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2. Find the period of oscillation of a simple pendulum

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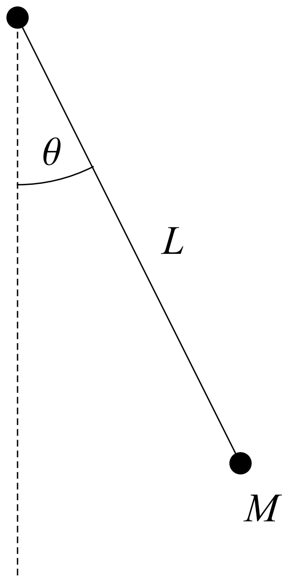
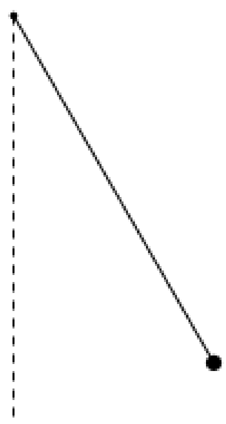
In this page, we will use dimensional analysis to find the frequency of oscillation of a pendulum.

We think of this pendulum as a small mass M hanging at the end of a massless string of length L with one end fixed to a vertical point. The angle θ describes how far to the right the pendulum hangs off of vertical.



We move the pendulum by a small angle θ off of the vertical stable equilibrium at the bottom and release it. The pendulum moves through an arc of a circle, back and forth.



We are interested in figuring out the period of this oscillation. What do we mean by the period of the pendulum? Try to figure it out and answer the poll question below. (You may look it up or use any resources.) You can read our answer below.

POLL

What do we mean by the period of the pendulum?

- ◯ **Number of full oscillations in one time unit.**
- ◯ **The time required for a complete cycle of motion.**
- ◯ **One over the time required for a complete cycle of motion.**
- ◯ **Total angle swept out by one complete cycle of motion.**
- ◯ **None of the above**

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What is the period?

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The period of the pendulum is the time required for a complete cycle of motion. For example, the time from the point of release to the point where it returns back to that point.

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Find the dimension of the period

1.0/1 point (graded)
What is the dimension of the period P of the pendulum?

(Type `T` for the dimension time, `M` for mass, `L` for length.)

$[P] =$ T ✔ **Answer:** T

Solution:

The period has dimension of time T.

Submit You have used 1 of 3 attempts

Answers are displayed within the problem

Find a formula

3/3 points (graded)
We might assume that the period of the pendulum depends in some way on the length of the string L, the mass at the end of the string M, and the acceleration due to gravity g.

Find numbers k_1, k_2, and k_3 so that the expression $L^{k_1} M^{k_2} g^{k_3}$ has the same dimension as the period P of the pendulum.

$k_1 =$ 1/2 ✔ **Answer:** 1/2

$k_2 =$ 0 ✔ **Answer:** 0

$k_3 =$ -1/2 ✔ **Answer:** -1/2

Solution:

To find k_1, k_2 and k_3 we balance the dimensions on both sides of the equation. We found above that P has dimension of time T.

Therefore we want to determine $L^{k_1} M^{k_2} g^{k_3}$ so that it also has dimension of time T. First we note that the only way to have a dimension of time is to have g which has dimension L/T^2. Therefore to get a unit of T we take $k_3 = -1/2$. Once we have k_3, we need to get rid of the unit of $L^{-1/2}$ introduced. We do that by setting $k_1 = 1/2$. The dimension of mass does not appear on the left and is not in our expression involving L and g, thus we must set $k_2 = 0$.

The expression $L^{1/2} M^0 g^{-1/2}$ has the same dimension as the period of the pendulum.

What you've actually found is that the period of the pendulum is a constant number times $\sqrt{L/g}$. It doesn't depend on the mass of the pendulum at all! If you are interested, you can try applying some physics or do some experiments to determine what this constant is! (Hint: it is a multiple of π.)

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Answers are displayed within the problem

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Topic: Unit 1: Functions of two variables / 2. Find the period of oscillation of a simple pendulum

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Find a formula - multiplicative constants with dimension
I was able to get to the answer to the question just by doing the arithmetic. But in 3.10 Variables and units, it was shown that consta... 3

[STAFF] Suggestion on "Find a Formula"
I have not had physics since my junior year in high school in 1965-1966. When I saw "acceleration due to gravity", I (incorrectly) assu... 5

Dimension of the Period
I took Physics (which I am neither fond of, nor good at) almost a decade ago in middle school, and I am wondering if this dimension ... 3

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