Feather and Guinea
Lesson Plan

Amount of time Demo takes: (2-3 minutes)
Try this at home!

Materials

- Tube (with guinea and feather inside)
- Rotary vacuum pump
- Extension cord
- Needs electricity from an outlet with 3 prongs and extension cord recommended
- Needs about three feet of space, or length of a table (to tilt tube upside-down)

Setup instructions

1. Check the oil level of the rotary vacuum pump on the side of the machine. It should be close to the line.
2. If there is not enough oil, the oil fill cap is the red cap on top of the machine. The most oil it can hold is 6.5 oz or 180 mL.
3. Plug the machine into a 3-prong outlet.
4. Check that the pressure gauge reads approximately 0 psi.

SAFETY!

- Do not let the students near the electrical cord or outlet.
- If refilling with oil at an event, do not let students near oil and avoid spills.

Lesson’s big idea

- Acceleration due to gravity: All objects accelerate at 9.8 m/s^2 downward due to gravity, and fall at the same rate under ideal conditions.
- Air resistance: The shapes that objects have affect the way in which air interacts with them. In absence of air, there is no air resistance.
- Vacuum: A vacuum eliminates air resistance because no particles are present to interact.
**Background information**

- **Vacuum**: A vacuum is a space in which matter, particularly air, has been partially removed, which causes the remaining matter to exert less pressure than the atmosphere.
- **Gravity**: the force that attracts a body toward the center of the earth, or toward any other physical body having mass.
- **Galileo** discovered that bodies fall on the surface of the earth at a constant acceleration. Also, the force of gravity, which causes all bodies to move downward, is a constant force (9.8 m/s^2). A constant force does not lead to constant speed, but to constant acceleration.
- However, air resistance causes objects with different shapes to fall at different rates. The only way in which objects will fall at the exact same rate is if they are unaffected by air resistance and friction. This property can be modeled by creating a vacuum (defined above). One can create a vacuum by lowering the pressure within a space. After this is done, it can be shown that any objects will fall at the same rate, regardless of shape, size, and density.

**Instructional Procedure**

1. Have the students watch the bottom of the tube and tilt the tube upside-down.
2. Attach the red hose on top of the machine to the piece on the top of the tube that has grooves. Ensure that a tight seal is formed.
3. Make sure that the lever on top of the tube is pointing parallel to the other piece on top of the tube. (parallel to the tube)
4. Turn on the rotary vacuum pump. The on/off switch is located next to the power cord.
5. Keep the machine running until the pressure gauge reads -30 psi. (meter pointing at end opposite to 0 psi)
6. Flip the lever on the tube sideways in either direction, perpendicular to the piece on top of the tube.
7. Turn off the vacuum pump and remove the red hose valve from the tube.
8. Have the students to watch the bottom of the tube and tilt the tube upside-down.

**Assessment/sample questions you can ask**

- Which object do you think will hit the bottom of the tube first?
What is a vacuum?
Why did the rate that the objects fell change?

Clean Up
- Unplug the rotary vacuum pump.
- Put the tube and rotary vacuum pump in their respective boxes.

References

Next Generation Science Standards
- 3-PS2-1