

VACUUM CANNON

Demonstrate the classic physics ballistic pendulum!

Safe

Reliable

Adaptable

Exciting!

A complete kit for students and educators



Read the reviews and view the complete brochure and sample of the Teacher's Guide at

www.austineducationllc.com

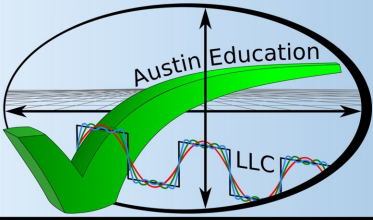
A ballistic pendulum was the first accurate method of determining the velocity of a projectile in the 1700's. The Vacuum Cannon from *Austin Education LLC* is a safe, exciting way to recreate this classic demonstration using only the atmosphere!



Applicable to: ■ Middle School
■ High School
■ College

What can students learn from the Vacuum Cannon kit?

- > Conservation of momentum and energy
- > Pressure/vacuum science
- > Basic pneumatic and mechanical design
- > Density, mass, volume, and unit conversions
- > Concepts of metrology, accuracy and precision
- > Analysis of plots and interpretation of data
- > Experimental design and error analysis
- > Basic data visualization using Excel and Python
- > Newton's laws, fluid mechanics, Hooke's law and concepts of material science
- > Applied algebra, geometry, trigonometry and calculus
- > Concepts in data acquisition, noise, and error quantification
- > Analytical/numerical differential equations, and more!



FEATURES

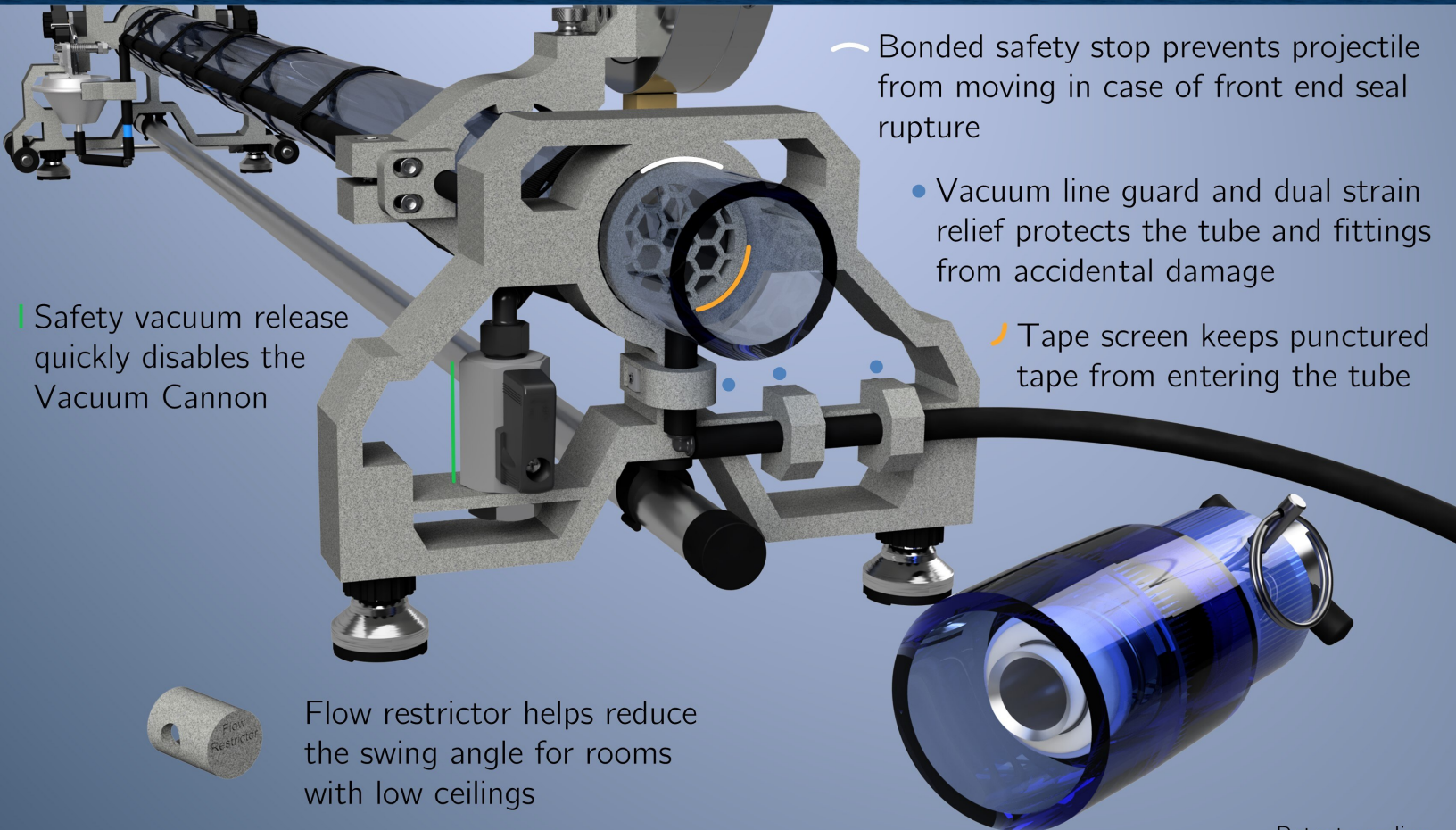
Large 4.5 inch pivoting vacuum gauge allows all students to see the pressure drop

Spring loaded launching mechanism makes consistent and reliable punctures of the seal



4 ft loading rod unclips and allows easy resetting of the projectile

Non-scratch, swivel leveling feet make alignment quick and easy!



Bonded safety stop prevents projectile from moving in case of front end seal rupture

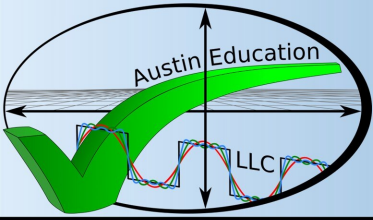
Vacuum line guard and dual strain relief protects the tube and fittings from accidental damage

Tape screen keeps punctured tape from entering the tube

Safety vacuum release quickly disables the Vacuum Cannon



Flow restrictor helps reduce the swing angle for rooms with low ceilings

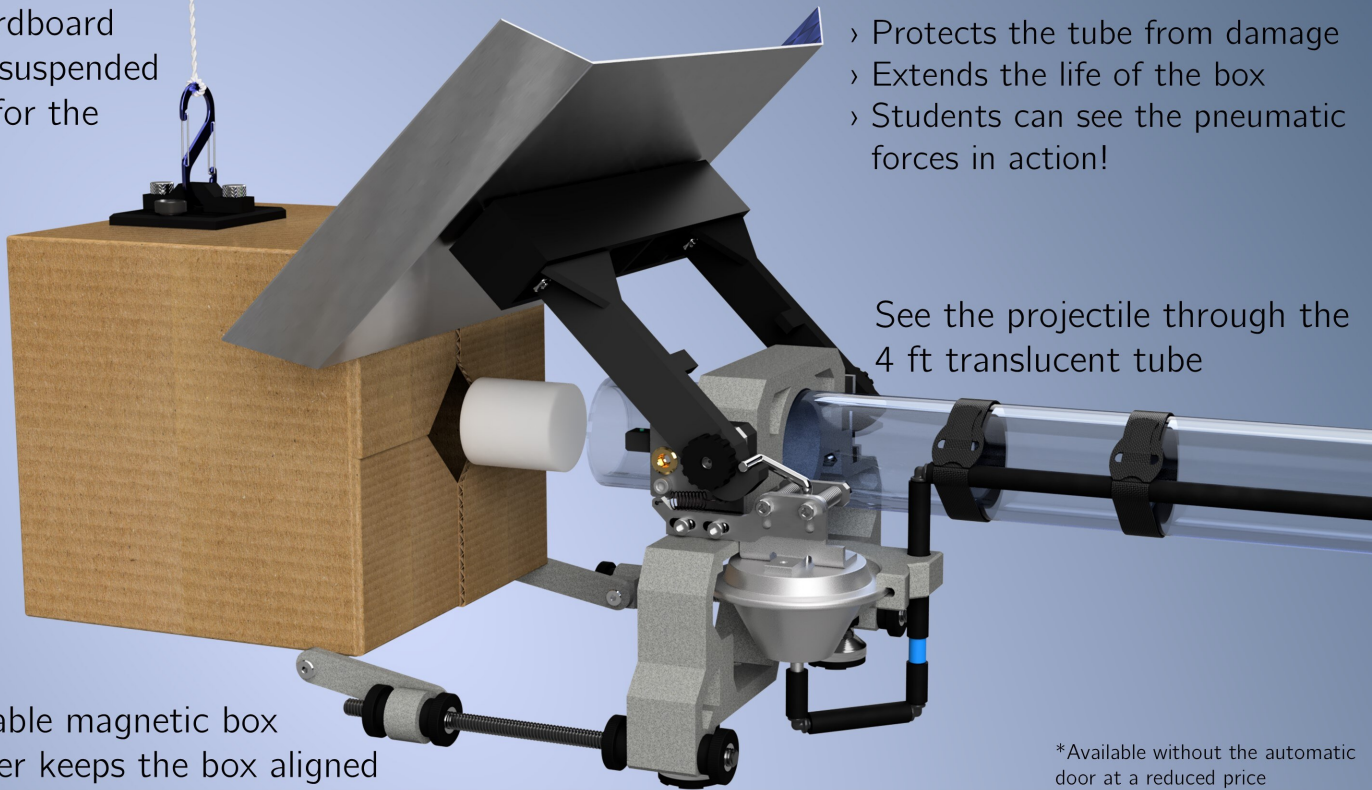


FEATURES

Detachable automatic door rises under vacuum and lowers after launching*

Reinforced cardboard box acts as a suspended target/catch for the projectile

- › Protects the tube from damage
- › Extends the life of the box
- › Students can see the pneumatic forces in action!

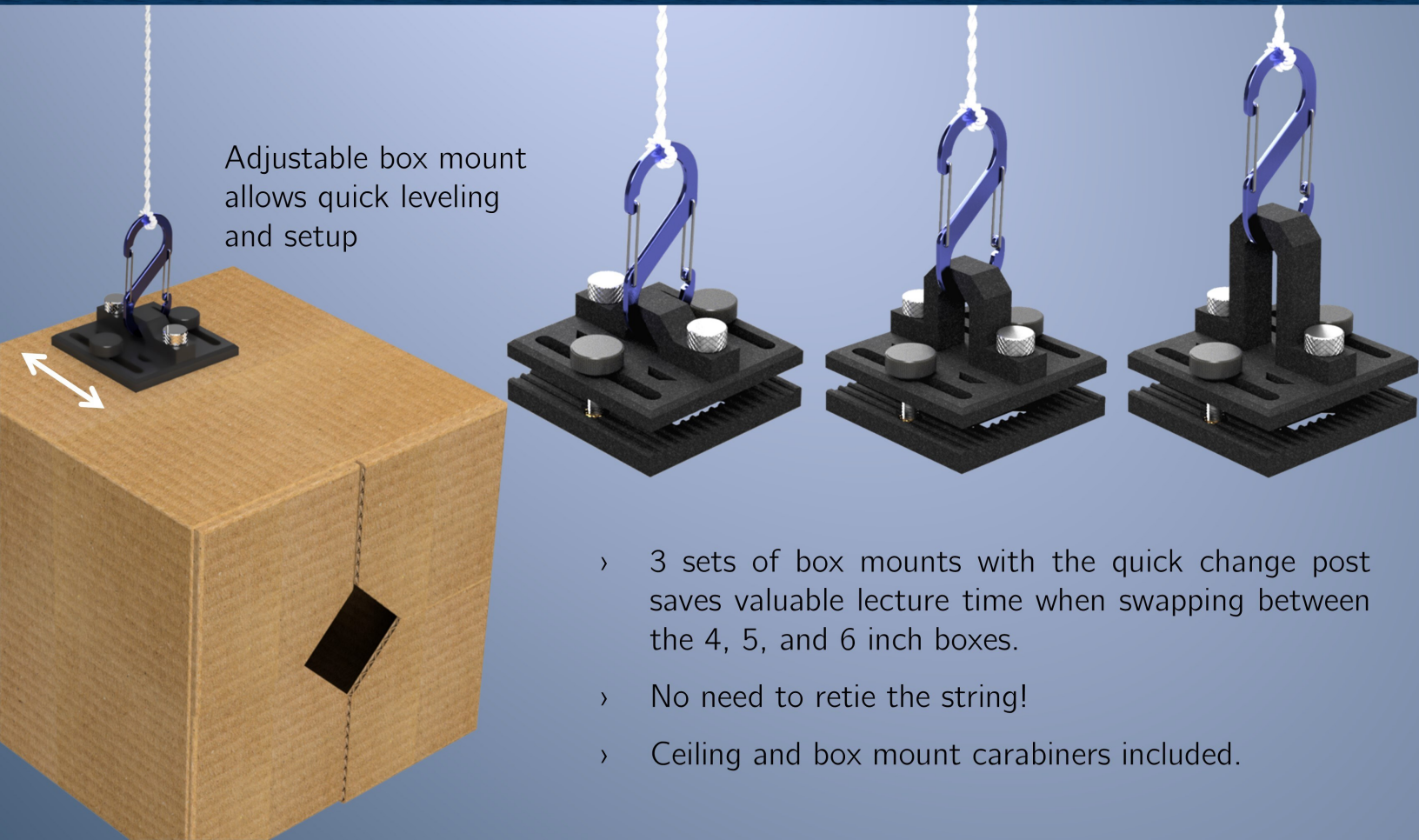


See the projectile through the 4 ft translucent tube

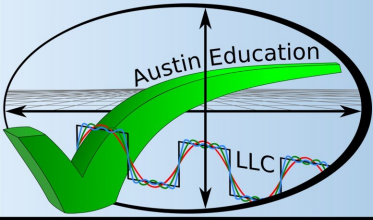
Adjustable magnetic box stabilizer keeps the box aligned

*Available without the automatic door at a reduced price

Adjustable box mount allows quick leveling and setup



- › 3 sets of box mounts with the quick change post saves valuable lecture time when swapping between the 4, 5, and 6 inch boxes.
- › No need to retie the string!
- › Ceiling and box mount carabiners included.

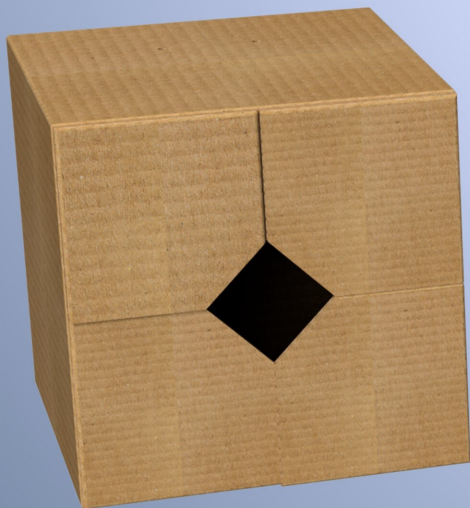


FEATURES

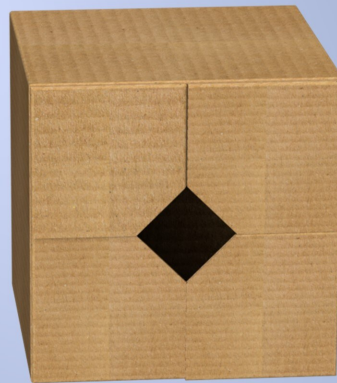
Over 140 unique box and projectile mass combinations

- › Stackable 1" and 2" low friction plastic projectiles with 24 reconfigurable weights makes it easy to get the perfect swing angle.
- › Projectile masses range from 25-150 g with final velocities ranging from 10-45 m/s.*
- › Includes 9 boxes of 3 different sizes.
- › Students can explore the science of energy and momentum conservation, Newton's laws, fluid mechanics, data analysis and more!
- › Ready for the next launch in under 90 seconds saving valuable lecture time.
- › Usable outdoors for projectile motion for 2D kinematics! See the User Manual for additional information.

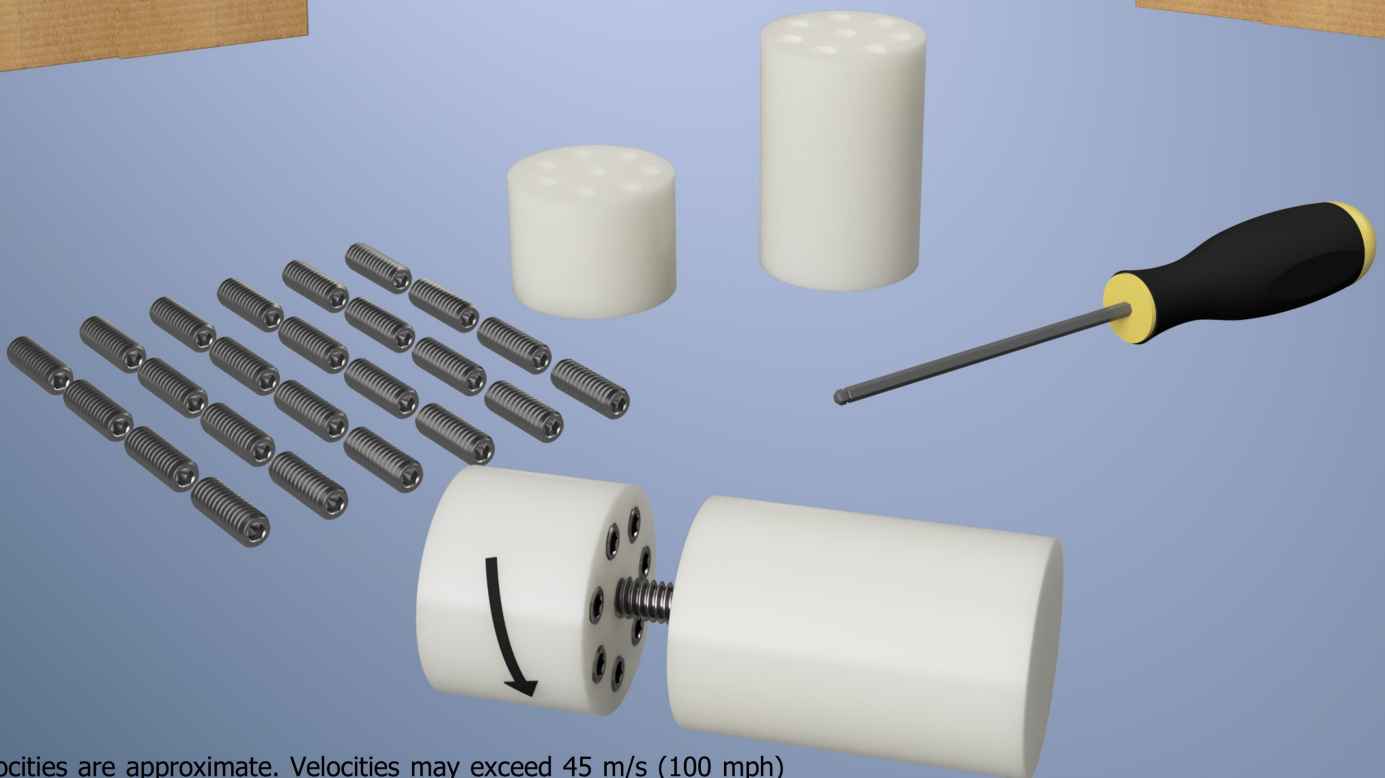
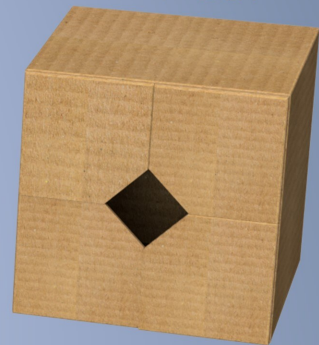
6" Box



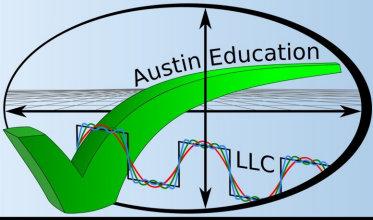
5" Box



4" Box

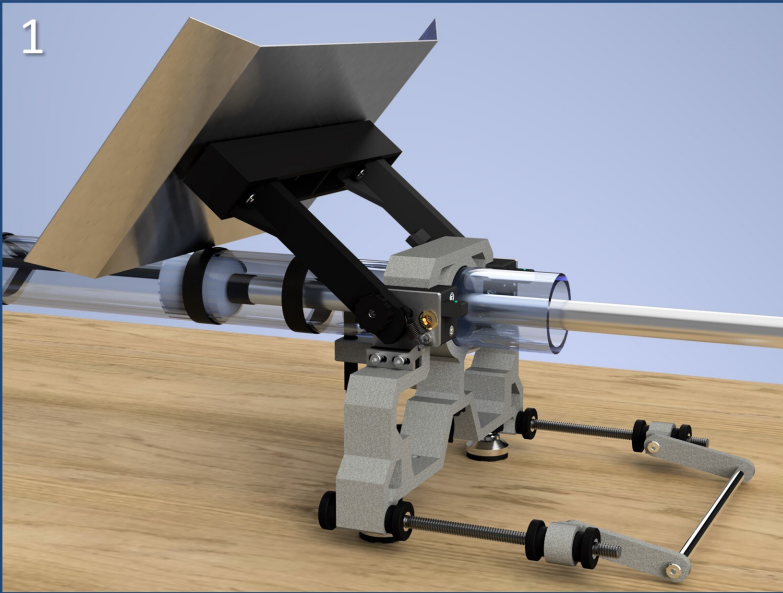


*Masses/velocities are approximate. Velocities may exceed 45 m/s (100 mph) based on various factors. See the User Manual for more information.

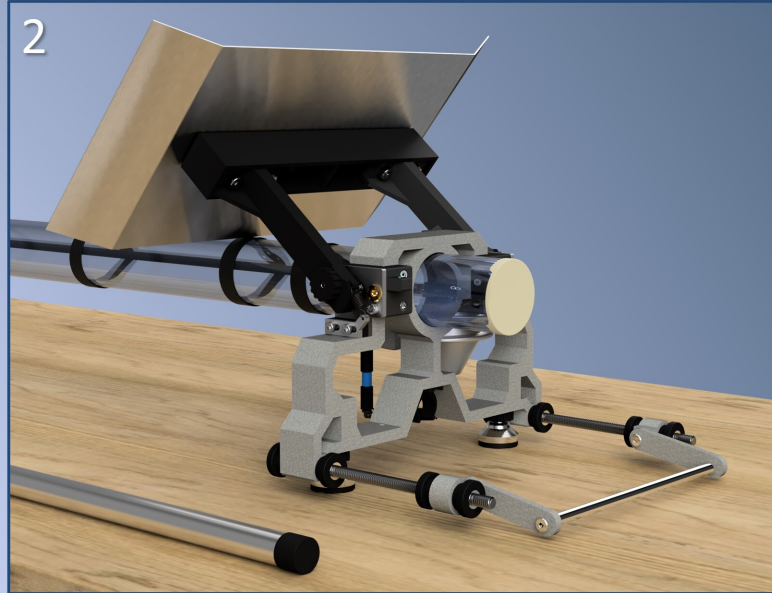


EASY OPERATION

Insert the projectile



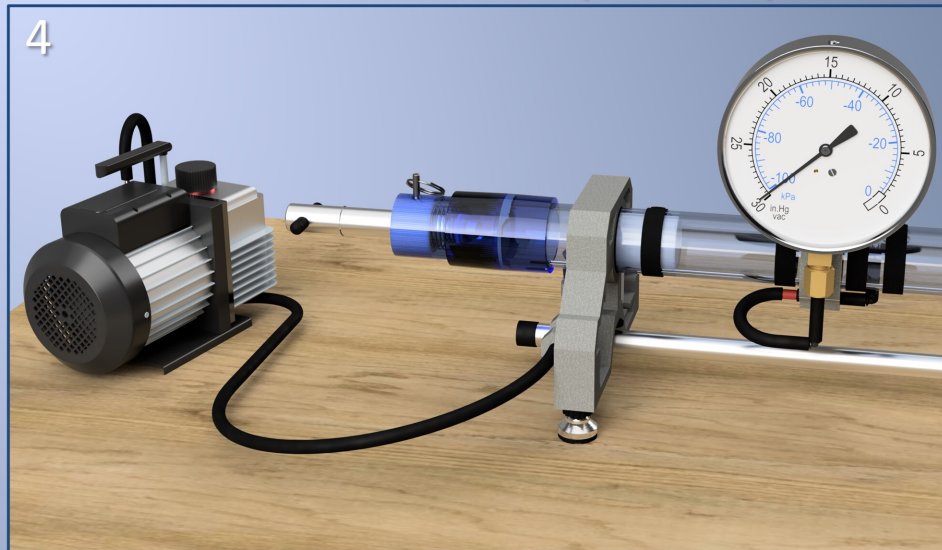
Seal the ends



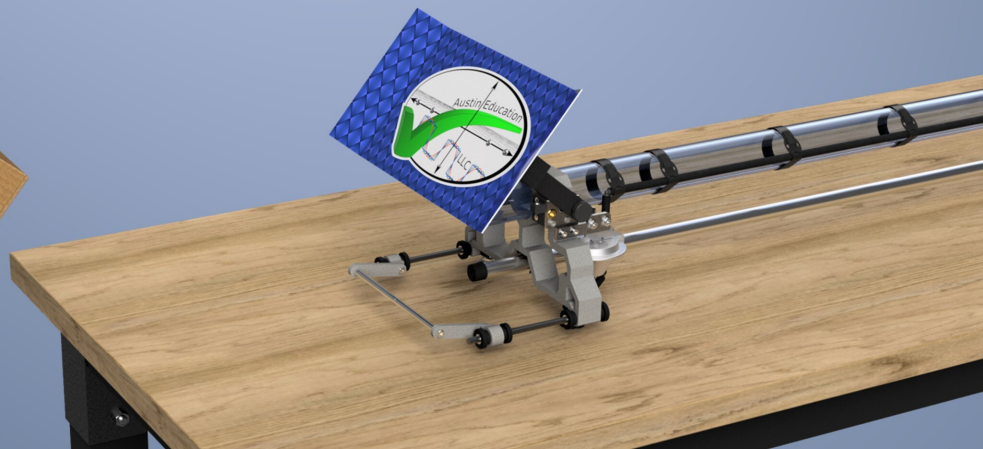
Set the box

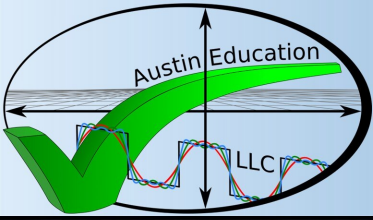


Create vacuum and pull the pin



Engage the students!





Teacher's Guide

Save countless hours with the complete Teacher's Guide!

- > Over 110 questions organized by difficulty.
- > Professionally formatted with fully worked out solutions with a hyperlinked table of contents.
- > Highlighted solutions, teacher recommendations, and external references.
- > All original problems: Students won't find these answers on the internet.
- > All figures are high resolution, in color, and 3D rendered. No stick figure sketches to be found!
- > The Vacuum Cannon combined with the Teacher's Guide is applicable from middle school to advanced undergraduate students in STEM.
- > Contains a wide range of questions from elementary conceptual/open response to challenging physics and engineering problems requiring numerical integration and other advanced undergraduate techniques.
- > Includes an algebraic worksheet intended for college STEM majors that illuminates where their algebraic skills need improvement.
- > Data files and Excel/Python examples are available for download from the website.
- > Quickly assemble lesson plans by choosing problems of the appropriate level.
- > Great for in class examples, activities and laboratories, homework, quizzes, exams, extra credit and challenge problems.

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2 Derivation of the Projectile Velocity Equation

The derivation of the ballistic pendulum velocity equation is a classic example utilizing conservation of energy and momentum. The method shown here is standard but different from historical approaches (and simpler) since we are not measuring the period of oscillation directly, briefly derived, and derived in various forms.

5.5 Conceptual Question: Pressure 5

Force is related to pressure by the area that the pressure acts on.

$$F = PA \quad P = \frac{F}{A} \quad (30)$$

The figure below shows two cylinders with different diameters but each has the same mass. Which one results in a larger pressure on the table and why?

Force (F) on the table so the pressure (P) is larger. The force is spread out over a larger area so the pressure is smaller.

Figure 65: S

2. At the peak swing about $t = 0.17$, potential energy is converted into kinetic energy or by approximating time for these lengths.

3. In an ideal projectile the centripetal force which could be losing energy as is due mostly to ideal equation.

4. This question generally, a full cycle other information of the wave. The next peak is the side it was released full cycles of.

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Figure 82: The free body diagram is shown below with the box replaced by a dot for simplicity. There are three forces acting on the dot: The force of gravity on the box, the force of the string.

Note the correct placement of θ .

The \hat{y} direction is toward the center of the swing circle. A common mistake for students is using the wrong trig function in relation to the angle θ when summing forces.

The \hat{y} direction is toward the center of the swing circle. Since the motion is circular it's best to use centripetal acceleration for the system. Note the exploded view to see the correct placement of the swing angle θ on the coordinate system. Let's define $m = m_b + m_p$ to be the total mass of the projectile and box. Summing the forces in the \hat{y} direction gives

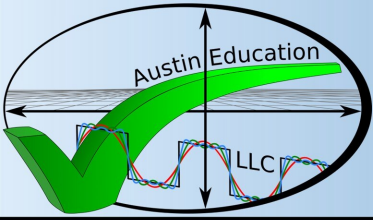
$$F_{\text{net},y} = m \left(\frac{v^2}{r} \right) = T - F_{g\theta}\cos(\theta) - F_{gp}\cos(\theta) \quad (299)$$

When the box reaches the end of its swing at the largest angle θ , its turning point has been reached and the instantaneous velocity is 0 m/s . Knowing that the force of gravity equals mass times the acceleration of gravity, our equation becomes

$$0 = T - m_b g \cos(\theta) - m_p g \cos(\theta) \quad (300)$$

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Students can return each year and attempt increasingly difficult problems!



User Manual

Detailed User Manual covers all aspects of the Vacuum Cannon including:

- › Introduction
- › Safety information
- › Unboxing
- › Component location and description
- › Setup and operations
- › Demonstrations and lesson plan recommendations
- › Troubleshooting
- › FAQ
- › Specifications
- › Resources for replacement parts

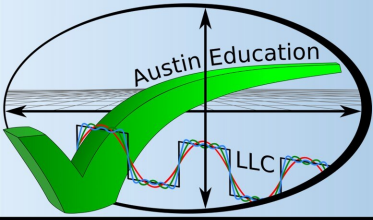
Any questions not fully answered will be added based on user feedback and an updated version sent out

Designed for decades of reliable performance

The following components can operate for 10,000 cycles without failure:

- › Automatic door
- › Vacuum diaphragm
- › Vacuum gauge
- › Launching mechanism*

The Vacuum Cannon will likely outlast the building you teach in! The system can still operate for demonstrations if any of the components listed above fail.



COMPLETE KIT

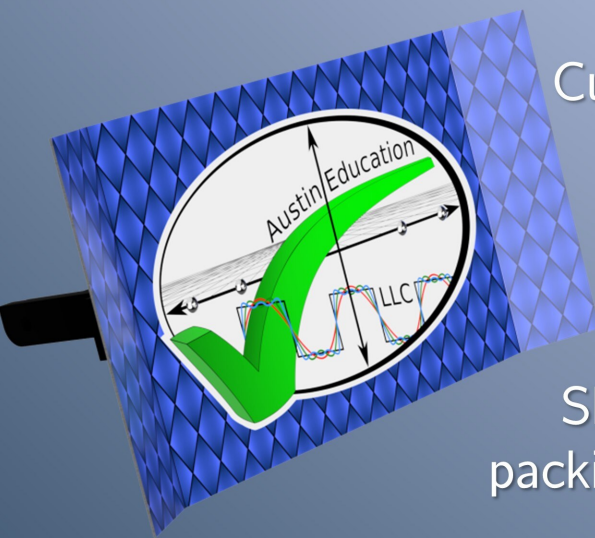
The Vacuum Cannon kit includes:

- › Vacuum Cannon with launching mechanism and automatic door
- › 2 stackable projectiles with 25 threaded weights
- › 9 total boxes (4, 5, and 6 inch)
- › 3 sets of box mounts with quick change posts
- › 2 aluminum carabiners
- › Flow restrictor
- › 25 feet of string
- › 1 roll of masking tape
- › 1 roll of recyclable packing tape
- › Vacuum pump barb adapter
- › Vacuum release valve wrench
- › Tube protector/end caps
- › Printed angle markers and placement guide
- › Adhesive magnets
- › Foam protectors
- › Allen wrenches
- › Drop ceiling mount
- › Teacher's Guide
- › Detailed User Manual
- › Two year warranty



Table not included

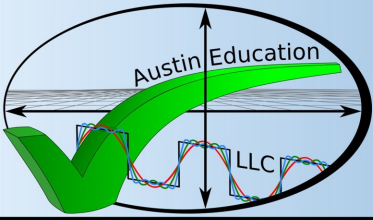
Each unit is hand assembled and fully tested prior to shipping



Custom door printing options available



Ships without Styrofoam, packing peanuts or plastic bags!



Production Status

Updated September 2025

- If your school is interested in purchasing the Vacuum Cannon kit from Austin Education LLC, please visit <https://www.austineducationllc.com> and see the **Purchase** tab. Please email support@austineducationllc.com with any questions! The cost/ownership can be split among schools!
- The Vacuum Cannon kit received may differ slightly from the figures shown in this brochure and on the website. Some components are shown in gray to highlight details and will be available initially in black only.
- The Teacher's Guide is available **only** to verified educators (including home schooling). The User Manual and Teacher's Guide are available only in digital (PDF) form. The Teacher's Guide may be purchased independently of the kit. If you decide later to purchase to the Vacuum Cannon kit, the price will be discounted by the cost of the Teacher's Guide already purchased.
- Limited quantities are kept in stock. Lead times may vary from one week to several months based on demand. If not in stock, please click the "Join Waitlist" button and fill out the form. Orders are filled based on position in the waitlist.
- Kits can be purchased through standard means on the website. Local pickup is available near the Space Coast region and the kits ship free in the continental US.
- A two-year warranty is included on all non consumable components. Details can be found in the User Manual.
- A model without the automatic door is available at a reduced cost.
- Multi-kit purchase discounts are available, see the FAQ section for details.
- A standard vacuum pump is required for operation and is not included with the kit. Most schools possess a vacuum pump that is adequate. See the User Manual for more information and how to rent a vacuum pump for free.
- The table shown is for visualization only and is not included with the kit.
- Custom printed door image is available for an additional fee. Requirements and restrictions will be provided via email. This option may be unavailable in the future and may increase the lead time by at least one week.
- Ceiling mount for string required. Consult qualified personnel for installation.

