IHAD Summer Camp Activities

Abbreviated Outline—Day 1

Day 1: Is it a solid, liquid or gas?

Tuesday, July 11

1. **Pre-activity preparation**
2. **Introduction and "Wow" Demo**
    - Both classes in same room
    - Make nametags, "Wow" demo, instructor introductions
2. **Nature of Science discussion**
    - We have a subset of questions taken from the CLASS, EBAPS, VASS, and VNOST and modified to present to the students.
3. **Describe solids, liquids and gasses (5 – 10 minutes)**
    - Individuals each draw two pictures of different states of matter one 'life size' and one zoomed in. This will be used as one form of content pre-assessment. Then we will put students into groups with white boards to brainstorm and share ideas to present to the class.
4. **Group Assignments (10 minutes)**
5. **Mystery matter (20 minutes)**
    - State of matter categorization with materials with balloons in groups with defined roles (recorder, equipment manager, skeptic, spokesperson). The balloons will be numbered, so that each # balloon has the same unknown substance in it. Begin with easy and familiar objects and then present unclear, difficult to categorize materials
6. **Class discussion (15 minutes)**
    - The student groups come up with defining characteristics for each state and discuss as a class.
7. **Break (10 minutes)**
8. **Student Molecules (20 minutes)**
    - Students begin to see the particle nature of matter by being a molecule in "student matter"
9. **What State of Matter is Oobleck? (45 minutes)**
    - Through experimentation with the Oobleck have the students come up with a list of 'tests' or experiments that you could perform on a substance to determine its state.

10. Conclusion (20 minutes)

- Concluding class discussion, share lists of ‘tests’

11. Review (5 minutes)

Detailed Daily Activities—Day 1

Day 1: Is it a solid, liquid or gas?

Objectives: Students will be able to…

- classify different forms of matter as solids, liquids or gases by determining shared properties of each category.
- classify Oobleck as either a solid or a liquid

Materials:

- Mystery Matter
  - 3 balloons filled with solids (ice, Lego, ball)
  - 3 balloons filled with liquids (water, glue, dish soap)
  - 2 balloons filled with gases (air, helium)
  - 1 balloon filled with sugar
- Student Molecules
  - Masking tape
- Oobleck
  - Utensils
  - Mixing containers
  - 1 Ziploc bag for each student to keep their Oobleck
  - Recipe for Oobleck (write on large Post-it at the front of the room)
    - Fill Dixie Cup ½ full of water
    - ¼ box of cornstarch (will be measured out in a Ziploc bag)
    - 1-2 drops of food coloring
    - Put the water and food coloring in a large bowl and begin adding the corn starch and mixing. Eventually the mixture will get thicker. Keep adding cornstarch and stirring until it is hard to stir. Then you will have Oobleck!

Instructors:

- As the students are working, the instructors should move from group to group
  - The instructors should:
    - Keep students on task
    - Ask questions to check for understanding
    - Help guide the students to recognize and correct their own mistakes

Background:

The term "Oobleck" is derived from the book ***Bartholomew and the Oobleck,*** by Dr. Seuss. Experimenting with Oobleck is much more than having fun with a weird substance. As students participate in this activity, they will develop important skills in scientific observation.

Oobleck is a non-Newtonian fluid. This means that when a small amount of force is used, it acts like a liquid, but when more force is applied, it acts like a solid. For instance, one can slowly put a spoon in Oobleck, but it is impossible to stir it quickly. Some students might have seen glass in very old buildings that is thin at the top and thick at the bottom. That is because glass is also a non-Newtonian fluid and is slowly flowing out of the pane.

The following is a lesson plan that lets students make there own assumptions about solids and liquids and then test those assumptions -- just like real scientists!

Activity:

1. Pre-activity preparation

- Fill the balloons with the solids, liquids and gasses described above.
- Number each balloon (balloons with the same substance have the same number)
- Prepare materials for Oobleck activity.
- Write “Solids, Liquids, Gasses” at the front of the room on Post-its. These vocabulary words will be referred to throughout the activity. Leave enough room to write properties and examples for each.
- Place desks or table/chairs into groups of four.

2. Introduction and “Wow” Demo

- Both classes will begin in one classroom
- Each student will create a nametag for themselves.
- “Wow” demo – Professor Noah Finkelstein
    - Will possibly include:
        - Freezing a flower, banana, etc in liquid nitrogen
        - Inverting a balloon inside a beaker
- Instructors introduce themselves
    - Who we are, why we are here and why we are scientists
- Camp Overview: We will be studying ***states of matter*** this week. The students will be making a movie about states of matter in their groups. They will get to show it in the JILA Auditorium at the University of Colorado in Boulder. So, as we do different activities, they should be thinking about what topic they want their group’s movie to be about.
- Separate into the two classes

3. Nature of Science Discussion

- We have a subset of questions taken from the CLASS, EBAPS, VASS, and VNOST and modified to present to the students. The types of questions will include personal interest, aspirations, organization of scientific knowledge, and real-world relevance of science. (see survey questions).
- Pass out the survey. Then have a class discussion about the meaning of the questions without swaying the students' answers. (Turhan and Chandra will take field notes through this discussion.)
- The students will write down their own personal answers to the questions.

4. Describe solids, liquids and gasses (5 – 10 minutes)

- Introduce the students to the idea that there are three states of matter. Do not give examples or properties.
- Hand out worksheet and Explain directions:
    - Have the students draw an example for each category.
    - Tell the students that they will tape their drawings to the front of the room when they finish.
    - (WORKSHEET 1, one for every student)
- After all the students finish, brainstorm ideas of what it means to be a solid, liquid or gas as a class.
- Have the student share ideas of properties and examples
- Write the ideas for each category at the front of the room on the labeled large Post-it paper.

5. Group Assignments (10 minutes)

- *Each class should have four groups of equal size*
- Have the class vote for either self-selecting or assigning groups of four
    - Tell the class that the instructor will re-assign the groups if need be.
- Have an already prepared method of selecting the groups if they choose group assignments (note cards with pictures, counting off to four, etc.)
- Allow students to move to groups
- Give the groups a couple minutes to come up with a group name.
    - Write the group names on a large Post-it.
- Have students in each group count off from 1 to 4
    - this will be their number for the entire week
    - if there is a group of three, combine Material Manager and the Measurer
- Assign each number a role: And explain the different roles (role play *skeptic*)

    1. **Equipment Manager** – gathers all materials and returns them at the end
    2. **Reporter** – shares the group's results and reasoning with the class
    3. **Skeptic** – questions the group's reasoning and writes down results

4. **Measurer** – makes the measurements, collects data and performs tests

*** *ALL* group members help with cleanup***

5. Mystery matter (20 minutes)

- Hand out the worksheet for the activity. (WORKSHEET 2, one per group)
- Explain the directions
  - Each group will classify the contents of each balloon as solid, liquid or gas
  - They will write down observations that support their claims
  - The members of the group should discuss their reasoning and come to an agreement about the classification
- **For the Mystery Matter activity (written on large Post-it):**
  1. **Equipment Manager** – gathers mystery matter balloons and returns them at the end
  2. **Reporter** –writes the group's name and results on the class chart at the front of the room (Enter "S" for solid, "L" for liquid and "G" for gas)
  3. **Skeptic** – questions the group's reasoning and writes down results on the group worksheet
  4. **Measurer** – primary balloon tester, helps group make observations about what is inside the balloons

6. Class discussion (15 minutes)

- Go through the groups results to come to a conclusion as a class. For the balloons that the groups disagree on, ask a couple reporters to share their group's reasoning for that balloon
- Then ask for the reasoning from a few groups for the sugar filled balloon
- Discuss the arguments for it being both a liquid and a solid
  - Refer back to this balloon when discussing particle nature of matter

7. Break (10 minutes)

- Set up for *Student Molecules* Activity—Make a container using chairs set up in a circle with the backs of the chairs facing in. Use masking tape to delineate the container's bottom.

8. Student Molecules (20 minutes)

- Start by asking the students to draw a zoomed in picture of the boundary of a piece of wood in an open container and what is outside the container, through at magnifying glass, (see worksheet). (5 min) (WORKSHEET 3, one per student)
  - Have a few volunteers share their ideas with the class
  - They should have some since of a microscopic picture

- Now move into the activity: The tell the students that they get to be molecules in a substance called "student matter" (10 min)
    - Tell all the kids in the class to sit squished close together on the floor in a circle of chairs. They might be able to rotate their heads or wiggle their bodies, but they would not be able to go anywhere. This is what happens to the *molecules* in a solid. *The solid made out of students keeps its shape and retains its same volume.*
    - Now we imagine that we raise the temperature of the student matter past the melting point. When that happens, the students can stand up and walk around within the circle of chairs (imaginary container). This would be a liquid—they are just as close together and still cannot go off on their own, but now they can move and change places. *Their volume is fixed but not their shape.*
    - Now we imagine that we raise the temperature past the boiling point. This changes the student matter into the next phase: a gas. The kids are too hyper to remain in the container and are able to jump out and run free spreading out everywhere in the room. *Since a gas does not have a fixed volume and does not have a fixed shape, it will spread out and take the shape of its container.*
- Brief recap/evaluation: Ask the class the following: (5 min)
    - What happens to a liquid if the temperature increases past its boiling point?
    - What happens to a liquid if the temperature decreases past its melting point?
    - Did the *number* of students change?
    - (See if they can make sense of the process backward—decreasing temp)

9. What State of Matter is Oobleck? (45 minutes)

- Go over directions
- Ask the groups to discuss are the differences between every solid and every liquid and how they could test that. What tests could you do? For example: They could come up with the following four tests:
    1. Push Test – can you push into it?
    2. Pick-up Test – if you pick some up, does it all come up?
    3. Pour Test – does it pour out smoothly, or does it just fall out in a clump?
    4. Shape test – does it keep the same shape?

- Have each group make a chart of these rules on their white board so that they can test any new materials by seeing if they match. (10 min)
    - Wait for all groups to finish before having the Material Manager get the materials for making Oobleck.

- **For the Oobleck activity (written on large Post-it):**

1. **Reporter** – shares the group's results and reasoning with the class
2. **Skeptic** – questions the group's reasoning and writes the group's tests, observations and conclusions on the worksheet.
3. **Measurer** – makes the Oobleck following the recipe posted at the front of the room
4. **Equipment Manager** – gathers materials needed to make Oobleck

- Hand out Oobleck Worksheet (WORKSHEET 4, one per group)
- Hand out Oobleck
    - Students make Oobleck
        - The recipe should be written at the front of the room
    - Allow some time for student to play with the Oobleck (5 min)
    - Instructors: Encourage the students to pour a little Oobleck in the palm of their hand and make observations about its behavior. (They can watch it puddle like a liquid. Then make a fist and quickly open their hand. The Oobleck will have formed a hard ball from the pressure of their fist; but when the pressure is release, it will seem to "melt" into a liquid again.) (5 min)
- Have the Skeptic wash their hands so that they can record the groups observations.
- The students will make observations and write them on the observation sheet
    - (25 min)
- Based on these observations the groups will classify the Oobleck
- Clean up (10 min)

10. Conclusion (20 minutes)

- Ask each group to share their tests, observations and conclusions
    - The Reporter can demonstrate the tests they performed on the Oobleck for the class
- What does the class conclude?
    - Behaves like both a liquid and a solid
- Make sure that the students understand that in science, things aren't always what you expect and that not everything falls into neat categories (non-Newtonian fluid).
    - Oobleck is fun, non-intuitive, and you can come up with parameters to classify it
    - Models have utility—understand that Oobleck acts like a solid under certain circumstances and a liquid in others. It is something in between a solid and a liquid.

11. Review (5 minutes)

- Walk through the activities of the day utilizing the Post-its throughout the room
    - Ask probing questions to guide the students through the review:

- What are the properties of a solid?
- How did we classify the states of matter in the balloons?
- What did we decide Oobleck is?
- Etc.