Curiosity Guide #607
Convection

Accompanies Curious Crew, Season 6, Episode 7 (#607)

Designing a Candle Convection Carousel

STEM Challenge

Description

Design and make this engaging gadget that shows convection!

Materials

- 2 aluminum pie pans
- Paper
- Scissors
- Markers
- Pan template from https://www.sciencebuddies.org/Files/6811/6/windmill-template.pdf
- Tape
- Protractor
- Bead
- Permanent marker
- Hot glue
- Straws
- Washers
- Rubber washer
- Ruler
- Clay
- Wood skewers
- Tac
- Dowel
- Wood screw

- Drill
- Finishing nails
- Hammer
- Copper wire
- Playdoh
- Candles
- Match or lighter
- Stopwatch

Procedure1: Design and make a fan blade

1) Cut off the sides of one of the pie pans, ending up with only the circular bottom.
2) Tape the windmill template onto the circular aluminum base.
3) Starting from the outside edge, cut along the solid black lines. Be careful to stop at the intersection with the dotted lines. This will create eight blades for the fan.
4) Using a protractor as a guide, bend the blades down about 30-40 degrees along the dotted lines.
5) Remove the paper template. Decorate the blades with markers.
6) Flip the blade assembly and lay it down.
7) Measure and find the exact center point. Mark the center point with a permanent marker. This will be the contact point for the carousel's support.
8) Select an item to serve as the post guide to the carousel. This could be a bead with an inserted straw, a washer with an inserted straw or a rubber washer with an inserted straw.
9) Hot glue the selected guide in place.
10) Cut and insert a straw of appropriate diameter and about 2 inches in length into the guide hole. Glue in place, making sure that the straw is completely perpendicular to the fan blade.

Procedure 2: Create the carousel platform

1) Measure and find the center of the second uncut pie pan. Mark the center with a dot of permanent marker.
2) Decide how many candles will be used for the carousel. If three are selected, measure to find three equidistant points on the circumference of the pan's base and mark with the permanent marker. If four candles will be used, find four points, and so on.

Procedure 3: Add a shaft and connect all the parts

1) Make the carousel support shaft, possibly using a wooden skewer with the point facing up and held in place with a lump of clay; or a thin dowel screwed through the bottom of the pan and finishing nail attached to the top; or 12g copper wire held with clay or Playdoh.
2) Mark the top of one blade with a large enough mark to be visible during rotation.
3) Fit the fan assembly on top of the shaft. Adjust as necessary to keep the assembly level with reduced friction. Test by gently spinning the fan.
4) Position the candles on the pan's marks.

Procedure 4: Perform the investigation, observe, and adjust

1) Light the candles. Wait several minutes.
2) What do you observe?
3) Have a friend watch the timer while you count the number of times the marked blade passes a given point in thirty seconds.
4) Double that number. That is the number of rotations per minute.
5) What adjustments could be made to increase the number of rotations per minute?
6) Record your modifications to your design and what happened each time.

My Results

Explanation

As the lit candles warm up the air around them, the air particles begin to collide more quickly and more forcefully, making the air less dense. As a result, the warmer air begins to rise. As those particles begin to create an air current the particles collide with the fan blades, or carousel top. The carousel top begins to rotate. This is a visible example of the convective updraft, which occurs in fluids like liquids and gases. This model shows the rising of the warmer, less dense air and the sinking of the cooler, denser air. This is the same kind of motion of energy transfer that is observed in the atmosphere, the ocean, and even in the mantle of the earth. As more candles are added to the carousel, the number of rotations per minute increases. A balanced carousel with minimal friction will rotate even faster.

Because gas is invisible, we can't see the convection currents, but we can see their effects, as when our convection carousels spin. You may have also seen this with a pot of boiling water that gets heated by conduction. The bubbles move to the surface and create steam rising into the kitchen. So, when does that rising air stop rising? When the rising air cools to the same temperature of the air around it. Of course, that rising air gets replaced with other air, which we feel as wind. What a nice convection current! I mean-- breeze.

Parents and Educators: use #CuriousCrew #CuriosityGuide to share what your Curious Crew learned!

Curious Crew is a production of Michigan State University.
Learn more at WKAR.org.