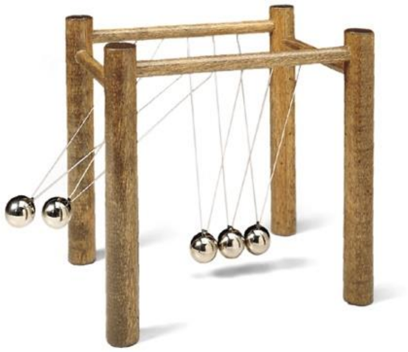
Newtonian Demonstrator – Newton's Cradle

P1-6001

INSTRUCTIONAL GUIDE

Contents



Introduction

This classic apparatus provides a dramatic demonstration of several fundamental physical principles, but is by no means a simple device. Since the historic seventeenth century demonstration of the effects of two colliding pendulums, there has been considerable debate over exactly what the demonstration was showing. Primarily, the Newtonian Demonstrator illustrates Newton's Third Law—for every action, there is an equal and opposite reaction. Thus, when one ball is swung out and released, one is "kicked" out the other side, two when two balls are released, and so on.

Background

The apparatus also is used to demonstrate the conservation of linear momentum: when two or more bodies collide, their total momentum (mass x velocity) is the same before and after the collision. An example of this principle is seen in the firing of a gun, the "collision" being provided by the discharge of gunpowder. When the gun is fired, the velocity of the bullet times its mass equals the mass of the gun times its recoil velocity. Since these two measures are equal and opposite (Newton's Third Law), their sum will be zero. Since their momentum before firing was also zero, it can be seen that linear momentum has been conserved. Momentum will be conserved in any colliding system, whether the colliding objects move opposite from one another, in the same direction, or at some angle after the collision.

Lifting one or more balls gives them energy of position, also known as potential energy. Releasing them to the forces of gravity gives them energy of movement, or kinetic energy. When the balls collide, the total momentum of the system is unchanged, that is, the sum of [mass x velocity] of each component is the same before and after collision. Thus, the momentum of the system is conserved.

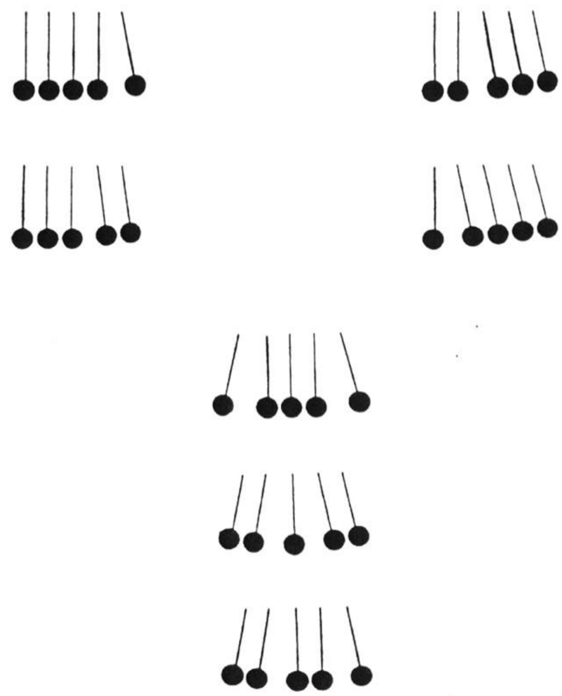
Great! But if momentum is truly conserved, why does the system eventually slow and stop? To answer this, one must consider the law of conservation of energy, which states that energy can neither be created nor destroyed, but can only change from one form to another. In this demonstration, we are not dealing with an "ideal" system isolated from all other forces. The balls are meeting resistance from the air, as are the supporting strings, and some energy is lost with each collision by being converted into heat, another form of energy. Though momentum is being conserved, energy is gradually "lost" (i.e.,

converted to other forms of energy), and the system eventually stops.
CARE:

Avoid magnetic fields: any magnetism in the balls will hamper performance. To prevent induced magnetism, let the balls swing in the East-West direction. If the balls appear to attract each other when hanging free, clean them. If the condition persists, store the unit in its original carton in a very warm, dry place. Use of electronic demagnetizers may hamper performance.

- Alignment of the balls may be adjusted by moving string gently through the ball.
- Clean the balls to keep them bright and free from surface dirt. Silver polish and a soft cloth are best.
- Rocking of the frame may occur during use. If adjustment is needed, try twisting the frame or shimming the short leg with a bit of clay or tape.

STARTING PATTERNS:



Related Products

Magnetic Accelerator (P4-1365) Is energy conserved in a magnetic field? Watch as students try to figure out this amazing demo.

Collision in Two Dimensions Apparatus (P2-8450) The Collision in Two Dimensions Apparatus allows students to experience the conservation of momentum and kinetic energy by investigating the difference between elastic, inelastic, and partially elastic collisions.

Bouncing Dart (PX-1204) The Bouncing Dart demonstrates the energy transfer that occurs in elastic and inelastic collisions. The dart has an elastic end and an inelastic end.