THE DEMONSTRATION CORNER

Demonstration of a Variable Tension in a Pendulum's String

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A very effective demonstration of a variable tension in a swinging pendulum can be performed using very simple equipment (Figure 1). Connect a large scale to a pendulum, pull it to the side and let go. As the pendulum swings the scale shows variable string tension values. The maximum tension will be observed at the bottom point of the swing (B). At this point, the mass will have its maximum speed and according to Newton's second law the string tension will exceed the pendulum's weight and will reach its maximum value: $T_B = mg + m\frac{v^2}{l}$. Notice that for all other points of pendulum's trajectory not only will the pendulum move slower, but also the tension and gravitational forces will not be aligned.

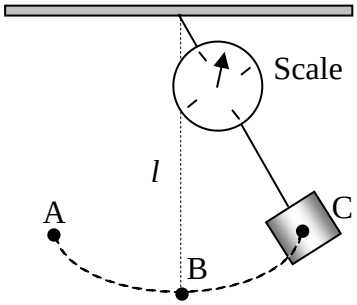

Figure 1: Demonstration – tension in the pendulum.

This demonstration can be turned into an interactive lecture experiment [1] using *Tracker: Open Source Physics Java Video Analysis Software* developed by Doug Brown at Cabrillo College [2] or using a video analysis feature of the Logger *Pro* software [3] and a video clip of the demonstration such as the one recorded by Doug Brown, the snapshot of which is shown on Figure 2.

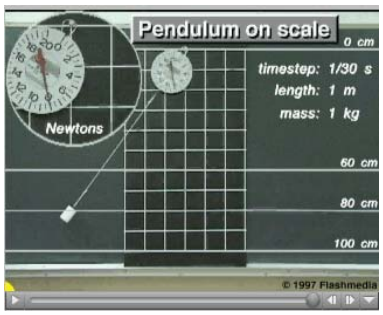

Figure 2: Video clip snapshot: tension in the pendulum.

References:

1. Milner-Bolotin, M., A. Kotlicki, and G. Rieger, *Can Students Learn from Lecture Demonstrations: The Role and Place of Interactive Lecture Experiments in Large Introductory Science Courses.* Journal of College Science Teaching, 2007. **Accepted for publication**.
2. Brown, D., *Tracker: Open Source Physics Java Video Analysis*. 2006, Doug Brown: http://www.cabrillo.edu/~dbrown/tracker/.
3. Vernier Technology, *Logger Pro*. 2006, Vernier Technology: Portland Oregon.

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