

## B.2.2 Shoot the Monkey

Key Concepts:	Velocity Components Vectors Ballistic Motion
Materials:	Aluminum tubing air gun Wooden projectiles for air gun Two Edison batteries connected in series Special connecting cables Electrical on-off switch and connecting wires Two support rods and two open mouth clamps Step ladder Monkey Padded box to catch monkey (Optional) Laser for aiming
Set Up Time:	
Time Estimate:	

### Set Up And Display

The air gun is mounted on the front of the lecture bench near the air jet, aimed towards the hanging magnet for the monkey. The plastic tube from the air gun is connected to the air jet. A valve has been installed to limit the air flow and control the speed of the projectile. This valve regulates the air flow so that the demonstrator can throw the handle full open to fire the gun. The valve may need adjustment to counter minor tweaking by any passerby, although once set it should be good for repeated trials.

The monkey has a ball bearing attached to its head and is suspended from an electromagnet on the ceiling. Two Edison cells in series power the electromagnet through the patch bay on the bench. Check to see with line the magnet is using before connecting the batteries with the special cable that has large plugs for the patch bay at one end and smaller hook connectors on the other. The batteries are connected in series with the patch bay, the trip switch on the air gun, and the electrical switch which is normally open to prevent draining the batteries.

Once the basic connections have been made, work on aiming the gun. The sequence of events is *important*. The gun must be loaded *before* the monkey is hung since the trip switch to the electromagnet is thrown when a bullet enters or leaves the gun. If the monkey is hung first, he will fall when the gun is loaded. After the gun is loaded, close the electrical switch, and use the ladder to hang the monkey from the electromagnet. The monkey tends to twist slowly one placed. With care, it can be placed so as to present a full frontal target to the gun to increase the odds of a successful shot. The gun should be aimed directly at the monkey. A laser can be used as a sight.

Once the gun is loaded and the monkey hung, remove the ladder and place the padded box under the monkey. A successful hit will usually make the monkey miss

the box, however. When the handle on the air jet is thrown, the bullet will shoot out and trip the electromagnet off, dropping the monkey. If the aiming was right, the bullet will hit the monkey. If not, adjust the aim and try again.

There is some risk the bullet will ricochet off the wall into the seats. If possible have the first few rows near the target area move back for the demonstration.

### **Explanation**

When the gun is properly aimed directly at the monkey, there is a direct relation of the bullet's initial velocity components to the horizontal distance from gun to monkey and the distance the monkey drops. As long as the initial velocity is great enough for the bullet to cross the horizontal distance before the monkey hits the floor, the relation of initial components is enough to hit the monkey. This can be solved algebraically without ever knowing the actual height fallen, the horizontal distance or the initial velocity of the bullet.

Related Demonstrations: B 2.1 B 2.3 B 2.24 B 2.42