

Activity 2

Free Fall Demonstrator

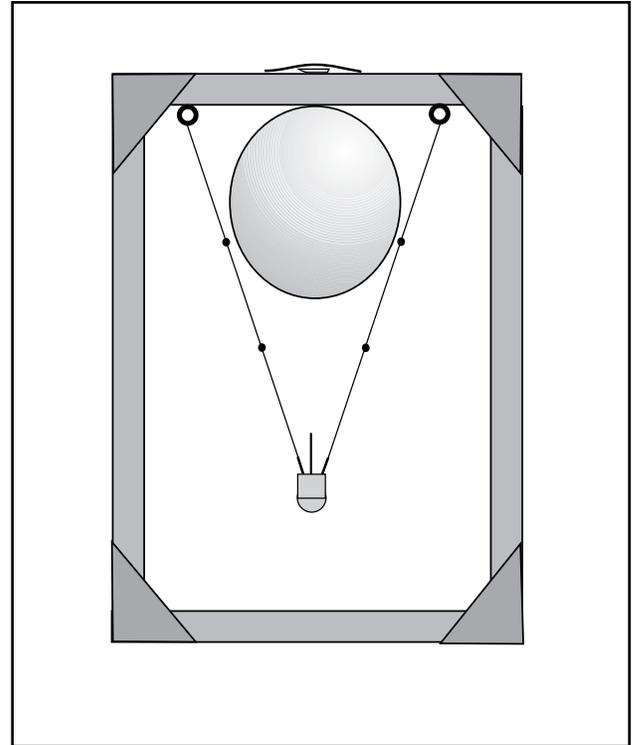
OBJECTIVE:

To demonstrate that free fall eliminates the local effects of gravity.

BACKGROUND:

Microgravity conditions can be created in a number of ways. Amusement park customers feel a second or two of low-gravity on certain high-performance rides. Springboard divers experience low-gravity from the moment they leave the board until they hit the water. NASA achieves several seconds of microgravity with drop towers and drop tubes. Longer periods, from 25 seconds to a minute, can be achieved in airplanes following parabolic trajectories. Microgravity conditions lasting several minutes are possible using unmanned sounding rockets. However, the longest periods of microgravity are achieved with orbiting spacecraft.

The free fall demonstrator in this activity is an ideal device for classroom demonstrations on the effect of low-gravity. When stationary, the lead fishing weight stretches the rubber band so that the weight hangs near the bottom of the frame. When the frame is dropped, the whole apparatus goes into free fall, so the weight (the force of gravity) of the sinker becomes nearly zero. The stretched rubber bands then have no force to counteract their tension, so they pull the sinker, with the pin, up toward the balloon, causing it to pop. (In fact, initially the sinker's acceleration toward the balloon will



be at 9.8 m/s^2 . Before the frame was dropped, tension in the rubber bands compensated for gravity on the sinker, so the force from that tension will accelerate the sinker at the same rate that gravity would.) If a second frame, with string instead of rubber bands supporting the weight, is used for comparison, the pin will not puncture the balloon as the device falls.

The demonstration works best when students are asked to predict what will happen when the frame is dropped. Will the balloon pop? If so, when will it pop? If your school has videotape equipment, you may wish to videotape the demonstration and use the slow motion controls on the playback machine to determine more precisely when the balloon popped.

MATERIALS NEEDED:

2 pieces of wood 16x2x1 in.
2 pieces of wood 10x2x1 in.
4 wood screws (#8 or #10 by 2 in.)
8 corner brace triangles from 1/4" plywood
Masking Tape
Glue
2 screw eyes
4-6 rubber bands
1 6-oz fishing sinker or several lighter sinkers taped together
Long sewing pin or needle
Small round balloons
Short piece of string
Drill, 1/2 in. bit, and bit for piloting holes for wood screws
Screwdriver
Pillow or chair cushion
(Optional - Make a second frame with string supporting the sinker.)

PROCEDURE:

- Step 1.** Assemble the rectangular supporting frame as shown in the diagram. Be sure to drill pilot holes for the screws and glue the frame pieces before screwing them together. Brace the front and back of each corner with small triangles of plywood. Glue and nail them in place.
- Step 2.** Drill a 1/2 inch-diameter hole through the center of the top of the frame. Be sure the hole is free of splinters.
- Step 3.** Screw the two screw eyes into the underside of the top of the frame as shown in the diagram. (Before doing so, check to see that the metal gap at the eye is wide enough to slip a rubber band over it. If not, use pliers to spread the gap slightly.)
- Step 4.** Loop three rubber bands together and then loop one end through the metal loop of the fishing sinker(s).
- Step 5.** Follow the same procedure with the other three rubber bands. The fishing weight should hang downward like a swing, near the bottom of the frame. If the weight hangs near the top, the rubber bands are too strong. Replace them with thinner rubber bands.
- Step 6.** Attach the pin or needle, with the point upward. There are several ways of doing this depending upon the design of the weight. If the weight has a loop for attaching it to fishing line, hold the pin or needle next to the loop with tape. It may be possible to slip it through the rubber band loops to hold it in place. Another way of attaching the pin or needle is to drill a small hole on the top of the weight to hold the pin or needle.
- Step 7.** Inflate the balloon, and tie off the nozzle with a short length of string. Thread the string through the hole and pull the balloon nozzle through. Pull the string snugly and use a piece of tape to hold it.
- Step 8.** Ask the students to predict what will happen when the entire frame is dropped.
- Step 9.** Place a pillow or cushion on the floor. Raise the demonstrator at least 2 meters off the floor. Do not permit the weight to swing. Drop the entire unit onto the cushion. The balloon will pop almost immediately after release.