Fan Cart

P4-1986

INSTRUCTIONAL GUIDE

Contents

- Fan Cart
- Clear Plastic Sail

Required but Not Included:

- **2 AA Batteries** (**P8-5600**)

Recommended for Activities:

- **PocketLab Voyager 2 (P4-1001)**
- **Electronic Spark Timer (P1-8000)**
- **Table Clamp Pulley (P1-6115)**
- **Hooked Mass, Set of 9 (91-1000)**

Background

The Fan Cart by Arbor Scientific provides an experimental model for the study of uniform acceleration. Whether studying the kinematics of acceleration or the force and motion of dynamics, the fan cart provides an effective base for labs and demonstrations. Over distances greater than two meters the fan unit on the cart provides a constant force resulting in a nearly uniform acceleration. When teaching Newton's Second Law, the mass of the cart can be changed.

The fan cart consists of a low-friction cart with an electric fan powered by two AA batteries. Included with the cart is an acrylic sail which, when added to the cart, causes the energy of the fan to be absorbed, canceling the net force of the fan and stopping acceleration.

Activities

A. Using the fan cart to develop a conceptual understanding of force and motion.

1. Have the student turn on the fan and hold the cart from moving. Draw a vector diagram of the forces acting on the cart in the horizontal plane. (Vectors of equal length but in opposite direction should be drawn and labeled representing the balanced forces of the hand and the fan unit.)
2. With the fan running, give the fan cart a push in the opposite direction of the push of the fan unit, causing it to accelerate away. After the push, the fan cart should slow to a stop, reverse direction and accelerate back toward your hand. Draw three force vector diagrams of the cart: during the push, after the push, while the cart is moving away from the hand, and after momentarily coming to a stop and moving back toward the hand. On a graph of speed vs. time, draw and label lines representing these three motions.

B. Experiments in Force and Motion

1. Measuring acceleration of the Fan Cart. Several methods can be used and their calculated values compared. The simplest and most accurate uses the distance and time for the cart to accelerate from rest. On a level surface, release the cart with the fan running and measure the time to travel 3.00 m. With the starting velocity zero, solve for the acceleration using the equation $d = 1/2 \cdot a \cdot t^2$. (Other methods to measure acceleration include the use of spark timers or the **PocketLab Voyager 2**.)
2. Determining the force of the fan. Again, several methods can be used and their values compared.
   a. Use Newton's 2nd Law (*F=ma*). Find the mass of the Fan Cart and multiply this value by the acceleration value calculated above.
   b. Place the Fan Cart on a level surface and attach a string or thread to it that extends over a low friction table top pulley. With the fan pushing in the opposite direction add increasing amounts of mass to the string until its weight balances the force of the fan and keeps the cart at rest. Compare the weight of the hanging mass to the force calculated in part "a".
   c. Place the fan cart on an incline plane. With fan running and pushing in the direction up the plane, raise and lower the plane angle until the cart remains at rest. At this plane angle the cart is in equilibrium with the force of the fan balanced by the cart's component of gravity parallel to the plane $F_{fan} = m \cdot g \cdot \cos\theta$.

Verify Newton's 2nd Law by varying the mass of the cart. The mass of the cart can be changed by placing masses on top of the cart. By keeping the force of the fan constant and measuring the accelerations of different mass values, the student can verify that the acceleration is inversely proportional to the mass ($a \propto {}^{1}/_{m}$)

Related Products

Constant Velocity Car (44-1090) This simple but powerful toy provides a visible source of uniform speed. Students can easily quantify and graph their results, starting them on the road to a conceptual understanding of motion.

Acceleration Car (P4-1980) This companion to our popular Constant Velocity Car demonstrates nearly constant acceleration. Simply pull back on the spring-loaded, die-cast truck, then release. Use a motion sensor or tape timer to measure the acceleration.