The World Around Me! States of Matter

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Abstract:

These lessons are designed to help young learners (age 4-7) understand core concepts in physical and life science. They will do hands on activities to promote discovery, problem solving, and a love for science. First a teacher with professional scientific background will introduce the concept of matter. Students will learn the major states of matter and discover how matter is transformed from one state to anther. Subsequent lessons will be focused on each of the three major states (gas, liquid, solid). Students will learn the properties of air, about water surface tension, and play with water in its solid state of ice. There will be demos carried out by the instructor, individual activities, and group activities that foster teamwork and collaboration.

Standards Achieved:

According to NGSS "In the earlier grades, students begin by recognizing patters and formulating answers to questions about the world around them." - DCI Arrangements of the Next Generation Science Standards

The following lessons seek to facilitate young minds in observing the world around them to generate questions about why certain patterns are observed. Students also perform examinations to reveal/deduce the answers. In these lessons, they will learn about "Matter and its interactions", "Properties of Air", "Properties of Water", and "Forces: Magnetism". Standards of students carrying out observation, inquiry, problem solving, collaboration, data collection, data interpretation, and communicating information are all achieved.

Lesson One: Introduction to States of Matter

Duration: 1 hour

Overview: Students will learn the three major states of matter (solid, liquid, gas) and be able to identify which group various items belong to. Students will complete a hands on molecule craft and create a "plastic" star to take home.

Vocabulary: Matter, solid, liquid, gas, transform

Objectives: Students understand that matter can transform from one state to another and be able and say the three major states of matter

Materials: States of matter worksheet, breakfast cereal, glue, milk, vinegar, paper towels, strainer, large poster paper, tape, pictures of everyday items

Resources: Song " Matter Chatter", Video excerpt from "Magic School Bus, Wet All Over"

The Lesson:

1. Open the lesson by playing the song "Matter Chatter"
2. Point out various objects and ask students if they are solid, liquid, or gas
3. Talk about molecules briefly and explain that they have different spacing depending on the state of matter
4. Ask the students to stand up and act like molecules. Shout out "gas" and the students spread out and move around quickly. Shout out "solid" and students huddle together and are still.
5. Give them the states of matter worksheet and have them glue the cereal "molecules" on each state with proper spacing.
6. Have small groups sort pictures of everyday things into the proper states of matter columns. Let each group show their poster to the class and explain some of the objects in each category.
7. Show the "Magic School Bus" video that illustrates water changing its state of matter.
8. Talk about how matter can be transformed from one state to another. Ask students to give examples of times the see matter change (most likely they will give temperature controlled transformations). Explain how matter can also change forms due to chemical reactions.
9. Perform the milk and vinegar into plastic transformation. Allow students to try on their own and make a plastic star to take home.

Homework: Write down five examples of each state of matter that can be found in your home.

Citations:

Harry Kindergarten Music, Matter Chatter (song for kids about solids, liquids, and gases), Published on Jun 12, 2014 https://www.youtube.com/watch?v=C33WdI64FiY

TangstarScience "The Magic School Bus-Clouds and Drizzle". Published on Feb 28, 2013. https://www.youtube.com/watch?v=jt6XczAsZvM.

ORIGINALLY FROM: The Magic School Bus (TV Series), Season 2, Episode 6, "Wet All Over". Written by: Jocelyn Stevenson, George Arthur Bloom & Kristin Laskas Martin. Directed by: Charles E. Bastien. Released: October 14, 1995.

Lesson Two: (Gas) Air properties

Duration: 1 hour

Overview: Students will learn the properties of air (air has weight, air has volume, air can do work)

Vocabulary: Air, weight, volume, power

Objectives: Students understand the properties of air and are able to say the three major properties of air

Materials: 20oz plastic soda bottles, balloons, straws, string, bowl of water, cups, paper man

Resources: Song "Air is Everywhere", Video excerpt from "Magic School Bus"

The Lesson:

1. Open by playing the song "Air is Everywhere"
2. Ask students about air. "Can you see air?" "Can you smell air?" "Can you feel air?" etc
3. Before the lesson prepare two soda bottles, each with a balloon inverted inside. In one bottle make small holes at the bottom. Leave the other bottle as is. Ask two students to come forward and try and inflate the balloon by blowing into the bottle. When only one student can ask them why. The students should find the small holes in one of the bottles. This will prompt discussion about how air "takes up space". Explain the meaning of volume to the students.
4. Now that you have introduced volume have the students see if they can put a paper man in a cup and make the cup go underwater without the man getting wet. Students should play and discover that if they put the cup straight down the volume of air will keep water out of the cup and the man dry.
5. Next talk about weight. Make a balance using one straight straw (or stick). Place an empty balloon on one side and a filled balloon on the other. Ask the students which one is heavier. Ask them why. This should illustrate to students that air has weight.
6. Play the "Magic School Bus" video
7. End by talking about what we saw air used for in the video. Talk about what things air is used for in everyday life (i.e. windmills, sail boats...) Let students know that next class we will be discovering the power of air!

Homework: Have students make a list of things at home their air cannon is strong enough to move and things it cannot move.

Citations:

Air Air Everywhere | Music Video | From Hip Hop Harry, Published on Jan 31, 2016, https://www.youtube.com/watch?v=GRKHchaP9Ms

The Magic School Bus (TV Series), Season 4, Episode 4, "Goes on Air". Written by: Brain Meehl, George Arthur Bloom, Jocelyn Stevenson. Directed by: Lawrence Jacobs. Released: October 4, 1997

Lesson Three/Four: Air power

Duration 1 hour for each lesson

Overview: Students will experience the power of air!

Vocabulary: Air, power, force, friction

Objectives: Students understand that air has power and can be used to do work. Air makes our lives easier. Students will make an air cannon and a hover craft.

Materials: 20oz soda bottles, electrical tape, balloons, CDs, sport bottle drink lids, hot glue gun/glue, candle, small puff balls

Resources: Youtube "How a hovercraft works" video. Video of racing hovercrafts, many choices on Youtube.

The Lessons:

1. Ask students what they have previously learned about air. Ask them what we saw the students in the "Magic School Bus" video do with air.
2. Tell them you are going to make an air cannon! The challenge will be if students can blow out a candle using the air cannon.

3. Making the cannon: Cut off the top of a soda bottle (just above the top of the label) using a box cutter. Tie a knot in the neck of a balloon. Cut off the very tip of the top of the balloon. Open the balloon and stretch it over the larger opening of the bottle top you cut earlier. Tape the balloon secure. You should be able and pull the knot of the balloon back, then release, to shoot a blast of air out the mouth of the bottle.
4. Allow students to play with their air cannons (move puff balls, pieces of paper, etc). Let the students come one at a time to try and put out a candle.
5. ASK HOW IT WORKS: Students should connect that air has volume concept here. Pulling the balloon back brings air into the bottle. When they let go air is quickly pushed out of the bottle creating a blast of air. This air can be used to do work.
6. BREAK HERE TO MAKE TWO LESSONS OR CONTINUE FOR A TWO HOUR LESSON
7. Play the hovercraft video
8. Ask students to rub their hands together. What do they feel? (HEAT). Explain the concept of friction. Guide students through questions and discussion to realize that friction is what keeps items from gliding around on surfaces.
9. How can we overcome friction? AIR!
10. Help each student to make a hovercraft
11. Making the hovercraft: Hot glue the sport bottle top on a CD such as it covers the central hole. Inflate a balloon and attach it to the bottle top (the bottle top should be in the down closed position such that air cannot be released from the balloon). Let the students place their hovercraft on the floor and open the top. Air should travel down the central hole to under the CD. This creates a thin layer of air that overcomes the force of friction and allows the CD to glide across the floor.
12. ASK HOW IT WORKS: Students should connect the concept of friction and that air is reducing the friction and allowing the CD to glide.

Homework: Ask the students if the hovercraft will work on water. Have them try it at home in a large bin or bathtub. Ask them to record a video with their parent's phone and send to the class group chat.

Citations:

Griffon Hovercraft Ltd. "How a hovercraft works" Published on Mar 27, 2007 by Suhyon Che https://www.youtube.com/watch?v=gCT7z0SlRT8

Lesson Five/Six: (Liquid) Water Properties

Duration 1 hour for each lesson

Overview: Students will learn the properties of water. Focus on surface tension and density (i.e. sink or float)

Vocabulary: Liquid, force, surface tension, weight, volume, density, sink, float, peel

Objectives: Students discover the properties of water and can explain the meaning of surface tension and density. Students can explain why some things float and other things sink.

Materials: Coins, water, pipettes, cups, large tub, various items, cans of soda (some diet and some regular), multiple oranges, LOTS OF TOWELS

Resources: Youtube Videos of creatures using surface tension "Basilisk lizard runs on water, rate my science" "water striders" etc. There are many choices available.

The Lesson:

1. Ask students what they have learned so far. Review the major properties of air. Ask what state of matter air represents (GAS!). Then ask what state water represents (LIQUID!).
2. Try to get the students talking about what things they see on water and what things they see underwater. Get them thinking about why some things sink and some things float.
3. Ask them "Did you know water has skin?" Introduce the concept of surface tension. Show some photos of phenomena like a swimmer breaking through the surface of water. It should look like a 'skin' is stretching over them.
4. Fill a glass with water. Ask them how many coins they think can be added to the glass until the water spills over the side. Let each student write down their guess for how many coins. Drop in coins one by one. You should be able to add more than 20 coins depending on their size/size of the glass. After completing this show a time-lapse video of the same experiment (there are many options of this online). Reiterate the concept of surface tension.
5. Ask students if they know of any animals that take advantage of surface tension. Show videos of animals using surface tension to move on water. (Basilisk lizard, water striders, etc)
6. Now ask the students how many drops of water can fit on one coin. Put the students in groups of 3-4. Have the groups write down their guess for how many drops. Let the students take turns adding drops of water to the top of the coin using a pipette. Use this as opportunity to present proper pipette techniques (important for students that will continue in science).
7. Have each group report their findings. Write the results for each group on the board. Calculate the mean, median, and mode of the data. Ask students why it is important to do the experiment more than once. The goal here is to introduce the concepts of experimental error and variation.
8. BREAK HERE TO MAKE TWO LESSONS OR CONTINUE FOR A TWO HOUR LESSON
9. This section is to introduce the concept of density. Ask students what things are able to float on water. Make a list on the board of things that sink and things that float. Write the equation for density on the board. Use this as an opportunity to review the concepts of weight and volume from the lessons about air.
10. Ask students if they think an orange will sink or float? Make tallies on the board showing how many student say it will float and how many say it will sink. Put the orange in the water. IT FLOATS! Now ask the students what you could do to the orange to make it sink. They might suggest adding weight etc. Add the complexity that they can't add anything to the orange. Hopefully a student will have the idea to peel the orange. The peeled orange will sink. Discuss what characteristic of the orange peeling the orange changes (density).
11. Do a sink/float discovery activity. Have the students get into the same groups they used for the drops on a coin activity. Give each group a paper on which they can write the name of an item, as well as if the item sunk or floated when placed in water.
12. Each group of students should have their own tub of water and many random items that they collected from home (given as previous assignment) or provided by the teacher. Have the groups test all of their materials. If students are older also have them weigh each item and approximate how many cubic centimeters the object occupies (volume). If students are really intrigued, ask them to estimate the density of water based on their estimated densities of items that either sank or floated.
13. Do a demonstration with various soda cans. Ask the students if they think a can of soda will sink or float. Have them discuss in their groups what they think and why. Put a large clear tub on a table in the front of the class. Place the cans in one at at time. The regular soda cans should sink while the diet soda cans float/sink only slightly.
14. Ask the students if they see a pattern in which can sink and which ones don't. Have them spend time discussing what patterns they see (eventually point out regular sink and diet float if they haven't said it yet). Ask them why regular cola sinks but diet doesn't. Have them say theories as long as it takes for one of them to realize regular cola has sugar, whereas diet doesn't. This would increase the weight but the volume of the can remains the same. Thus regular soda has a greater density than diet soda. This density difference spans the density of water, so they display different behaviors.

Homework: Ask students to experiment at home with various liquids in their kitchen (vinegar, oil, soy

sauce, etc). Which ones are more dense than water and which ones are less dense than water? How do they know? Challenge them to make a glass have at least three distinct layers of liquid.

note: $density = \frac{mass}{volume}$

Lesson Seven: Super Solids! Magnetic Force

Duration 1 hour

Overview: Students will play and discover using a solid material, magnets!

Vocabulary: Magnet, magnetism, magnetic, metal, solid, North, South, attract, repel, iron

Objectives: Students discover the concept of magnetism and learn what things around them are magnetic.

Materials: Coins, paper clips (other various objects both magnetic and not), a variety of magnets, large powerful magnet, figs, grapes, apples, chopsticks, string, small stand, "magnetic or not" worksheet, matches

Resources: Youtube Video of "amazing tricks with magnets"

The Lesson:

1. Open with review of the states of matter (solid, liquid, and gas). Ask the students to give an example of each. Ask the students what they learned about the properties of the gas air. Ask students what they learned about the properties of liquid water.
2. Explain today we will be doing activities and experiments with solid materials, specifically in the form of magnets.
3. Ask students what a magnet is. What kinds of things are magnetic.
4. Review that a force is a push or a pull. Ask which of these two things magnets do (both). See if students connect that magnetism is an example of a type of force.
5. Depending on the age of the students, do a "magnetic or not" activity. Students will be put into pairs. With their partner they will use a magnet to test various items in the classroom. They will mark on their worksheet which items they tested, as well as the result if the item was magnetic or not. If students are older instead have them play with polar magnets. Ask them to also observe which ends of the magnets are attracted to each other and which end are repelled by one another.
6. Have each pair share a result they found interesting with the class.
7. Show the "amazing tricks with magnets" video. Don't show the portion with the fruit being 'magnetic'
8. Now tell the students you are going to do some "magnet magic" in class.
9. First do a simple demonstration with matches. Show the students that new matches are not magnetic. Let a student come up and try so they know you are not tricking them in any way. While wearing the proper safety material, light a handful of matches, allow them to burn a few seconds, and then put them out. Now the burnt matches will be magnetic!
10. Allow the students time to be in awe. Show again how the new matches aren't magnetic but the burnt ones are. Let the students shout out guesses as to why. This is a more advanced concept so they might not guess, but here is the answer. The heads of most matches contain iron oxide. When you light a match the fire the iron oxide is reduced, carbon oxide released, and ferromagnetic iron remains on the match head. This is more magnetic than the iron oxide was, so the magnet is able to lift the burnt matches. *Be sure to test the matches before you do this experiment. Not all matches contain iron oxide in the match head, so won't work.*
11. Before the class have constructed a stand with an 'arm' able to support a horizontally suspended chopstick with string. The chopstick should be able to rotate freely.

12. Show the students a fig. Ask them what it is. "Is it magnetic?" The students should say NO. Demonstrate how a magnet doesn't stick to a fig.
13. Place the one fig fruit on each side of the chopsticks. Slowly approach the fig with the magnet but DO NOT actually touch the fruit with the magnet. The fig should very slowly move away from the magnet, causing the chopstick to rotate. Move the magnet to the other side of the same fig, or to the other fig on the opposite side. This should cause the chopstick to stop rotating.
14. Ask the students how this is possible. Let them discuss it in small groups and present their theories to the class.
15. Repeat the demonstration with a grape. Show first that the grape is not magnetic. Then place one grape on either end of the chopstick. The chopstick should rotate faster than it did with the fig fruit.
16. Now reveal the answer to how this is possible. Some matter is diamagnetic. Simply put, this means that the matter is repelled by both ends of a magnet. Water, a main component of fruit, is an example of a diamagnetic material. Friction from the table prevents the fruit from moving away from the magnet when students were testing to see if it was magnetic. Only when the fruit is suspended, and therefore friction reduced, is the fruit able to move away from the magnet. This force is a very weak force, explaining why it is often passed over when studying magnets.

Homework: What other fruits could you use for this same experiment? Which fruits would work the best? Bring your fruit to the next class to test!

Citation:

Mr. Hacker "10 AWESOME MAGNET TRICKS!" Published on Feb 8, 2017. https://www.youtube.com/watch?v=h5oXWtSMHzw