

The Flying Zippies

The Flying Zippies is a whimsical online story designed to teach about particles changing states when the ambient air is heated. The particles are represented as a set of circus performers called the Zippies.



Getting to Know the App

Children might need a reminder to tap the speaker or forward arrow when they are flashing. Encourage children to speak out loud when the narrator asks them a question. The scene will not advance automatically so the child can take her time to answer the questions and then hit the forward arrow icon when ready. If possible, let two children work together. In that case it works well for one child to operate the speaker icon and the other child to operate the forward arrow icon.

What it Teaches

The Flying Zippies interactive animation tells the story of circus acrobats. These "acrobats" represent particles of matter. When the interaction starts, the Zippies are sleepy and clustered together, packed together tightly as in a solid. Eventually the Zippies fly above the ground as a gas. Along the way, there are failed attempts to get the Zippies to fly by tilting their cart or adding more Zippies. In the end, when the ringmaster wants them to stop flying, there are failed attempts to bring them down with a butterfly net or to get them cozy again as a solid by sweeping them together.

The Zippies are made to fly by moving them from the relatively cold air in their dressing room to warmer air in the circus tent (melting of a solid state to liquid state), and then by lighting torches to warm the air even more (evaporation of liquid state to gas state). The reverse of extinguishing the flames and moving the Zippies back to the cooler air in their dressing room causes the particles to condense into a liquid and then congeal as a solid. From time to time the narrator asks questions and pauses while the children can answer, such as "Will tilting the Zippies in their cart make the Zippies separate?"

States of matter do not change without an identified cause. We cannot just say, "You add heat" because that will reinforce the misconception that heat is some undefined "stuff." The Flying Zippies interactive makes it clear that the Zippies do not change their speed or state unless they are bombarded by particles of air. Rocking or jostling a solid as a whole does not change its state. Adding more warm particles to already warm particles does not create a change of speed or distribution. We believe that young children will enjoy the story of the circus acrobats who need to fly, and they will have the chance to reason at key points using their understanding of the physical world (e.g., melting, freezing, evaporating, condensing).

The Flying Zippies

Navigating the App

The viewer works through the various scenes in the interactive by tapping either the speaker icon on the left bottom or the forward (right-facing) arrow icon on the right bottom. These icons flash to cue when they should be tapped. The viewer can return to a previous screen by tapping the left-facing arrow on the bottom left of the screen. The Home button returns the screen to the very first page that shows the six sections of the story of the Flying Zippies: Introduction, Solid, Liquid, Gas, Liquid Again, Wrap Up. The Home button lets you randomly access sections if you want to skip around, say on a second or third viewing. The Replay button lets you return to the beginning of the short unit between two pauses. When you hit the Replay button the speaker icon will flash. Hit that button to listen again just to that unit.

How it Works

The Concord Consortium's Molecular Workbench computational model (<http://mw.concord.org/nextgen/>) is embedded in the interactive. Views of this model are preceded by the narrator saying, "Let's see what really happens."

The Flying Zippies demonstrate the role of the ambient (surrounding) air as the causal agent that changes the state of matter. The Zippies are cozy together in the slow air of their dressing room, more like a liquid in the faster air in the tent, and gaseous when the air in the tent is heated by the torches.

Talking About Discoveries

The narrator asks several questions during the process of viewing the interactive. These questions are carefully worded. They explicitly mention the current state of the Zippy particles and the current speed of the air particles. The narrator specifies that the faster air bumps the Zippies harder than the slower air. Some questions come on the heels of strategies that do not work. Asking children questions about what does not work helps the children understand why the successful strategies do work.

After reading The Flying Zippies, you may want to assess what the children have learned. Start with a general set of questions.

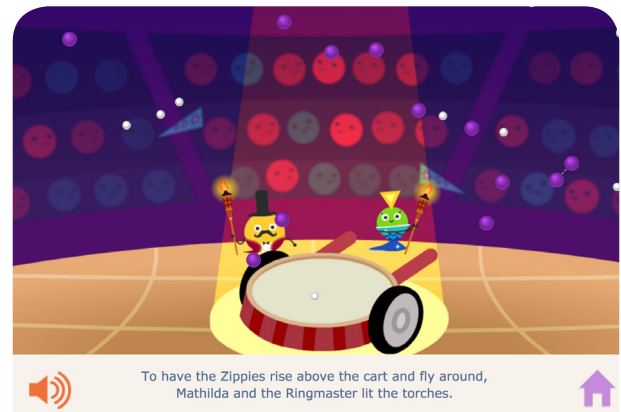
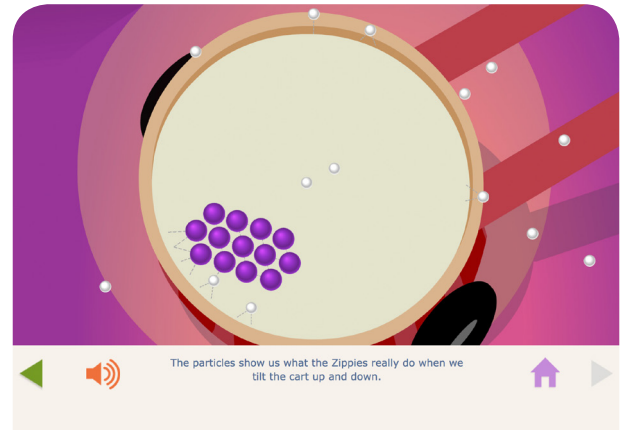
- 1 What did the ringmaster do to make the Zippies become a liquid? [Listen for some mention of moving the Zippies into the warm air of the big tent.]
- 2 After the Zippies became a liquid, they were still unable to fly above the ground. What happened to make them fly? [If children say, "They lit the torch," ask how that helped. The torches made the air move faster and bump the Zippies harder.]
- 3 Can you tell me when Matilda did something that did not change the Zippies' speed or make them move apart? [Listen for comments about shaking the cart or adding another set of Zippies moving at the same speed as the first set of Zippies.]

The Flying Zippies

4 Can you tell me when something happened in the story that we could call "melting"? [This happens when the solid Zippies were moved from the cold air in the dressing room to the warm air in the big tent.]

5 And what happened that we could call "freezing"? [This happened late in the story when the Zippies were returned to the dressing room where the air was slow and cold.]

6 Why did adding more Zippies to the cart not break the Zippies into a gas? [Because the new Zippies were moving at the same speed as those in the cart. They would not bump the Zippies hard enough to break them into a gas.]



The Flying Zippies

Supplemental Activity: Using Real-World Objects

What to Do

It is important for children to use The Flying Zippies as a bridging metaphor to help them understand the microscopic world of particles of matter and changes in the state of matter. Of course, if we use real objects as examples, then children have to imagine the microscopic-level objects we call particles. Nevertheless, we can provide the children objects with which they are asked to speculate on what the particles are likely doing. And once we hear what the children say, their comments will provide a scaffold for us adults to build supporting words or drawings.

Show the children one glass (Glass A) filled with one-third with warm water and another glass (Glass B) also one-third filled with warm water. Let the children feel the temperature of each glass. Assume that they agree both glasses are about the same temperature. Now pour the contents of Glass A into Glass B. Ask them if the temperature of the mixture is the same, less, or more in Glass A than before the transfer of water from Glass B. Once they make their prediction, encourage them to go as far as they can to explain their prediction. Toward the end of their explanations, ask, "Did you learn anything from the Flying Zippies that helped you explain what happens when the two glasses of warm water are mixed?"

Purpose of the Activity

The warm water activity will help the children treat the Zippies as physical particles in the liquid state of matter. More specifically, mixing warm water with warm water often leads children to say that now the water will be hotter (confusing heat with temperature). In the Flying Zippies the plain dots animation showed that particles of a given speed do not change the speed of a recipient group already moving at that same speed. This animation happened immediately after Matilda added a new group of Zippies to the original group.

What to Notice

Children are more likely to predict that hot and cold water mixed will lead to some temperature in-between. They may know this from times they turn on the cold water if the bath water is too hot or when they turn on the hot water faucet if the water in the wash basin is too cold. Nevertheless, adding hot to hot or stacking one ice cube on top of another often leads them to say, "It will be hotter (or colder) than before." By emphasizing that temperature is the relative speed of particles, The Flying Zippies should help children understand that fast hitting fast does not change the speed of either. Be alert to any comments about speed, bumping, change of speed as the result of bumping. If necessary help the children stay focused on the micro-level (particles speed up) rather than the macro level (the water gets hot).



Carolyn Staudt
(cstaudt@concord.org)
Senior scientist at the Concord Consortium



George Forman
(geforman@gmail.com)
Emeritus professor at UMass Amherst, past lead researcher at Harvard's Project Zero

This material is based upon work supported by the National Science Foundation under Grant No. DRL-1621299. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

