer and blow hot air into the bottom of the tissue paper or plastic bag for about a minute, then turn off the dryer and release the bag. It should float up, at least briefly.
15. Ask students to think about why this happened and record their ideas in their notebook.
16. Have partners share theirs with each other, then ask a couple of partners to share their thinking.

**Evaluate (10 minutes) Warm air is less dense than cool air.**

17. Return to the example from Step 2. Ask a group of students to stand closely together in a specific space. Then ask them to start moving quickly around. Ask the class to observe what happens (they move “outside of the space”).
18. Now ask the class to relate this movement to what they think happened in the hot air balloon. What causes the molecules to move (heat); what happens when things are heated (they expand).
19. Ask students to answer this prompt in their notebook:
  - When the balloon lifted, was the air more or less dense inside the balloon than the surrounding air? How do you know?
  - What is the density of cool air compared to warm air?
  - What questions do you still have about density?