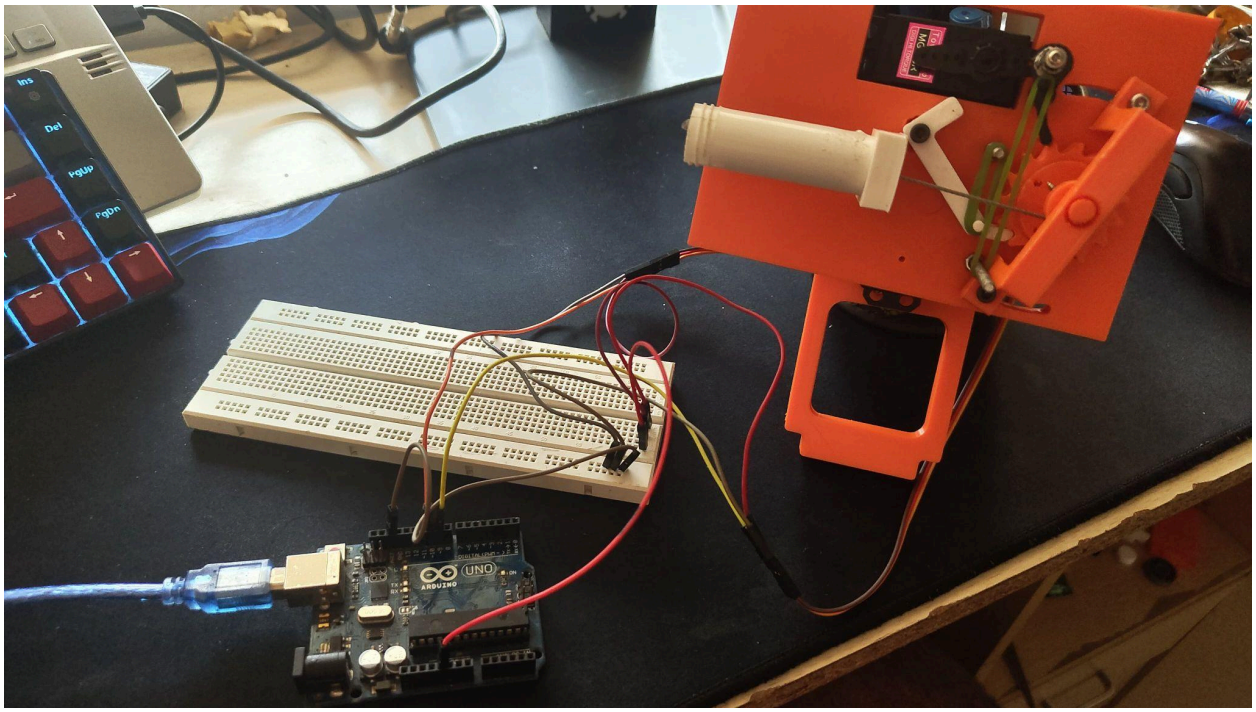
Design Report: Educational Kit for Teaching Projectile Motion

As a Product Design Intern at Ideastorm Technologies, I engineered a hands-on educational kit to teach projectile motion through physical experimentation. A single ratchet double pawl mechanism powered by a servo to load and launch projectiles, with a second servo adjusting the shooting angle. The system included a linear rail-based goal that repositioned automatically based on angle and velocity, enabling accurate motion visualization rooted in physics and kinematics principles.



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1. Introduction

Projectile motion is a foundational concept in physics that describes the motion of an object thrown into the air under the influence of gravity. While the mathematics of projectile motion is straightforward, young learners often find it difficult to grasp the real-world behavior of projectiles through theory alone. To bridge this gap, we have designed a **hands-on educational kit** that demonstrates projectile motion in a tangible, interactive, and engaging manner.

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2. Objective

To create a **simple, low-cost, and interactive educational kit** that enables children to learn the fundamentals of projectile motion through direct experimentation and play-based learning.

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3. Applications

- Teaching aid in **classrooms and STEM labs**
- Hands-on exhibit in **science fairs and exhibitions**
- Activity module for **after-school science clubs**
- Home-based learning kit for **curious young minds**

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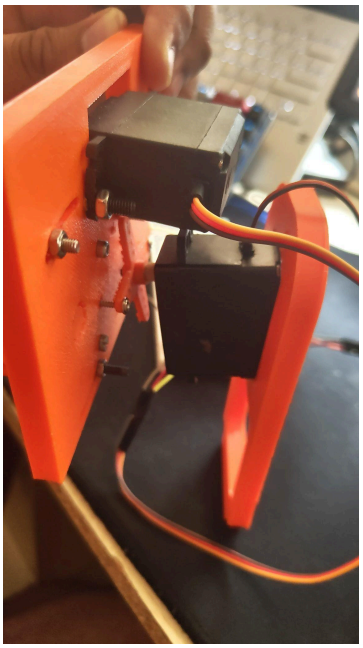
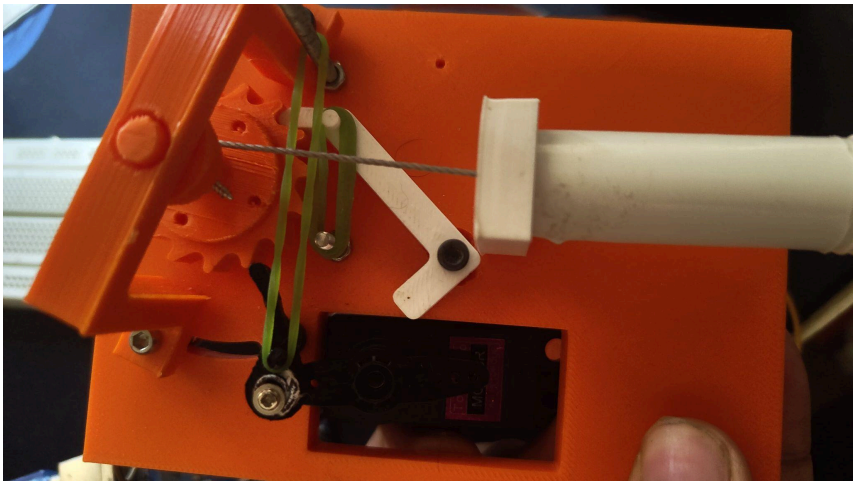
4. Description of the Kit

Structure:

- The kit includes a **spring-loaded launcher mechanism, acrylic tube as the shooting barrel containing a spring, ratchet gear with a spool to wind the thread and 2 pawls** mounted on a **wooden base**.
- Servos (MG996R) x2 to load the spring and launch the object and control the shooting angle.





Components:

- Wooden baseboard
- Spring-based plunger mechanism
- Servo MG996R X2
- Small spherical projectiles (balls)
- Rubber bands
- Nylon string
- Acrylic tube of diameter 8mm
- Screws

Working Principle:

The kit works on the basic physics of projectile motion. By varying the launch angle and compression of the spring, the projectile's range and height will change. This makes it possible to demonstrate key concepts such as:

$$\text{Range} = \frac{v^2 \sin(2\theta)}{g} \quad \text{and} \quad \text{Max Height} = \frac{v^2 \sin^2(\theta)}{2g}$$

Where:

- v is the initial velocity (dependent on spring compression)
- θ is the launch angle
- g is acceleration due to gravity

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5. Features

- **Durable wooden construction** for classroom use
- **Adjustable launch angles** for varied experimentation
- **Spring-powered launcher** with a safe and reliable design
- **Portable and compact** kit layout
- **Visual and interactive** learning experience

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6. Anticipated User Experience

When used in classrooms or workshops, students **will be able to**:

- Predict and test projectile paths
- Change variables like angle and force to see real-time results
- Compare outcomes to theoretical values
- Collaborate in groups to perform hands-on experiments
- Foster deeper engagement and understanding of motion

This kit **will promote** curiosity-driven learning, making abstract concepts more tangible and helping children develop critical thinking and scientific observation skills.

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7. Conclusion

The Projectile Motion Educational Kit is designed to make physics **more approachable and enjoyable** for young learners. With a focus on hands-on learning and interactive demonstrations, this kit has the potential to greatly enhance understanding of projectile motion. It transforms theoretical knowledge into practical discovery, empowering the next generation of curious minds.

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8. Future Scope

- Incorporating **digital tracking** using sensors and microcontrollers
- Using **3D printed parts** for more refined and modular components
- Adding **multi-angle support arms** to test projectiles in 3D space
- Including **worksheets and challenge cards** for guided learning