10-106 Galileo Lab Apparatus

Purpose:

To investigate the circumstances of acceleration using tools similar to those available to a seventeenth century scientist. Galileo reasoned that a measured constant acceleration on a straight inclined track, and a greater constant acceleration at steeper angles, should indicate a constant acceleration in free fall. This idea was opposed in his time.

Required Accessories:

One or two ring stands and rings, short pieces of fine wire, 10 or 15 ml graduate, 250 or 500 ml beaker, thin ruler, clamp

Track Assembly:

Mount the track at an incline using rings and ringstands. The holes in the lower edge of the track can be used to wire the track to the rings for additional stability. Attach the wooden stop block (dowel) with a rubber band at the lower end of the track.

Water Clock Assembly:

Mount the stopper and plastic tube assembly in the throat of the funnel. Suspend the funnel assembly in a clamp so that the plastic tube is over the graduate which has been set in the beaker to catch overflow.

Track Operation:

Place the steel ball at the top of the track, and hold it in place with the thin ruler held on edge. To release, use a quick vertical movement of the ruler. Time using the water clock from release to the sound of the ball hitting the stop block.

Water Clock Operation:

Place a finger over the hole in the rubber stopper and fill the funnel with water. As ball is released, lift the finger off the hole. Cover the hole again when the ball strikes the stop block. Measure and record the amount of water in the graduate and discard it. Be certain there is enough water left in the funnel for a complete run.

Background:

Galileo believed that the speed of free-falling objects increases in proportion to the time of fall -- that is, that they have uniform acceleration. But since free fall was much too rapid to measure, he assumed that the speed of a ball rolling down an incline increases in the same way as an object in free fall does, only more slowly. The average speed could be measured, but the instantaneous speed could not. Galileo reasoned that if the acceleration was a constant for a particular incline, then the distance traveled is proportional to the square of the time elapsed. The distance was easy to measure, that's where he started the ball rolling. For the elapsed time, he needed something whose behavior was constant with respect to time. He placed a large vessel of water in an elevated position with a small pipe at the bottom to deliver a thin jet of water. By collecting and weighing the water, he had his timer. He knew he was on to something when the time to roll the last quarter of the track length took half the time of rolling the whole track. It would seem reasonable for the modern investigator to collect and graph distanced rolled on the track versus the square of either the weight or the measured volume delivered by the water clock.

Note:

Galileo did not have to deliver his apparatus in a modern truck. The metal ramp may not fulfill the nostalgia, but it is more durable during and after delivery. If the ramp has a slight bow when positioned upside down, it will make a straight line incline when in its proper position. This means fewer support

stands are needed compared with a wood track.

Time Allocation:

To prepare this product for an experimental trial should take less than two minutes. Actual experiments will vary with needs of students and the method of instruction, but are easily concluded within one class period.

Feedback:

If you have a question, a comment, or a suggestion that would improve this product, you may call our toll free number.