POPPY SCHOLARS · PHYSICS OF THE UNIVERSE

Home lab 8 · Unit 8 · about 45 minutes

Why does a magnet fall slowly through a copper pipe but quickly through a plastic one?

Name _____ Date _____

MATERIALS

You supply everything. Tick each item as you gather it.

- ☐ A copper pipe about 30 cm long with an inside diameter of at least 1.5 cm (plumbing supply)
- ☐ A plastic pipe or cardboard tube of the same length and size, for comparison
- ☐ A small neodymium magnet that fits easily in the pipes (about 10 mm across; a craft magnet)
- ☐ A kitchen scale (grams), a phone for slow-motion video, a ruler, and a pillow to catch the magnet

SAFETY

Neodymium magnets are very strong. They can pinch your skin, shatter if they slam together, and be swallowed with serious danger: keep them away from small children. Keep them away from pacemakers, phones, credit cards and computers. Catch the magnet with the pillow so that it cannot hit a hard floor. Wear safety glasses.

PROCEDURE

1. Weigh the magnet in grams and convert to kilograms. Measure the length of the pipe (about 0.30 m).
2. Stand the plastic pipe upright over the pillow. Record video as you drop the magnet in from the top, and find how long it takes to come out of the bottom. Use the video's time stamp, or count frames at a known frame rate. Do 3 drops.
3. Repeat with the copper pipe, holding the pipe vertically. Do 3 drops.
4. Compute the mean fall time in each pipe, and the average speed (length ÷ time).
5. Compute the time that the magnet would take in free fall: $t = \sqrt{(2d \div g)}$.
6. At a steady speed, the upward magnetic drag force equals the weight mg. Compute the weight, the energy lost (mgh), and the power lost to heating, $P = F \times v$.

RECORD YOUR DATA

Pipe	Trial 1 (s)	Trial 2 (s)	Trial 3 (s)	Mean time (s)	Average speed (m/s)
Plastic					
Copper					

Also write the mass of the magnet, the length of the pipe, and the free-fall time.

LAB REPORT

Write a report that gives your table, compares each fall time with the free-fall time, and calculates the drag force, the energy converted to heat and the power. Use Faraday's law and Lenz's law to explain why the copper pipe slows the magnet, and say where the magnet's gravitational energy went.

Report the numbers you actually got, even when they disagree with the lesson. Write on the lines, or type your report on the website and send it to a teacher there.

Question and hypothesis *State the question in your own words, what you expect to happen, and why you expect it.*

Method *What you changed, what you measured, what you kept the same, and how many trials you ran.*

Observations *Describe what you saw, including anything unexpected. Your data tables are added to the report automatically.*

Calculations *Show each calculation step by step, with units.*

Claim and reasoning *Answer the question using your numbers, then explain why, using the science from the unit.*

Limits and next step *What could have affected your results, and one change you would make next time.*