Curiosity Guide #601
Collisions

Accompanies Curious Crew, Season 6, Episode 1 (#601)

Air Track Collisions

Investigation #7

Description

Crashes are fun, and an air track makes them easier to understand!

Materials

- Plastic downspout, 65 inches long
- Downspout caps
- Drill or hand Dremel
- Drill bits
- Pencil
- Measuring tape
- 2-by-4 piece of wood
- Saw
- 90-degree aluminum, 36 inches long
- Hack saw
- Vacuum cleaner with blower ability
- Plastic Ziploc snack bags
- Metal washers
- Digital scale
- Magnets
- Threaded or solid magnetic rod of $\frac{1}{4}$-inch diameter
- Magnets
- Duct tape
- Construction adhesive
- Meter stick

- Scotch pad
- 3 threaded rubber feet and metal inserts
- Level
- 2 wood screws

Procedure 1: Make the track.

1) Lay the downspout on one side. Make a series of pencil marks one centimeter from a chosen edge and one centimeter apart. Leave the first two inches on each end without any holes. This edge will be referred to as the apex.
2) Mark a second row of marks 2 centimeters down and one centimeter apart so that the marks are staggered from the first row.
3) Rotate the spout a quarter turn and repeat the two rows of marks from the same apex on the other side.
4) Drill each of the holes, using a 1 mm bit and drill.
5) Clean the holes. Use a scotch pad on the outside and a scotch pad taped to the end of a meter stick to clean the inside of the pipe.
6) Cut two 8-inch sections of wooden 2-by-4.
7) Notch a v-shaped groove into each edge of the 2-by-4 so the spout can sit in the groove with the drilled apex facing up.
8) In one 2-by-4, drill two holes on the uncut edge at each end.
9) Tap in the metal inserts and screw in the rubber feet, leaving $\frac{1}{4}$ inch of threading exposed.
10) Cut a 3-inch section of 2-by-4 and with a wood screw, fasten the 2-by-4 to the bottom center of the second notched 2-by-4 so that the pieces form an L-shaped joint.
11) Drill a centered hole in the flat part of the L joint.
12) Insert the metal clip in the underside of the L bracket and thread the foot through the hole.
13) Drill a hole the same diameter as the vacuum nozzle in the center of one of the downspout caps.
14) Slide the caps onto each end of the downspout and secure in place.

15) Place the track on the 2-by-4 supports. Level the track using the single foot adjustment on one end.
16) Cut two 2-inch sections of the aluminum 90 and glue them down on each end of the track to serve as stops.
17) Slide the vacuum nozzle into the opening and turn the vacuum on in blower mode to test.

Procedure 2: Make the cars.
1) Using the hack saw, cut the aluminum section into 2 cars that are 4 inches long and 2 cars that are 8 inches long.
2) Fill 2 snack bags with 4 large washers and 2 bags with 1 large washer.
3) Cut the metal rods into 4-inch lengths. Tape the rods onto the aluminum cars so the rods extend one inch beyond the front edge of the cars.

- Consider cars with Velcro ends, spring ends, magnet ends

Experiments
1) Turn on the air. Place one four-inch car in the center of the track.
2) If the car drifts to one side, level the track with the adjustable single foot.
3) Gently push the other 4-inch car from one end so the two cars collide and hit the metal rods. What do you notice?
5) Try again, this time pushing both cars from opposite ends. What happens?
6) Substitute a stationary heavy car for a lightweight car. What happens? What if you add sandwich-bag saddles on the lighter car? What about adding saddles on the heavier car?
7) Now attach two opposing magnets to the front of the metal rods and push the two of them together from each end. What happens?

My Results

Explanation

Because air tracks reduce the amount of friction the aluminum cars experience, we can more easily see how momentum is conserved after the collisions.

- When the smaller cars are each moving and collide, they bounce away and move with a similar amount of kinetic energy and a similar speed as the two cars had in the beginning.
- If one small car strikes a stationary car, the stationary car moves away with the transferred kinetic energy, and momentum is conserved.

- If a more massive car strikes a stationary car with less mass, both cars move in the direction of the more massive car, with the less massive car traveling faster.
- If the lighter car strikes the heavier one, the lighter car bounces back, while the heavy car moves slowly away.
- If the moving car attaches to the stationary car in an inelastic collision, both cars move in the direction of the moving car but at a slower speed when linked.
- Depending on how the magnets are arranged, the collision may be an elastic one when the magnets repel, with no energy transferred into sound, or inelastic when the magnets attract.

The air track is an easy way to see how objects react when they collide head on. Collisions that we observe are not perfectly elastic because some kinetic energy will transfer to other forms. But if we had microscope eyes, we could see how molecules can have perfectly elastic collisions. Molecules traveling at normal speeds can collide and bounce away, keeping all their kinetic energy. The molecules will keep traveling in straight lines until they collide with something else and bounce off again. Now that's energizing!

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