



1
00:00:10,710 --> 00:00:14,370
So here we have a simple
harmonic oscillator.

2
00:00:14,370 --> 00:00:17,380
I've got this long
spring, and I've held it

3
00:00:17,380 --> 00:00:20,830
between with two clips
between hand rails.

4
00:00:20,830 --> 00:00:26,100
And I've got my knitting needle
here that's just a marker.

5
00:00:26,100 --> 00:00:28,090
And I've got a little
timer that you can see

6
00:00:28,090 --> 00:00:31,250
and then here's a length scale.

7
00:00:31,250 --> 00:00:33,950
And I've got a nut on there.

8
00:00:33,950 --> 00:00:37,610
That's a $\frac{3}{8}$ 16 nut.

9
00:00:37,610 --> 00:00:40,110
I'm going to give this
a small displacement,

10
00:00:40,110 --> 00:00:43,110
and we can watch it oscillate.

11
00:00:43,110 --> 00:00:46,440
So the oscillation is going
to be related to the mass

12

00:00:46,440 --> 00:00:50,800

that I have there, so this is
weighing the nut so to speak.

13

00:00:50,800 --> 00:00:54,190

We're determining the
mass of the nut based

14

00:00:54,190 --> 00:00:57,170

on oscillation period.

15

00:00:57,170 --> 00:01:00,070

The period for this one
I measured at the period

16

00:01:00,070 --> 00:01:05,540

for 20 oscillations, complete
cycles, is 21.26 seconds.

17

00:01:05,540 --> 00:01:08,010

And it's incredibly repeatable.

18

00:01:08,010 --> 00:01:11,920

And now we're going to put
a different nut on here.

19

00:01:11,920 --> 00:01:16,090

This is a 10/32 nut.

20

00:01:16,090 --> 00:01:17,260

Look at that.

21

00:01:17,260 --> 00:01:18,980

It's oscillating at
a higher frequency.

22

00:01:18,980 --> 00:01:22,230

This nut does not have as much

mass, and it's oscillating

23

00:01:22,230 --> 00:01:23,300
at a higher frequency.

24

00:01:23,300 --> 00:01:25,820
The period for this I measured

25

00:01:25,820 --> 00:01:30,370
as 10.7 seconds for
20 oscillations.

26

00:01:31,760 --> 00:01:34,840
Okay, here's a quarter 20 nut.

27

00:01:34,840 --> 00:01:41,850
I counted for 20 oscillations
on this I counted 14.2 seconds.

28

00:01:41,850 --> 00:01:44,530
Now, this is a pendulum.

29

00:01:44,530 --> 00:01:48,710
And of course a pendulum
doesn't work in weightlessness.

30

00:01:48,710 --> 00:01:50,930
This is just the end of
the pendulum right here.

31

00:01:50,930 --> 00:01:53,650
I've got an 84 gram
mass and I'm using Legos

32

00:01:53,650 --> 00:01:55,610
as the pendulum stick.

33

00:01:55,610 --> 00:01:57,050
And of course it just...

34

00:01:57,050 --> 00:01:58,440
pendulum requires gravity.

35

00:01:58,440 --> 00:02:00,160
It's a gravity machine.

36

00:02:00,160 --> 00:02:01,350
And it just doesn't work.

37

00:02:01,350 --> 00:02:04,080
It just sits there.

38

00:02:04,080 --> 00:02:09,190
Now, I'm going to do a little
modification to this pendulum.

39

00:02:09,190 --> 00:02:13,630
I've got a long, weak
spring right here.

40

00:02:13,630 --> 00:02:17,230
And if I put the spring
on here like that.

41

00:02:17,230 --> 00:02:20,100
Now, for small angle
displacement,

42

00:02:20,100 --> 00:02:23,950
this spring will exert
a constant force.

43

00:02:23,950 --> 00:02:28,260
And it's a small force because
it's a long, weak spring.

44

00:02:28,260 --> 00:02:29,810
It's almost a meter long.

45

00:02:29,810 --> 00:02:32,270

So first it's going to appear like gravity.

46

00:02:32,270 --> 00:02:37,260

So this pendulum now is going to swing and behave just

47

00:02:37,260 --> 00:02:39,750

like a pendulum on Earth where instead

48

00:02:39,750 --> 00:02:44,100

of gravity we're using the force in this spring.

49

00:02:44,100 --> 00:02:47,370

And I'm also going to change the length of the pendulum and show

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00:02:47,370 --> 00:02:50,420

if that is what varies the period, is the length

51

00:02:50,420 --> 00:02:52,980

of the pendulum not the mass.

52

00:02:52,980 --> 00:02:56,320

So the pendulum is five inches longer than before,

53

00:02:56,320 --> 00:02:58,590

and it's swinging slower.

54

00:02:58,590 --> 00:03:00,950

Here's the pendulum in its shortest configuration

55

00:03:00,950 --> 00:03:04,770
and it's got three Lego lengths.

56

00:03:04,770 --> 00:03:09,840

Now I'm going to
double the mass.

57

00:03:09,840 --> 00:03:17,760

So now we have a 168 gram mass
instead of an 84 gram mass,

58

00:03:17,760 --> 00:03:20,890

and it turns out something
interesting is going on.

59

00:03:20,890 --> 00:03:27,020

Because when I measured the
period I got about 7.9 seconds

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00:03:27,020 --> 00:03:31,450

for the period at three
lengths with a 168 gram mass,

61

00:03:31,450 --> 00:03:37,480

but when I only had the 84
gram mass it was more like 5.8.

62

00:03:37,480 --> 00:03:39,200

So something interesting
is going on.

63

00:03:39,200 --> 00:03:42,020

There is a dependency on
the mass on this pendulum,

64

00:03:42,020 --> 00:03:47,610

so perhaps the spring does not
exactly replace gravitational

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00:03:47,610 --> 00:03:50,490

force, and it's behaving
a little bit

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00:03:50,490 --> 00:03:52,990

like a simple harmonic
oscillator.

67

00:03:52,990 --> 00:03:54,200

So it will be interesting

68

00:03:54,200 --> 00:03:56,750

to see whether maybe this
is a combination of both

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00:03:56,750 --> 00:04:00,480

of simple harmonic oscillator,
which is mass dependent,

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00:04:00,480 --> 00:04:03,390

and a pendulum, which
is mass independent

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00:04:03,390 --> 00:04:05,220

but length dependent.

72

00:04:05,220 --> 00:04:08,900

And of course this is all
Freshman level physics,