Distinct Falling Motion of Paper Cones in Air

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1. Introduction

When 1 paper cone falls, it falls straight.

When 2 paper cones fall, how will they fall ?

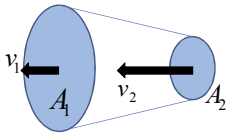
The falling motion of 2 paper cones will be explained

2. Theory

Fluid flow equations

• Continuity equation

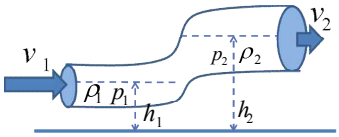
$$A_1 v_1 = A_2 v_2$$



v_1 = speed (m/s)
v_2 = speed (m/s)
A_1 = area (m²)
A_2 = area (m²)

• Bernoulli's principle

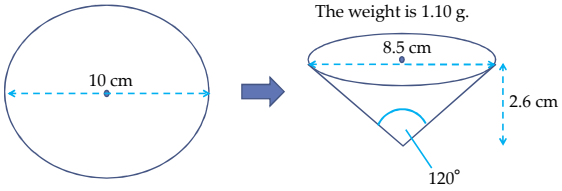
$$\frac{1}{2}\rho_1 v_1^2 + \rho_1 g h_1 + p_1 = \frac{1}{2}\rho_2 v_2^2 + \rho_2 g h_2 + p_2$$



v_1 = speed (m/s)
v_2 = speed (m/s)
ρ_1 = air density (kg/m³)
ρ_2 = air density (kg/m³)
p_1 = pressure (N/m²)
p_2 = pressure (N/m²)
h_1 = height (m)
h_2 = height (m)

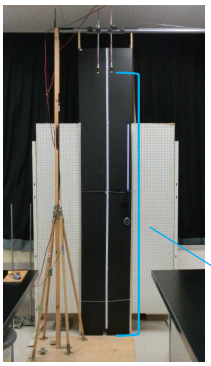
3. Equipment

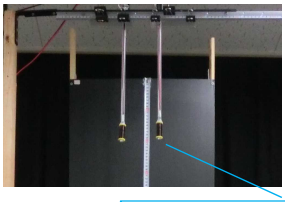
•Cone



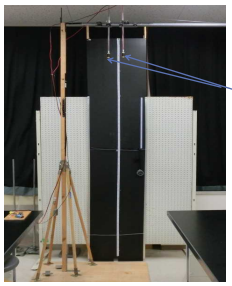
•Machine to drop 2 paper cones at the same time

This machine has 2 electromagnets.





4. Experiment



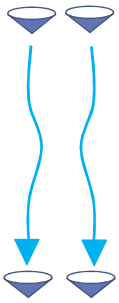
• Drop 2 paper cones of the same size and weight at the same time.

• Take pictures of the falling 2 paper cones using a stroboscope.

• Analyze the motion of the falling 2 paper cones

5. Results

The 2 paper cones close to each other always get separated without touching each other.



6. Discussion 1

A1 is larger than A2. Therefore from this "Continuity equation", V2 is higher than V1

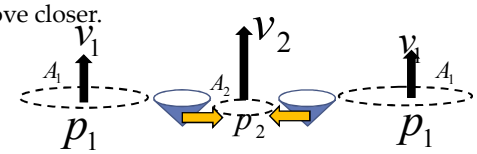
So the right side term of the kinetic energy is higher than the left side term of the kinetic energy. Therefore from this "Bernoulli's principle", P2 is lower than P1. So the 2 paper cones move closer.

• Continuity equation

$$A_1 v_1 = A_2 v_2$$

• Bernoulli's principle

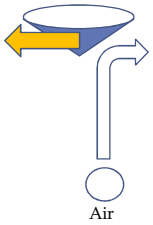
$$\frac{1}{2}\rho_1 v_1^2 + \rho_1 g h_1 + p_1 = \frac{1}{2}\rho_2 v_2^2 + \rho_2 g h_2 + p_2$$



7. Discussion 2

When the 2 paper cones separate, more air can pass between them.
But when the 2 paper cones are closest to each other, the air can hardly pass between them.

Maybe, the closer the 2 paper cones move toward each other, the more strongly the mass of air hits the left side paper cone. Then the mass of air turns right by the action of the left side paper cone pushing the mass of air. And the left side paper cone is pushed left by the reaction of it pushing the air to the right. The right side paper cone moves similarly.



8. Conclusion

The falling motion of the 2 paper cones getting closer to each other could be explained by the "Continuity equation" and by "Bernoulli's principle".
But the reason why the 2 paper cones moved farther from each other could not be fully explained.

9. Future research

To make sure the reason why the 2 paper cones getting farther