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Centripetal Force on a Turntable

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With a rowdy class in a small room, I despaired of having students explore centripetal force with stoppers whirling at the ends of strings, as suggested by PSSC and *Project Physics*. Instead, I conducted a class experiment to study forces acting on a cart on a turntable. I found that this experiment gives reasonably good data and also gives students an intuitive feel for centripetal force.

The apparatus, shown in Fig. 1, is quite simple. A piece of standard-size 2 × 8 wood framing 2- or 3-m long is attached at the center to a rotating platform. An inexpensive "lazy Susan"[1] proved to be a satisfactory bearing.

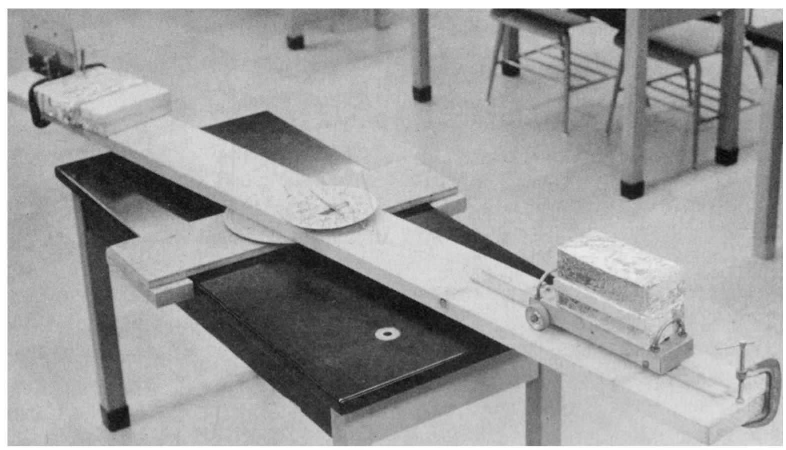

Fig. 1. Centripetal force apparatus. The board rotates on a bearing at the center. A liquid accelerometer helps convince the students that acceleration is toward the center.

A section of Hot Wheels track taped near one end of the board served as a guide for one wheel of a brick-laden cart. The cart was connected by wire (spiral-notebook binding works well) to a large spring balance attached to a nail. To assure that the cart did not run up or down hill, I checked the board with a level and added bricks to the other side as needed.

To gather data, we simply put the turntable in motion, giving it a gentle shove each half-rotation to keep the force reading constant, while a stopwatch measured the period of one or several rotations. Data collected in my class easily showed that the square of the period is inversely proportional to the force.

This apparatus is also useful for studying the effect of mass on centripetal force. Using the same force for each trial, we placed one to four bricks on the cart. Results showed that if force and radius are constant, the square of the period is proportional to the mass.

The effect of changing the radius of revolution was more difficult to study. A longer board would help since the major problem was having a suitably large range of values. Our data showed that if force and mass are constant, the square of the period is proportional to the radius of revolution.

In other words

$$T^2 \propto 1/F \quad (1)$$

$$T^2 \propto m \quad (2)$$

$$T^2 \propto r \quad (3)$$

By combining the three proportionalities, adding a proportionality constant K, and rearranging, we get

$$F = Kmr/T^2 \quad (4)$$

With care, these experiments give values of K that are within ten percent of $4\pi^2$, which is the value obtained from vector analysis. ◆

Reference

1. Edmund Scientific, 101 East Gloucester Pike, Barrington, NJ 08007, sells these for about $6.

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