ARBOR SCIENTIFIC
TOOLS THAT TEACH.

Air-Powered Projectile

P4-2200

BACKGROUND:

From its beginnings in experiments on the football field of Glenbard South High School in Glen Ellyn, Illinois, the Air-Powered Projectile has become a standard device for projectile motion experiments. Field data will conform to a high degree of accuracy with theoretical data of physics formulas. Your students will be amazed when they see proof that these formulas really work.

SEND IMAGINATIONS SOARING:

The Air-Powered Projectile is a safe, chemical-free tool for exploring projectile motion. It is free of the numerous variables that plague solid-fuel and water rockets, and it flies straight and true with minimum wind effect, so your experiments have precise, consistent results.

PRODUCT INFORMATION:

The Air-Powered Projectile uses compressed air as fuel to power its launch. One of four thrust washers (sizes Low, Medium, High, and Super) is pressed onto the top of the launcher, **the projectile slides down and then is pressed onto the launching tube.** Air is pumped into the launcher with the air pump. When it reaches the pressure needed to launch the projectile, the thrust washer is forced off the launching tube, sending the projectile into the air.

Thrust washer pushes rocket

WARNING:

Goggles should be worn and care taken in the launching of the Air-Powered Projectile as it launches at a high velocity! Do not lean over the launch pad when pumping the air pump.

For those who will be launching the Air-Powered Projectile in a cold climate, limit your outside launches to days above 50° F to reduce the possibility of

the projectile body cracking. Please launch projectiles to land in large grassy areas, such as a football field. Repeated landings on hard surfaces such as concrete or asphalt may damage the red projectile body.

ACTIVITIES:

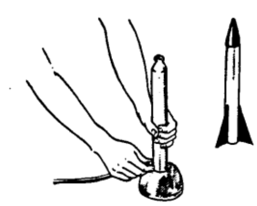
An example used in many classrooms is to have students launch the projectile vertically and time how long it takes for the projectile to complete the trip up and down. This time is then divided in half to get a pretty good approximation for the time of the upward portion of the trip. Your students, knowing that the Air-Powered Projectile slows at the rate of 10 m/s^2, can now calculate the initial speed. (We have found using 10 m/s^2 instead of 9.8 m/s^2 allows the students to do the calculations in their heads.) Let's say it took the projectile 6 seconds total time in the air when launched vertically. Then the time spent on its upward trip would be 3 seconds, multiplied by the acceleration due to gravity-- the projectile's initial speed would be 30 m/s. Air resistance is not formally calculated but taken into consideration when calculating the initial velocity.

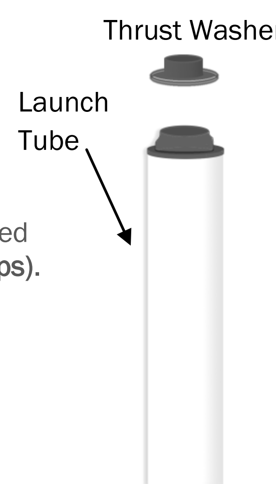
With this bit of information, your students can calculate the distance the projectile will travel at any angle the launch pad is placed! For example, if an angle of 60 degrees was assigned, a little trigonometry would yield both the vertical (y) and horizontal (x) components of velocity. Since all the energy of the launch is not going into upward thrust, your students should expect a lower velocity for the y direction.

The initial velocity stays the same at 30 m/s. The equations would be vy = 30 m/s (sin 60o) = 26 m/s and the v_x = 30 m/s (cos 60^o) = 15 m/s. If the projectile starts out at 26 m/s in the y direction and gravity slows velocity by 10 m/s each second, it will take 2.6 seconds to reach the top and 2.6 seconds to fall to the ground, totaling 5.2 seconds in the air. Since the projectile travels in the air for 5.2 seconds at 15 m/s in the horizontal direction, it will go 78 meters before hitting the ground (5.2 seconds x 15 m/s = 78 m). Your students will be stunned by how accurate their calculations will be.

IT'S SIMPLE AND SAFE:

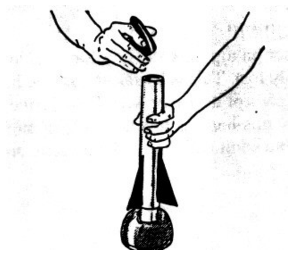
1. Select a launching site clear of obstructions and preferably about 50 meters in diameter. Attach the Arbor Scientific air pump to the rocket launcher and adjust the launching pad to the desired angle. Set the rocket launcher in its launching position.





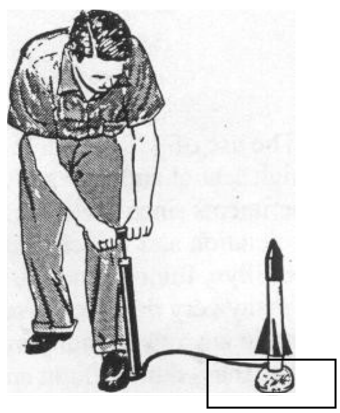
2. Select the super, high, medium or low thrust washer according to desired altitudes. Snap the thrust washer onto the launcher top (**be sure it snaps**).

3. PUSH THE ROCKET COMPLETELY ONTO THE LAUNCHER. MAKE SURE THAT THE TOP OF THE WASHER SEATS INTO THE HOLE AT THE TOP OF THE ROCKET. FAILURE TO DO THIS WILL CAUSE REDUCED PERFORMANCE AND INCONSISTENT RESULTS.



4. Attach the nose cone onto the rocket. Push the cone on all the way it will only slide approximately ½" onto the rocket body.

5. Stand sideways to pump and pump until the rocket launches automatically.



6. Have a student retrieve the rocket and nose cone.

7. Push the thrust washer out of the end of the rocket with your thumb or finger and repeat the above steps for the next launch. The thrust washers fit tightly when new and are easier to push out if a small amount of lubricant is applied to the tapered plug on top of the thrust washer.

TEACHERS' NOTES:

A number of things can happen to generate error in the calculations of your students. The largest of these is in their ability to pace off the distance when estimating the expected range of the Air-Powered Projectile. To avoid this, have the experiment take place on the football field or prior to the experiment have distances measured with a meter tape.

Additionally, when doing the calculations the majority of your students will actually use the wrong angle of launch. For example, if the angled wedge used in the launch pad was the 55 degree wedge, the actual launch angle was its complementary angle or 35 degrees. A way to show why the correct range was calculated in spite of the error would be to introduce them to the projectile range equation, $R = (v_o^2/g) \sin 2\theta$. The fact that the sine of twice an angle and twice the complement of an angle yield the same result demonstrates the mathematical reason why your students still got the right answer. Be sure to measure the angle of the launch pad and not the wedge, because the wedge can move.

RELATED PRODUCTS:

- Our exclusively designed **Launch Pad** (P4-2210) is stable and durable.
- The set of six **Angled Wooden Wedges** (P4-2215) allows you to vary the angle of your launches from 30 to 55 degrees.
- The **Heavy Duty Air Pump** (P4-2222) is a necessity for any successful launch.
- **Replacement Washers** (P4-2225) and the **Spare Projectile Body** (P4-2205) allow your experiments to continue even if you lose your original components.
- The **Classroom Set** (P4-2230) gets everyone involved. Includes 6 projectiles, 6 launch pads, 6 air pumps, one set of wedges, one deluxe trundle wheel and one set of replacement washers.
- Use the **Altitude Finder** (P4-2250) with the Air-Powered Projectile or with the **Bottle Rocket Launcher** (P4-2000) to find the altitude that the projectile went.

ACKNOWLEDGEMENTS:

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