KATHERINE JOHNSON

"I counted everything. I counted the steps to the road, the steps up to church, the number of dishes and silverware I washed... anything that could be counted, I did."

Katherine Johnson (1918-2020) was an extraordinary African-American mathematician whose calculations were critical to the success of NASA's space missions. Her work made human spaceflight possible and inspired a new generation of women and minorities to pursue careers in STEM.

A Path to the Space

Katherine Johnson's contributions to space exploration went beyond performing calculations; she fundamentally transformed the field of aerospace engineering with her precise mathematics. Her most celebrated work includes determining the precise trajectories for the first U.S. manned space flight, for the historic moon landing Apollo 11, and for the Earth resources satellite programs. Before his flight, astronaut John Glenn specifically requested that Katherine verify the computer's calculations for his mission to orbit Earth. He famously said, **"If she says they're good, then I'm ready to go."** Katherine's calculations ensured the mission's success.

More information

https://katherinejohnson.net/

Experiment

Reverse engineer the trajectory and velocity of a catapult launch.

Part I: Build a catapult

A simple catapult can be built using popsicle sticks, rubber bands, and a bottle cap/plastic spoon. Many tutorials are a Google search away, and we encourage exploring the different approaches before building.

Part II: Collect Data

What you need:

- The catapult, a protractor, measuring tape, and object to launch (cotton ball, ping pong ball, bottle cap, …)

1. Place the catapult on a flat surface.
2. Use a protractor to measure the angle θ of launch (e.g., 30°, 45°, 60°).
3. Launch the object and measure the horizontal distance (range R) with the tape.

Part III: Reverse Engineer

Calculate the velocity v and time of flight t with the formulae below.

$$v = \sqrt{\frac{R \cdot g}{\sin(2\theta)}} \qquad t = \frac{2v\sin(2\theta)}{g} \qquad g = 9.81\,\frac{m}{s^2}$$

Questions

1. Can you calculate and plot the x and y coordinates of the trajectory of the flight?
2. How do the trajectories differ when using different objects to launch?
3. How accurate is your calculated time of flight? Compare with a stopwatch/phone.
4. How does this experiment relate to the work of Katherine Johnson?

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