

**Parts List for Pendulum of Hansen & Lieberman**  
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As of August 2013, Hansen and Lieberman have published 2 papers that employ a torsion pendulum/balance to detect and quantify what appears to be a biofield that is produced around and above a subject who is sitting under the pendulum.

The first was published in 2009 and is available in the University of Maryland Digital Repository

The URL is: <http://hdl.handle.net/1903/9421>

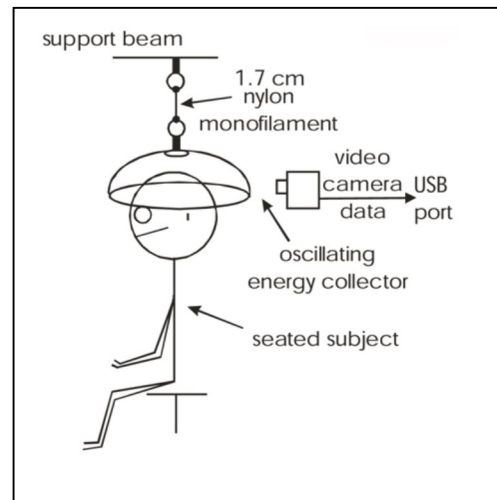
The second was published in the Journal of Scientific Exploration in 2013

Journal of Scientific Exploration, Vol. 27, No. 2, pp. 199–219, 2013

This article is now available at: <http://hdl.handle.net/1903/15607>

The earlier paper has more details about the construction of the pendulum than does the later paper.

The diagram shows components of the pendulum and how it is suspended above the subject during an experiment. The twisting oscillations of the pendulum are captured by a video camera which stores position data directly into an Excel .csv file.



Components that are required to construct and operate the pendulum follow.

1. PC software that is designed to determine the center of a 1 cm white dot on a black background. As the dot moves horizontally to the right and left, the position of the white dot is recorded in a file along with a time stamp.
2. A video camera that can produce a video picture of the white dot, and has a USB cable that can feed this picture into a USB port of a PC.
3. A dome-shaped hemisphere that acts as an energy transducer to convert the energy of the subject into the twisting motions of the pendulum, which are monitored by means of the video camera observing the position of the white dot, over time.
4. Nylon monofilament that is used to suspend the hemisphere above the subject. This filament also provides the crucial role of acting as a torsion spring that causes the hemisphere to oscillate according to the principles of simple harmonic motion.

5. Hardware to connect the hemisphere to the nylon monofilament, and to attach the nylon monofilament to a rigid support. The rigid support consists of a tripod which is attached at one end of an aluminum angle, and the other end of the aluminum angle is attached to the hardware supporting the nylon fiber.
6. A second tripod is employed to support the video camera in the position required to make videos of the motions of the white dot.

The following are specific examples that are suitable for fulfilling the requirements for the pendulum.

1. Irene He at Hytek Automation has written a program that works very well. It has two versions, one that works only with XP, and another that works only with Windows 7. Once started, the program looks for the single brightest component in the video frame and computes the center of it to the nearest pixel, less than a millimeter. It records the position of the center as an x and a y value. It also computes the diameter of the component (the 1 cm white circle). Each time the computer takes a measurement; it stores the time, x-position of the white dot, the y-position of the white dot, and the diameter of the white dot. This is stored in a default file called C: test.csv. Before you start the program, you can adjust the rate of measurements; we usually use 10/sec, which provides excellent resolution with respect to the position of the pendulum vs. time. Irene He has been selling this program for \$80, and she can be contacted at [info@hytekautomation.ca](mailto:info@hytekautomation.ca). The program does just one thing, which is to determine the exact center of the white dot and store this position in a file along with the time the measurement was taken. It does not produce a video file which is good, because they are enormous and useless. One more thing, each time it determines the center, it draws a red circle around the center that it has calculated, and shows it on the screen. Another important thing is that the program displays the progress of the experiment in two side-by-side panels, the left one showing the white dot with the red circle, and the right one showing a chart of the data in real-time. All this is very good for anyone with interest in using the output as biofeedback to enable the subject to try and consciously alter the motions of the pendulum.
2. Analysis of the data for frequency components requires Fourier analysis, specifically the Fast Fourier Transform. This is implemented in my programs, including Excel. We use sigview, provided by sigview.com. It has a modest learning curve, and once passed, is extremely user-friendly and effortlessly performs complex signal analysis.
3. The video camera. The Irene He program accommodates most standard video cameras, and even very inexpensive webcams will suffice. The crucial thing is that the video image contain nothing other than the 1 cm white dot on a black background, which can be created using a standard drawing program and printing on standard printer paper, trimmed appropriately, and attached to the side of the hemisphere. If the image includes anything else, the program will usually choose some other bright spot to measure, and the red circle will jump away from the white dot to someplace else, completely disrupting the flow of the data. Room lighting is also important, in that inappropriate lighting can create reflections in the video image that can cause the red circle to jump to the reflections.

Because we already had one, we have used the ProScope HR2 video camera with the

10X lens that is available as an accessory. Unfortunately, it is an expensive laboratory camera. An important consideration in choosing a camera is its having a standard tripod mount, so it can be attached to a standard tripod pan head. The ProScope has this. Exploring cheaper options, we have identified the following camera, and tested it. It works very well, and has a standard tripod mount.

Logitech HD Portable 1080p Webcam C615 with Autofocus (960-000733) from Amazon.com. The current price is \$48.

A link is: [http://www.amazon.com/Logitech-Portable-Webcam-Autofocus-960-000733/dp/B004YW7WCY/ref=sr\\_1\\_1?s=electronics&ie=UTF8&qid=1376158801&sr=1-1&keywords=Logitech+HD+Portable+1080p+Webcam+C615+with+Autofocus+%28960-000733%29](http://www.amazon.com/Logitech-Portable-Webcam-Autofocus-960-000733/dp/B004YW7WCY/ref=sr_1_1?s=electronics&ie=UTF8&qid=1376158801&sr=1-1&keywords=Logitech+HD+Portable+1080p+Webcam+C615+with+Autofocus+%28960-000733%29)

Description: Logitech HD Portable 1080p Webcam C615 with Autofocus (960-000733)  
We know of one person who has successfully done pendulum experiments using an \$18 webcam. Just saying.

4. A dome-shaped hemisphere. The original hemisphere was discovered in the garden section of a hardware store. It was a steel-mesh hemisphere whose intended purpose was to protect food on a picnic table from insects, and is called a 'food cover.' It turned out to be the perfect choice. It had a mass of 220 g, and a diameter of 35 cm (14 inches). At the time, this particular food cover was available throughout the internet. Because we had this particular hemisphere/food cover, we used it exclusively for several years. We have recently found that this particular food cover is no longer available, or at least, we have not been able to find it. The original food cover was black, and had a mass of 220 g. Alternate food covers can be found at:

<http://www.campingworld.com/shopping/item/mesh-food-cover-dome/35001>

This red food cover has a mass of 180 g. It works well, but to conform to our experimental conditions, you need to extend the nylon fiber so as to obtain a period of 30-40 sec. A fiber length of 2-2.5 cm should be appropriate.

Description: Dimensions: 14" dia. x 6"H Manufacturer: Intersource Enterprises Co Ltd Mfg Part #: D14-983

Another food cover is available at:

[http://www.polyvore.com/kitchen\\_craft\\_round\\_metal\\_mesh/thing?id=39807187](http://www.polyvore.com/kitchen_craft_round_metal_mesh/thing?id=39807187)

Description: Kitchen Craft Round Metal Mesh Food Cover, 35cm: Amazon.co.uk: Kitchen...  
We have used this one also, and it is excellent. The 35 cm (14 in) hemisphere has a mass of about 200 g. We argue that it is important to use hemispheres with a diameter of 35 cm/14 inches, because those are the hemispheres that we have employed and studied. If you are interested in replicating our results, you need to use these items which are either what we employed, or very similar. That is not to say that other things will not 'work.' However, in the spirit of the scientific method, those who want to verify our findings need to, at least at first, replicate the conditions that we employed.

The nylon monofilament. We employed a nylon monofilament with a diameter of 0.7 mm, and a length of 1.7 cm. This was a standard fishing line of 30 lb test. A link to the exact nylon fiber we used is:

[http://www.amazon.com/South-Bend-Monofilament-Line-30-Pound/dp/B000BUC7IM/ref=sr\\_1\\_2?s=sporting-goods&ie=UTF8&qid=1376160641&sr=1-2&keywords=30+pound+fishing+line](http://www.amazon.com/South-Bend-Monofilament-Line-30-Pound/dp/B000BUC7IM/ref=sr_1_2?s=sporting-goods&ie=UTF8&qid=1376160641&sr=1-2&keywords=30+pound+fishing+line)

Description: South Bend Monofilament Line, 30-Pound

It is South Bend monofilament fishing line, 30-Pound test. The diameter of the filament is 0.7 mm. The filament length we used was 1.7 cm. The important thing is to choose a filament length that gives a period of 30-40 sec, in order to replicate our conditions.

5. Rigid support for the pendulum. The support beam for the pendulum consisted of an aluminum angle. The angle is important to provide rigidity. A link to a suitable support is: [http://www.amazon.com/gp/product/B000H9FWY8/ref=ox\\_sc\\_sfl\\_title\\_1?ie=UTF8&psc=1&smid=ATVPDKIKX0DER](http://www.amazon.com/gp/product/B000H9FWY8/ref=ox_sc_sfl_title_1?ie=UTF8&psc=1&smid=ATVPDKIKX0DER)

A description of the item is:

6061 Aluminum Angle, Unpolished (Mill) Finish, Extruded, T6 Temper, Equal Leg Length, Rounded Corners, 1-1/4" Leg Lengths, 1/8" Wall Thickness, 24" Length

6. Hardware to connect the support beam to the pendulum, and to connect the other end of the support beam to a tripod.

To make the attachments to the pendulum and the tripod, you need to drill a hole near one end of the support beam for the pendulum, and another hole 18 inches from that hole to provide an attachment to the tripod. It is convenient to use standard 1/4 inch threads, especially because a standard tripod pan head has a 1/4 inch screw that ordinarily screws into a 1/4 inch camera mount. It is therefore a good idea to provide standard 1/4 inch screw threads in the holes you drill in the aluminum support. To do this, you need a drill and tap, the drill to make the appropriate hole, and the tap to create the threads. The drill/tap we used is:

[http://www.amazon.com/Vermont-American-21666-Drill-Combo/dp/B000CFNPGE/ref=sr\\_1\\_1?ie=UTF8&qid=1389027194&sr=8-1&keywords=1%2F4+inch+tap+and+drill+set#productDetails](http://www.amazon.com/Vermont-American-21666-Drill-Combo/dp/B000CFNPGE/ref=sr_1_1?ie=UTF8&qid=1389027194&sr=8-1&keywords=1%2F4+inch+tap+and+drill+set#productDetails)

A description of it is:

## Vermont American 21666 Size 1/4 x 20 NC Tap No 7 Drill Bit Combo

You now need hardware to connect the support beam to the nylon support and to the pendulum. We used eyebolts, 1/4 x 2 in, standard 1/4 in thread.

This item is available at Lowes:

[http://www.lowes.com/pd\\_208142-1277-V2161\\_0](http://www.lowes.com/pd_208142-1277-V2161_0)

A description is: Stanley-National Hardware 1/4-in x 2-in Stainless Steel Eye Bolt

The picture of the eye bolt shows a standard 1/4 inch nut screwed on. When/if you go to Lowes, you will find packages of 1/4 inch nuts and washers that fit these eye bolts and you should get some.

Whereas the eye bolt screws perfectly into the hole you made in the aluminum support, it is a good idea to put a nut on each side of the support and tighten them. Finger tight is fine, just so things don't rattle around.

**A link to this hex nut is:**

[http://www.lowes.com/pd\\_63301-37672-150003\\_0\\_?productId=3058547&Ntt=1%2F4-in+hex+nut&pl=1&currentURL=%3FNtt%3D1%252F4-in%2Bhex%2Bnut&facetInfo=](http://www.lowes.com/pd_63301-37672-150003_0_?productId=3058547&Ntt=1%2F4-in+hex+nut&pl=1&currentURL=%3FNtt%3D1%252F4-in%2Bhex%2Bnut&facetInfo=)

**A description is: The Hillman Group 1/4-in- 20 Zinc-Plated Standard (SAE) Hex Nut**

**Item #: 63301 | Model #: 150003**

**A link to the washer is:**

[http://www.lowes.com/pd\\_67847-37672-35010\\_0\\_?productId=3037622&Ntt=1%2F4-in+washer&pl=1&currentURL=%3FNtt%3D1%252F4%2Bin%2Bwasher&facetInfo=](http://www.lowes.com/pd_67847-37672-35010_0_?productId=3037622&Ntt=1%2F4-in+washer&pl=1&currentURL=%3FNtt%3D1%252F4%2Bin%2Bwasher&facetInfo=)

**A description is: The Hillman Group 100-Count 1/4-in x 3/4-in Zinc Plated Standard (SAE) Flat Washers**

**Item #: 67847 | Model #: 35010**

**Now make the attachment of the food cover hemisphere to the support. The food covers come with plastic handles attached to the metal covers. Just remove them completely, and what remains in the food cover is a small opening at the top.**

**Take one of those eye bolts and screw a nut onto it, followed by a washer. Insert that through the hole in the top of the food cover, and put a washer on the underside, and then screw on a nut.**

**Tighten things up, just using your fingers.**

**You now have one eye bolt attached to the aluminum support and extending downward, and another eye bolt attached to the hemisphere and extending upward. You need to connect these two eye bolts with the 35-lb test nylon fiber. Well, it might be a good idea to attach the nylon fiber to the eye bolts before attaching them to the support and pendulum, but you will probably realize that before long.**

**Once you have all the hardware assembled, you need to connect the support to the pendulum via the nylon filament. This involves connecting 2 eyebolt rings, one from the support, and one from the pendulum. This requires tying a knot from the support fiber to the upper eyebolt, and to the lower eyebolt. The knot used has been the 'double half hitch knot' which is very simple to tie, and very secure. It can be secured tightly to each eye-bolt, which precludes any effect of the knot on the movement of the pendulum.**

**A link to a double half-hitch knot is:**

<https://www.google.com/search?q=double+half+hitch+knot&tbm=isch&tbo=u&source=univ&sa=X&ei=jk4nUtCEGrS0sQTNzIHIBQ&ved=0CEQQsAQ&biw=1366&bih=653>

**The tripods that we used to support the aluminum support, and the camera, respectively, are now described. The tripod we used to support the pendulum needs to be heavy duty, and be able to extend high enough to support the pendulum at the height needed to suspend the pendulum above the subject. The tripod we used to support the camera was not as demanding, so was cheaper.**

**The tripod we used to support the aluminum support beam which was supporting the pendulum is available at:**

[http://www.amazon.com/gp/product/B003GVCUKI/ref=wms\\_ohs\\_product?ie=UTF8&psc=1](http://www.amazon.com/gp/product/B003GVCUKI/ref=wms_ohs_product?ie=UTF8&psc=1)

**A description of the tripod is:**

**Sunpak 620-7575CC Pictures Plus 7575 Digital Pro 74-inch Heavy-Duty Photo and Video Tripod with 3-Way Pan Head. Current price, \$70**

**A smaller/cheaper tripod was used for the camera:**

[http://www.amazon.com/gp/product/B004BLISHQ/ref=wms\\_ohs\\_product?ie=UTF8&psc=1](http://www.amazon.com/gp/product/B004BLISHQ/ref=wms_ohs_product?ie=UTF8&psc=1)

A description is:

**PlatinumPlus by Sunpak 6600DX Heavy Duty Tripod for Still and Video Cameras in Professional Black Supports Up to 6.6 lb and Extends Up to 65.3 Inches**

**A description of the tripod for the camera is:**

**PlatinumPlus by Sunpak 6600DX Heavy Duty Tripod for Still and Video Cameras in Professional Black Supports Up to 6.6 lb and Extends Up to 65.3 Inches. Price \$40**

**If you have any questions/difficulties, contact me at [nhansen@umd.edu](mailto:nhansen@umd.edu).**