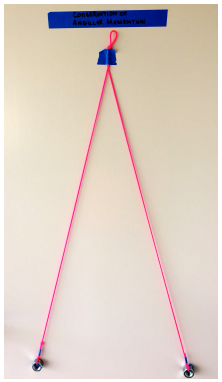
Conservation of Angular Momentum

2 colliding spheres of equal mass

Materials:
String
2 large hex nuts
Scissors
tape

To do and notice:
Cut string ~1 m long. Tie one hex nut at each end. Tape the knot. Hold the string at the center so that both hex nuts are equal length and tie a loop at the top.
Hold the string with extended arm and swing into motion the hex nuts rotating around each other.
Notice that as the distance between the hex nut decreases the rotating speed increases.



What's going on?
The hex nuts rotate around each other with large rotational inertia (1 and 2) as they whirl inward, the rotational inertia decreases and the rotational speed correspondingly increases (3 and 4.)

LIGO connection: a binary system loses angular momentum as the two orbiting objects spiral towards each other—the angular momentum is radiated away by gravitational waves.

Pendulum Snake Lesson

By Paul Doherty

At the museum we often get asked, “where to the exhibit ideas come from?”
No one asks, “where do the science lessons behind the exhibits come from?”

I was inspired by a visitor question on Monday, April 1, to create a new lesson at Pendulum Snake.
I was taking around a tour of foreign visitors when we came upon pendulum snake. As it was in motion, a man behind me said to his young companion, “this exhibit shows common factors.”
So with my visitors watching, I pointed out that pendulums numbered 15 and 16 had not common factors other than 1 and so they repeated their pattern once every 30 seconds.
Then having never done it before I started pendulums 16 and 18, s they swung I said, “what is their common factor?” (2) I said, “watch and you’ll see that they come together twice in 30 seconds.

Try 15 and 18 -common factor 3
What about 16 and 20, 15 and 20.
After it was all over, I asked the original observer if he was a mathematician, “No” he repiled, “but I like mathematics.

Coupled Resonant Pendulums

What you will need: string, dowel stick or ruler, washers or straws, scissors, and tape.

What to do:

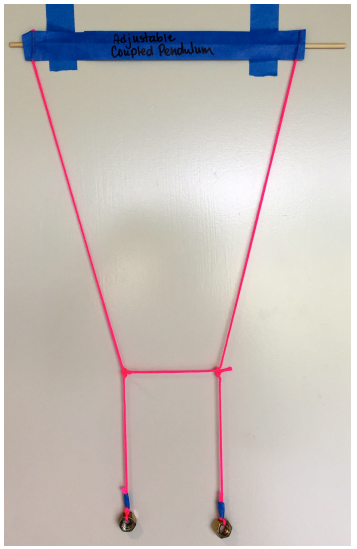
- Cut 3 strings- 2 short and 1 long string.
- Tie the long string to each side of the dowel stick and tape securely.
- Tie the 2 shorter strings to the longer string as shown in the photo, making sure that each string is the same length.
- Tie a nut at the end of each of the short strings. Use tape to secure and prevent motion on the longer string.

To do and notice:

- Gently pull one pendulum back a short distance and let it go. As it swings back and forth, notice that the other pendulum also begins to move, picking up speed and amplitude with each swing. Notice that the pendulum you originally moved slows down with each swing and eventually stops, leaving the second pendulum briefly swinging by itself. Then the process begins to reverse, and soon the first pendulum is swinging again while the second one is stopped.
- The pendulums repeatedly transfer the motion, energy back and forth between them.

What's going on?

As the first pendulum swings it pulls on the neighbor pendulum making its neighbor swing more. As the initially stopped pendulum's motion builds up, it also pulls on the string, slowly bringing the first pendulum to rest. When the pendulum you started comes to rest, its energy has been completely transferred to the second pendulum, which is swinging.



Kholt 2016
LIGO LLO SEC
Pendulums made easy!

Pendulum Necklace and Snake Ver. 2.0

How to calculate the correct LENGTHS:

The longest pendulum on this snack is 38.79 cm (measured to the center of mass of the hexnut) and will swing back and forth 24 times in 30 seconds.

Length 30 seconds	**Number of Back and Forth Swings in**
(L)	(N)
38.79 cm	24

Subsequent lengths can be calculated by using the following formula:

$$L_{n+1} = L_n (N/N + 1)^2$$

For example,

$L_{25} = L_{24} (24/25)^2$

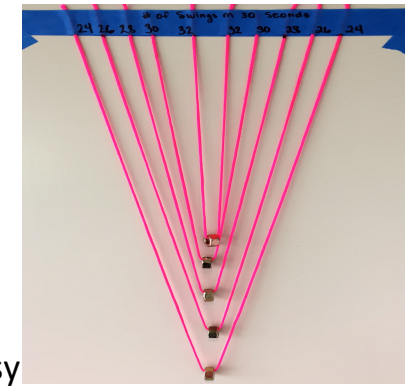
$L_{25} = 35.75$ cm

Length seconds	**Number of Back and Forth Swings in 30**
(L) cm	(N)
38.79	24
35.75	25
33.05	26
30.65	27
28.50	28
26.56	29
24.82	30
23.25	31
21.82	32
20.52	33

Exploring the relationship between pendulum length and period.

What to do?

1. Cut string 2x's the length, mark both ends with a marker as shown in the diagram. Measure to the center of the mass of the nut.
2. Lay tape on the table sticky side up, use tape on each end to secure tape to table.
3. Place strings with mark at the edge of the tape so that it will hang freely.
4. Place 2nd piece of tape over the 1st to secure strings.
5. Attach the pendulum necklace to the edge of a table or counter.
6. Use a ruler to pull back all the nuts on the string at one time and release.



Kholt 2016
LIGO LLO SEC
Pendulums made easy