Force and Acceleration

MATERIALS LIST

- balance
- calibrated masses and holder
- cord, smooth
- dynamics cart
- hooked mass, 1000 g
- LabPro® or CBL 2™ interface
- mass hanger
- meterstick
- pulley with table clamp
- rod and parallel clamp
- square of poster board, 25 cm × 25 cm
- support stand with V-jaw clamp
- tape
- TI graphing calculator with link cable
- Vernier dual-range force sensor
- Vernier motion detector

SAFETY

- **Tie back long hair, secure loose clothing, and remove loose jewelry to prevent its getting caught in moving or rotating parts.**
- **Attach masses securely. Falling or dropped masses can cause serious injury.**

PROCEDURE

Preparation

Follow Preparation steps 1–3 for the Skills Practice Lab "Force and Acceleration" in the chapter "Forces and the Laws of Motion."

Apparatus Setup

4. Connect the LabPro or CBL 2 interface to the calculator with the unit-to-unit link cable. Connect the Dual-Range Force Sensor to the CH1 port on the interface, and set the switch on the sensor to 10N. Connect the motion detector to the DIG/SONIC 1 port on the interface.

5. Turn on the calculator, and start the DataMate® program. Press CLEAR to reset the program.

6. Set up the apparatus as shown in **Figure 1.** Securely tape the force sensor to the dynamics cart. Tape the poster board to the opposite end of the dynamics cart to make a flat, vertical surface. Clamp the pulley to the table edge using a table clamp, rod, and parallel clamp so that the pulley is level with the force sensor hook. Position the motion detector so that the cart will move away from it in a straight line. Securely clamp the motion detector to the ring stand. Place a piece of tape 0.5 m in front of the motion detector to serve as a starting line for the cart. (**Note: Do not pull on the force sensor.**)

Constant Mass with Varying Force

7. Carefully measure the mass of the cart assembly on the platform balance, making sure that the cart does not roll or fall off the balance. Then, load it with masses equal to 0.60 kg. Lightly tape the masses to the cart to hold them in place.

8. Attach one end of the cord to a small mass hanger and the other end of the cord to the force sensor. Pass the cord over the pulley, and fasten a small mass to the end to offset the frictional force on the cart. The mass is correct when the car moves forward with a constant velocity when you give it a push. The car will have constant velocity for only a short period after it is pushed, then it will accelerate as the counterweight drops. *This counterweight should stay on the cord throughout the entire experiment.* Add the mass of the counterweight to the mass of the cart and masses, and record the sum as *Total Mass* in your data table.

9. For the first trial, remove a 0.10 kg mass from the cart, and securely fasten it to the end of the cord along with the counterweight. Record 0.10 kg as the *Accelerating Mass* in the data table.

10. Place the cart so that the poster-board end is closest to the motion detector and is lined up with the tapeline, 0.5 m in front of the motion detector. Keep the force sensor cord clear so that the cart will be able to move freely.

11. Make sure that the calculator is turned on. Make sure that the area under the falling mass is clear of obstacles. Select START to begin collecting data, and release the cart simultaneously. The motion detector will begin to click as it collects data.

12. Carefully stop the cart when the 0.10 kg mass hits the floor. Do not let the cart fall off the table.

13. When the motion detector has stopped clicking, the graph selection screen will appear on the calculator. Press ENTER to plot a graph of the force sensor reading against time. Use the arrow keys