Coupled Pendulum Investigation

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Many natural systems can be modeled by a simple oscillating system like a pendulum or by multiple connected pendulums. Construct an approximation of a simple pendulum with a weight and a comparatively light string. The pendulum string length (L) from support to center of the weight should be variable and at least 60 cm (24 in) from the support to the center of the weight.

(1) Use a stopwatch to time 10 or 20 (N) full oscillations of your pendulum for several string lengths from a minimum of 10 cm (4 in) to at least 60 cm (24 in). For each string length, repeat the measurement twice more and average the results.
(2) Divide your average time value for each length by N for that length to find the average oscillation period (T) for each length..
(3) Compare your oscillation period values to the theoretical value for small oscillations of a simple pendulum:

$$T = 2\pi\sqrt{\frac{L}{g}}$$

, where g = gravity acceleration at the location of the pendulum. Explain any significant discrepancies.
(4) Construct a second pendulum similar to the first one, and mount it near enough to the first so that the two pendulum strings can be connected by a straw. The straw should be slit at each end to grab a string. With the two pendulums at their maximum length, place the connecting straw about 10 cm (4 in) down from the support points. Hold one pendulum steady, and start the other one swinging. Measure the time required for the maximum transfer of motion from the initial pendulum to the other one. Repeat a few times and find the average time for the motion transfer.
(5) Repeat the measurements in (4) with increasing distances of the straw from the support points of the pendulums. Describe and explain any pattern you see in the motion transfer times.
(6) Repeat the measurements in (4) with one pendulum shorter than the other by at least 10 cm. Describe how the motion of the pendulum system in this case differs from that in (4).
(7) Find and describe as many normal modes of the two-pendulum system as you can. In a normal mode, all parts of the system vibrate sinusoidally with the same frequency and each part has a constant phase relation with the other parts of the system.