

JSD 3D Learning Activity Template

Grade: 6th

Title: Uneven Heating and Particle Movement

Utah Science with Engineering Education Standard (SEEd): 6.2.3 Plan and carry out an investigation to determine the relationship between temperature and the amount of heat transferred and the change of particle motion in various types or amounts of matter.

Key crosscutting concept(s) (CCC): Energy and Matter Particle Flow; Cause and Effect;
Key science and engineering practice(s) (SEP): Planning and carrying out an investigation

Materials: 5 Styrofoam cups; room temperature water (70 degrees); hot water; cold blue food coloring; cold red food coloring; 15" x 9" x 6" (depth) clear tub; pipette; 4 eighth-inch risers

Time: 1 hour for the experiment; 1 hour for the analysis and questions.

Teacher background, key content information and hints: When different surfaces are heated by the sun, each surface will release the heat differently. Depending on how quickly the heat is released will determine the temperature of the air above that surface. As the air gets warm, the air molecules will begin to separate from each other. As they separate, that volume of air becomes less dense and will rise above the air that is not as hot. As the air rises, cooler air comes in and takes the place of the air that rose. In the air, this is wind, and in the water, it is a current. This causes a convection current to happen.

Prior knowledge that students need: Students need to know what density is and what the differences in density in a solid, liquid, and gas. They should also know that different densities of solids, liquids, and gases have slower or faster movement depending on the states of matter.

Learning Activity Plan

These three aspects of a lesson should be identified in your learning activity.

Gathering: Students are to plan and carry out an investigation of how Dust Devils form by using the materials give to them. They are to record as much data as they can as they are watching the results of the experiment. They will use their own method of recording.

Reasoning: Students are to evaluate the data and construct an explanation to develop arguments from the evidence. They are also to draw a model of what is happening in the experiment and label their models.

Communicating: Students are to communicate their information and argue from their evidence by the use of their models.

Phenomenon: Harmless Dust devils appear on land and twirl for a while and then die down.

Learning Activity:

1. Students will be told about and shown pictures of dust devils.
 - a. https://www.google.com/search?q=dust+devils&safe=active&tbm=isch&source=lnms&sa=X&ved=0ahUKEwiA9oLSuqHV AhWI14MKHZQ_A78Q_AUIBygC&biw=1172&bih=775&dpr=2
2. Students will be told about and shown videos about dust devils.
 - a. <https://www.youtube.com/watch?v=4aswt6Cobo>
 - b. <https://www.youtube.com/watch?v=AwKc7H5gIWo>
 - c. <https://www.youtube.com/watch?v=CzEssvEpAPI>
3. Students are to have a background knowledge that hot air rises and why it rises. It has to do with the density of solids, liquids, and gases.
4. Students will be given the materials and try to figure out how to plan and carry out an investigation to show how this phenomenon works.
5. Students are to record what they see.
6. Students are to use a timer of sorts to show the timing of the movement of the food coloring.
7. Students are to use a measurement of sorts to show stretch of the food coloring.
8. Students are to construct a reasoning with their written data and background knowledge as why dust devils happen.
9. Students are to use a model to construct an argument using their data and model to show evidence of their conclusions.

How to set up the experiment: (for the teacher).

10. Place 4 Styrofoam cups upside down on the 4 risers.
11. Place the 4 Styrofoam cups to the size of the container so the container will sit on the four Styrofoam cups, open side up.
12. Put very cold water in the container so it fills up the container about 2 inches from the top.
13. With the pipette, drop about 5 drops of blue food coloring in the water near each end of the plastic container.
14. With the pipette, drop about 5 drops of red food coloring in the center of the plastic container.
15. The food coloring of each should drop straight down to the bottom of the container.
16. With hot water in the 5th Styrofoam cup, place that cup under the center part of the plastic container right under the red food coloring.
17. After a few minutes, the water around the red food coloring will get warm and start to move upward carrying the red food coloring with it.
18. As the red food coloring is moving up, the blue water at the bottom begins to move toward the center of the container along the bottom.
19. The blue water will eventually become warm by the heat source and begin to rise too.
20. More blue cold water will be drawn in because of the rising water.

Explanation:

21. All the food coloring being the same cold temperature dropped to the bottom of the plastic container because it was colder than the water in the container.
22. The colors stayed together as they were dropped because the water molecules of the room temperature water were not moving very fast to spread them around.
23. As the hot water was placed under the red food coloring, it was heating the water above it.
24. As the water heated up, the water molecules began to move around and rise to the top carrying the red food coloring.
25. As the warm water became warm, the water molecules separated from each other and become lighter in weight because it was less dense.
26. The cold water molecules were still close together which made the cold water more dense. Because the red water was less dense than the blue water, the red water rose to the top of the container.

27. As the red water was rising, the blue water moved across the bottom toward the place where the red water was. It moved there to take the place of the water that was moving up.
28. The cycle will finally stop when the heat source is gone.
29. Rising Convection Current Video (Explanation of the experiment)
 - a. <https://www.youtube.com/watch?v=B8H06ZA2xmo>

Connection to Dust Devils:

30. As the ground gets hot by the sun, the heat radiates up and heats the air.
31. As the air gets heated, the air particles separate and become less dense.
32. The air farther out is still cooler denser.
33. As the hot air rises because it is less dense, the colder, denser air is drawn in and becomes warm by the ground and becomes less dense and rises.
34. This will continue to happen as until the heat from the ground is gone and the dust devil will die out.
35. The turning motion of the dust devil is caused by the Coriolis effect. As the earth is spinning it will cause the winds to turn on an angle cause it to spin.

Assessment of student learning

- Students will be able to explain why the red and the blue food coloring dropped to the bottom when first put in the water.
- Students will be able to explain why the red food coloring rose.
- Students will be able to explain why the blue food coloring is drawn into the red food coloring area.
- Students will be able to explain why the blue food coloring rises as it is drawn into the center of the container.
- Students will be able to explain what heat does to substances.
- Students will be able to explain what cold does to substances.
- Students will be able to explain why dust devils form.
- Students will be able to explain why dust devils spin.
- Students will be able to explain why dust devils die down.

Student Name _____

Student Sheet

Uneven Heating and Particle Movement

Phenomenon:

Harmless Dust Devils appear on land and twirl for a while and then die down.

Materials:

5 Styrofoam cups; room temperature water (70 degrees); hot water; cold blue food coloring; cold red food coloring; 15" x 9" x 6" (depth) clear tub; pipette; 4 eighth-inch thick risers; timer; ruler

Procedures:

1. Students look at these pictures of dust devils and watch some Youtube videos of dust devils.
2. Students are to explain why dust devils happen through experimentation.
3. Students are shown the materials they are going to use to show how dust devils form and happen.
4. Students are grouped in groups of 3-4 and receive the materials they need to see how dust devils are made by nature.
5. Students are to figure out how to put the materials together to make a dust devil happen in the water.
6. When the experiment starts to work, the students are to observe and write down in a journal what they see happening.
7. Students are to use a timer to measure how long it takes for the process to work.
8. Students are to use rules to measure the length the colors stretch during the experiment.

Data tables or graphs:

1. Students are to make a graph of how long it takes for the red food coloring to move and the blue food coloring to move.
2. Students are to graph the measurement of the stretch blue and red food coloring.
3. Students can put time and measurement together to show the time and movements of the food coloring.

Analysis:

Students are to look at their data and graphs and analyze what is happening that causes the colors to do what they do.

Conclusion:

1. Students are to create an argument of why the colors did what they did in the tub by using their data and graphs to construct the explanation.
2. The students are to transfer this knowledge to why dust devils form and continue to move around and then die down.

Questions about the Food Coloring Experiment
To Explain Dust Devils

1. Explain why the blue and red food coloring dropped to the bottom of the tub when first put in but didn't expand about.

2. Explain why the red food coloring began to spread out and rise when the cup of hot water was placed under the red food coloring.

3. Explain why the blue food coloring started to move in toward the red food coloring.

4. Explain why the blue food coloring began to rise when it got to the center of the tub

5. Explain why the red food coloring gradually went down when it reached the top of the water.

6. Explain what happened to matter when it becomes heated.

7. Explain what happens to matter when it becomes cold.

8. With what we know what happens to water when it becomes warm and cold, explain what is happening when a dust devil is present.

9. Why do you think that dust devils die down?

10. What do you think that dust devils spin?
