Pendulum Activity

Materials: String, metal washers, wooden skewer, stopwatch.

Part I: Single pendulum

(a) Make a string/washer pendulum (roughly 1 foot in length). Loop and knot the free end over the skewer, and support the skewer (e.g. on chair backs) so that the pendulum can swing freely.

(b) Release washer from some large angle, and observed the motion. How does the amplitude change? How long does it take for the pendulum to stop swinging altogether?

(c) During each swing, potential energy is converted to kinetic energy, and then back again. Create a pictorial representation of this situation that might be called an "Energy Flow Diagram" that you think would be understood by your students.

(d) Release the washer from an angle of about 30 degrees, and measure the time it takes for the pendulum to complete 10 periods, 20 periods, and 30 periods of its motion. Repeat this (at least) three times, to get an idea of how reproducible the motion is. Use your data to determine the period of one oscillation.

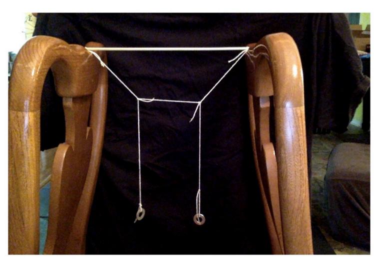
(e) Compare your measured value of the period T with the theoretical formula

$$T = 0.32 \times \sqrt{L} \quad \text{seconds}$$

where L is the length in inches of the pendulum.

Part II: Two Pendulums.

(a) Make a second pendulum, as close to the same length as the first one. Attach this to the skewer as before, so that the two pendulums hang side by side and a few inches apart. Next, tie a length of string to connect the two pendulums. Adjust the top ends, moving them apart along the skewers, so that the connecting string is taut. Finally support the skewer so that the two pendulums are free to swing. The final product should look something like the contraption in the photo.



(b) Demonstrate the transfer of energy from one pendulum to the other (this process is sometimes called "beating"). To do this, pull back one pendulum while leaving the other alone, and release. Over several oscillations, energy will gradually transfer from one pendulum to the other. Ideally, there will be a moment when all of the enegy resides in pendulum #2, after which the transfer will reverse, as energy is slowly fed back to pendulum #1. The entire process then repeats. See if you can get the back-and-forth transfer to occur several times before the whole process runs down.

(c) Sketch an "energy flow diagram" to depict the situation, showing both the transformation of potential-to-kinetic-and-back within each pendulum and the transfer of energy between the two pendulums.

(d) Design Challenge: what can you do to maximize the number of "full energy exchanges" between the two pendulums? Test out one or two of your ideas to see what works best.

Part III: Three Pendulums.

(a) What do you think would happen if you added a third pendulum? Draw an energy flow diagram to illustrate your guess.

(b) (optional) Add a third pendulum, and see what happens.

Part IV: Watch these videos:

"Pendulum Waves" (1:45)
https://www.youtube.com/watch?v=yVkdfJ9PkRQ

Two "egg pendulums" beating, part of "sixty symbols" series (1:42)
https://www.youtube.com/watch?v=izy4a5erom8