XIII...Simple Harmonic Oscillation (Part 2)

Introduction:

As you will quickly notice, although the mirror sensor card has no pendular motion, it does oscillate from side to side. This motion can be studied by the students to learn about torsional oscillation in the horizontal plane, as opposed to the pendular oscillation in the vertical plane.

Procedure:

There are two components to the motion, its oscillation period and its amplitude.

Oscillation Amplitude:

1) Construct a table with one column giving the swing number and the second column giving the maximum distance of the swing.

2) Set the magnet into a smooth oscillation mode in the horizontal plane, but with little vertical pendular motion. This makes the measurement process easier.

3) Have the students measure how far the light spot moves from the 'zero' position at the maximum of each swing. Just record the distance. Don't try to do the differencing in your head to get the actual deflection distance.

4) From the table, construct a third column that gives the difference between the 'zero' location and the location of the spot at its maximum.

5) Plot the amplitudes against the cycle number to show a declining curve.

Materials:

1) The Magnetometer

Extension Activity:

Change the type of string or thread being used to suspend the magnet in the magnetometer and repeat this experiment for each one.

Change the size of the card that the magnet is attached to.

Question:

1) How many oscillations elapse before the mirror stops moving?

2) Which factor makes the biggest difference in the number of cycles or time it takes the motion to stop...the nature of the string or the **area** of the card? Each of these changes the friction that causes the swings to change.

3) What would happen if you filled the magnetometer with water, covering the magnet completely? (use a plastic card not paper to test this!)

Example:

The magnet was set to swing, and a measurement of the spot on the wall was made each time it reached its maximum left-side excursion from the null position. The null position was at 235 centimeters. The distance from the magnetometer to the wall was 5 meters. Two trials were conducted, each consisting of 22 cycles. Because the spot diameter was 5 centimeters, the following numbers were rounded by eye to the nearest 5 centimeter mark. Compute only the absolute value of the amplitude. Its direction (positive or negative with respect to the 'zero' position) is not needed.

Data Table

Cycle	Trial 1	Trial 2
1	145	155
2	150	160
3	165	170
4	170	175
5	180	185
6	185	185
7	190	195
8	195	200
9	200	205
10	200	205
11	210	210
12	210	210
13	215	215
14	215	215
15	220	215
16	220	220
17	220	225
18	225	225
19	225	230
20	225	230
21	230	230
22	230	230

Calculated Amplitudes

Cycle	Trial 1	Trial 2
1	90	80
2	85	75
3	70	65
4	65	60
5	55	50
6	50	50
7	45	45
8	40	35
9	35	30
10	35	30
11	25	25
12	25	25
13	20	20
14	20	20
15	15	20
16	15	15
17	15	10
18	10	10
19	10	5
20	10	5
21	5	5
22	5	5

The results of the two trials in Table 2 can be plotted against the cycle number to measure the amplitude decay, and to show the classic curve of a decaying system.

Because, in the physics of decay, the curve followed is often an exponential one, we can measure its 'half-life' by finding the cycle number where the amplitude was half of its starting amplitude. In Trial 1, this happened in Cycle 7. Since from the previous Lesson we know that each cycle period is 3.0 seconds, the half life for this magnet oscillator is 3.0 x 7 = 21.0 seconds. As with radioactive systems, if we wait another 'half life' to Cycle 14, the amplitude should have fallen by another factor of two. This is very nearly the actual case.