A Matter of Air

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Middle School Physical Science

Lesson Overview:

This lesson is intended to correct a common misconception that students may have that air cannot be matter because it does not have mass. In order to demonstrate that air is matter, and does, in fact, take up space and have mass, a demonstration will be done using two balloons and a makeshift balance using a ruler, preferably a meter stick. The balloons will be inflated until they are about equal size. They will be attached to each end of the meter stick by either tape or string. A string will be tied to the middle of the meter stick and hung from a desk, making sure that the balloons are in balance. One balloon will be deflated, revealing that the other balloon weighs down the balance.

Duration: 30 minutes

Objectives:

Students will conclude that air is matter.

NGSS Standards Addressed:

MS.Structure and Properties of Matter.

PS1.A: Structure and Properties of Matter

Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it. (MS-PS1-3) (Note: This Disciplinary Core Idea is also addressed by MS-PS1-2.)
Gases and liquids are made of molecules or inert atoms that are moving about relative to each other. (MS-PS1-4)

Materials:

Meter Stick
String/Yarn
Tape
Balloons
Student Notebooks

5E's

- **Engagement**

Students are engaged during the class opener by answering a short class opener in their science notebooks.

The teacher will provide the writing prompt for all students to see upon entering class. It can be written on the whiteboard, or projected on a screen. The prompt is "What is matter?" Students will write what they know up to this point in their education about what defines matter. Most students will write about something that is tangible and visible.

Students will have 3-5 to answer the question, then the teacher will lead a discussion, starting with asking who wants to share what they wrote about. Many students will recall the definition of matter that they have previously learned, that it is anything that has mass and takes up space.

Possible facilitating discussion questions:

Is everything around you, in this room matter?
What are some examples of things that have mass and take up space?
Do you have mass and take up space? Are you matter?

The teacher may have some students touch items around the room, and pick them up. The teacher may demonstrate the mass of some items as well.

- **Exploration:**

The teacher will bring to light the concept of gases, or air, being matter, in a way that doesn't reveal that they are, in fact, matter. The teacher may say, "If everything around us is matter, then does that make the air we are surrounded by matter?"

Or, "somebody tried to tell me that air is matter? That's sounds crazy. How can something we can't see, or feel take up space and have mass?"

This will get the students thinking. They will try to answer the questions. Students will probably take both sides, but not have any real explanation as to why they think that.

The teacher will then engage the students in a demonstration. Two students will be asked to inflate two balloons to as close to the same size as they can.

The balloons got bigger as they were filled with air. They now take up more space. The teacher will ask the students what happened when the balloons were filled with air. They should observe that they got bigger. The teacher will hold up a deflated balloon against an inflated balloon and ask if they take up the same amount of space. The students should conclude that they do not.

Possible probing questions:

Since we concluded that the inflated balloon, that is full of gas, does take up more space than a deflated balloon, have we concluded that the gas is matter?

How can we find out if the gas inside has mass? Do you think it does have mass?

If the students think the gas has mass: "So you're telling me that the balloon that is inflated weighs more than this balloon that isn't inflated?

The teacher will have a student hold both an inflated balloon and a deflated balloon and ask him/her to compare the two. What weighs more?

The student will not be able to tell the difference between the masses of the two. This will bring the students back to disequilibrium.

The teacher will then engage the students in a demonstration to discover whether or not the inflated balloons have more mass.

The teacher will tie a string to the middle of a meter stick, then tape that string in the middle of a table, so the meter stick is hanging horizontally like a balance. The two inflate balloons will then be tied to each end of the meter stick. The meter stick will be in balance with the two balloons on each end.

The teacher will ask the students “So what will happen if I poke one of these balloons with a needle?”

Some possible answers:

Nothing, it will remain in balance.
If the air has mass, it will lean towards the side with the inflated balloon.

The teacher will pop one of the balloons, and the students will observe what happens to the balance. The balance will, indeed, lean towards the side with the inflated balloon, because it has more mass.

The teacher will ask the students what happened, and why.

The students should conclude that the gases in the air have to be matter because we proved it takes up space, and has mass.

- **Explanation:**

The teacher will once again facilitate a discussion.

Possible probing questions:

The balance proved that air has mass, so why couldn’t we tell the difference between the inflated and deflated balloon when we were holding them?

Answer the teacher is looking for:

The air is not very dense.

So does this mean that a sports ball that is inflated has more mass than one that is deflated?

What happened to the air that exited the popped balloon?

- **Elaboration:**

The students will return to their science notebooks, and the teacher will now ask them to answer this question “Is air matter? Explain”. The students will write their explanation

using the information they gathered form observations during the demonstration. This will be their exit pass.

- **Evaluation:**

  Students will demonstrate that they have the correct understanding of gases and matter by participating in the demonstration and the discussion throughout the lesson. They will also answer the questions in their science notebooks to show that they truly understand the concepts that were explored during the activity.

  Formative: The teacher will check for understanding throughout the demonstration by asking questions, as well as asses students on their willingness to participate during the class discussion.

  Summative: Student notebooks will be assessed, and their thoroughness in answering the questions, as well as their writing skills will be assessed. The notebook entries will be worth 5 points.

Differentiation:

Students with special learning accommodations:
Reading: Students with IEPs for reading should not have an issue, as the posted questions for the science notebook will be read to the class.
Writing: Students with IEPs for writing may type their have their science notebooks saved on a google doc so they can type their answers. They may also have an aid to assist them.
Social: Students with social issues will not be assessed on participating in the discussion, but will be assessed on paying attention and staying engaged.

Extensions for advanced students:
The advanced class will be given the opportunity to do the demonstration as a lab activity. They will perform the activity themselves, and come to their own conclusions before leading a class discussion. The class will be divided into groups of four, each group will be given a meter stick, some string, and two balloons. Instructions will be projected on the front screen, and they will record their observations regarding matter as they do the activity.

Safety Considerations:

Students should wear protective glasses in case pieces of the balloon detach during the deflation process.
Procedures will be in place for observing a teacher-led demonstration.
Procedures will be in place for doing a lab activity, and retrieving materials for the lab, as well as lab cleanup.

Balloon Balance Instructions (for advanced class)

Step 1. Divide into groups of four. Make sure each group has their own work space (own table).

Step 2. One person from the group will retrieve the following materials from the back counter:

1 Meter Stick
3 pieces of string
2 balloons
tape

Step 3. Inflate one balloon. Compare it to the deflated balloon. Record your observations in your science notebook. (Think properties of matter)

Step 4. Inflate the second balloon to the same size as the first balloon.

Step 5. Tie one string to the middle of the meter stick. The exact middle! Tape the string to the end of your table so the meter stick is dangling horizontally.

Step 6. Tie each balloon to an opposite end of the meter stick. The meter stick should appear to be in balance, or close to.

Step 7. Make predictions as to what is going to happen when one of the balloons is deflated. Record your predictions.

Step 8. Ask the teacher for assistance at this point. The teacher will bring a needle to your work station, and assist in deflating one of your balloons.

Step 9. Observe what happens when one of the balloons is deflated. Record your observations.

Step 10. Explain what the purpose of the activity is in your science notebook. Be ready to discuss your observations.