

OPERATING INSTRUCTIONS

Monkey and Hunter Experiment Apparatus No. 32154

1. Introduction

The Monkey and Hunter Experiment Apparatus provides a convenient means of performing an experiment to demonstrate the laws governing the trajectory of a projectile.

2. Description

The Monkey and Hunter Experiment Apparatus contains the following items:

A. The gun assembly. This consists of a heavy metal frame on which a spring-loaded projectile launcher (the "gun") is mounted. The angle of the gun barrel can be changed in order to aim the gun. The gun assembly includes a holder for a 1.5V "D" cell battery (which you must supply). This battery is used to power the included electromagnet. A rectangular piece of plastic is attached to the assembly by a chain. It will be used in aiming the projectile gun.

B. The electromagnet assembly. This component consists of an electromagnet in an L-shaped bracket, which is mounted on a 1cm diameter rod. An electric cord about 7 feet (2.2m) long is attached to the electromagnet. At its free end, the cord terminates in a phone-type connector, which plugs into a jack on the gun assembly.

C. The angle mirror device, used to help you aim the gun.

D. The "monkey". This is a hollow, semi-spherical plastic object about 5cm in diameter, with a metal stud projecting from its top. It is equipped with a string to keep it from rolling away after it falls.

E. Two projectile balls.

In addition to this apparatus, you will need the following things to perform this experiment. If you do not have these items on hand, we recommend appropriate items listed below.

You will need a C-clamp to secure the gun assembly to a table or countertop; a 1.5V "D" cell battery; and some means of attaching the electromagnet assembly to a high place (a base, a rod, and a parallel clamp set up on the table will work very well).

3. Accessories

<u>Description</u>	<u>Cat. No.</u>
C-Clamp, 3.5 x 8cm	88056-01
"D" Alkaline Battery	31801
A-Shaped 22 x 20cm Support Base with 3/8-16 Threads	72002-02
Threaded 13 x 81cm Aluminum Rod with Shoulder	72175-04
Right-Angle Aluminum Alloy Clamp for 13mm Diameter Rods	12241-01

4. Theory

This popular experiment is based on a story problem, from which it takes its name: A hunter in the jungle sees a monkey in a tree. He fires at it, whereupon the monkey lets go of its branch and drops to the ground. Will the monkey be hit by the hunter's bullet?

The student may suppose that the bullet will miss — because it was aimed at the monkey's original location, and the monkey has since dropped to the ground.

But in fact, if the hunter aimed correctly in the first place, the monkey will be hit as it is falling. Although the monkey is dropping straight down from the tree, and the bullet is describing a parabolic path, both are accelerating downward under the influence of gravity. The experiment shows that the action of gravity on a body is independent of other forces acting on the body, or of any velocity the body may have in any direction.

The result of this experiment may come as something of a surprise to the student, who probably was considering the effect of gravity only on the monkey. The experiment reinforces the student's understanding of gravity as a force which operates on all falling bodies, and of the acceleration due to gravity as a constant.

A thorough discussion of projectile motion will be available in any good physics textbook. One area in which an understanding of projectile motion is put to practical use is in the field of ballistics.

5. Operation

CAUTION! Remind students to stand clear of the path of the projectile so they will not be hit by it.

Fasten the gun assembly to a sturdy table or countertop, using a C-clamp on the flange (which has rubber padding to protect the metal finish). Put the battery in the battery holder.

Set up the rod and stand about 3 feet away from the gun assembly. Attach the electromagnet assembly to the rod 2 to 2½ feet above the tabletop. Run the electrical cord from the electromagnet to the gun assembly and insert the phone-type connector in the jack on the back of the assembly.

Notice that the metal disk on the plunger of the gun is touching a switch on the gun assembly. This switch controls the circuit to the electromagnet. When the disk is forward and is touching the switch, the circuit is open. Thus, when you pull the plunger back, the circuit will be closed, activating the electromagnet. When the gun is fired, the plunger will come forward. The disk will depress the switch, breaking the circuit and causing the "monkey" to begin falling at the same time as the projectile ball leaves the gun.

Take the string attached to the "monkey" and tie its free end to the support rod. This will keep your target from rolling away across the floor after it is hit. You might want to put something soft, or some crumpled newspaper, around the stand base. Both target and projectile are of sturdy plastic and will not be damaged, but the soft material will protect the table and also muffle the noise these objects make when they fall.

Take the plunger and pull it back about an inch. Put the rectangular piece of clear plastic between the handle of the plunger and the barrel of the gun as shown in Fig. 1. Now the circuit to the electromagnet is closed and the electromagnet is energized.

Fig. 1

Take the yellow target ball and touch the metal stud on its top to the metal rod projecting down from the electromagnet. The target should now be held in place.

Line up the stand, rod, and target with the projectile gun as well as you are able. Now attach the angle mirror to the handle of the plunger as shown in Fig. 2, holding it in place by turning the set screw with the black handle. Look into the lens of the mirror system. You are now sighting through a cylindrical hole in the plunger. (If you prefer, you can sight through this hole without the mirror, as in the illustration in Fig. 2.)

Fig. 2

Now you must aim the gun. Loosen the upper butterfly nut on the gun assembly as shown in Fig. 1 to release the gun barrel from its position. Now you can move the barrel up and down. Sighting through the angle mirror device, move the gun barrel until you can see the yellow target ball with its red index line. This image will be very small; give yourself a moment to get accustomed to its appearance. Try to center this image in your sights, as in Fig. 2. When you are satisfied with your aim, tighten the butterfly nut to hold the barrel in position (for best results, hold the barrel steady with one hand while tightening the butterfly nut with the other). Remove the angle mirror device and set it aside.

Put a projectile ball into the barrel of the gun. Grasp the handle of the plunger and hold it still. Remove the rectangular piece of clear plastic, not letting the plunger move forward. Now pull the plunger back as far as it will go, and release it. The yellow target ball will begin to fall; then it will be struck by the white projectile ball before the

target reaches the table top (see Fig. 3).

Fig. 3

If you don't get quite these results, you may have to adjust the position of the components of the setup. Try moving the target a little nearer or farther away, setting the target higher or lower, or varying the amount of force used in launching the projectile by changing how far back the plunger is pulled.

When the experiment has been run several times, you might want to ask your students whether the monkey would have been better off if it had just stayed in its tree. If the bullet had followed the same trajectory as the projectile ball in this experiment, it would have passed harmlessly beneath the monkey.

6. Maintenance

The Monkey and Hunter Experiment Apparatus needs no special maintenance and if not abused should give years of satisfactory service. If any problem develops with this apparatus, contact Central Scientific Company, giving details of the problem. To ensure better service, please do not return any apparatus until we have sent you authorization.

Written 7/89