**The Mysterious Harmonograph**

**Brief Description:**
The harmonograph is a machine for creating mathematical drawings. Students begin by putting a piece of paper under the middle or one end of the bar and holding the paper down with a couple of magnets. The harmonograph is set in motion; once the bar has settled into a regular motion, pen(s) can be added to create drawings.

**Objectives:**
Students can explore fascinating wave motion in a two-dimensional plane with a pendulum that creates beautiful curved drawings similar to Lissajous figures. Several different variables can be manipulated to create unique drawings, and students can investigate the effect of changing each control.

**Links to Websites:**
http://mathmidway.org/Training/harmonograph.php
http://ngsir.netfirms.com/englishhtm/Lissajous.htm
http://www.math.com/students/wonders/lissajous/lissajous.html

**Vocabulary:**
Amplitude  
Circle  
Ellipse  
Frequency  
Lissajous figure  
Pendulum motion  
Plane  
Sinusoidal equations  
Square  
Wave

**Before:**
- **(Level 1, 2, 3)** Pair students so that one person moves a pen left and right while the other moves the paper up and down. Compare the class’ drawings.
- **(Level 1, 2)** Introduce the toy called Etch-A-Sketch. Try to draw a square and then try to draw a circle.

**During:**
- **(Level 1, 2, 3)** Each student should make one drawing and record the position of the weights and the cables. Adjust either the weights or the cables and make a second drawing. Record the difference in the drawings. Share what each student noticed to discover how the weights and cables affect the wave motion.

**After:**
- **(Level 3)** Study the following applet about Lissajous figures:
  http://ngsir.netfirms.com/englishhtm/Lissajous.htm
  How does changing the values of the frequency, initial phase, and amplitude affect the Lissajous figure?
Students can view more complex Lissajous figures at
http://www.math.com/students/wonders/lissajous/lissajous.html