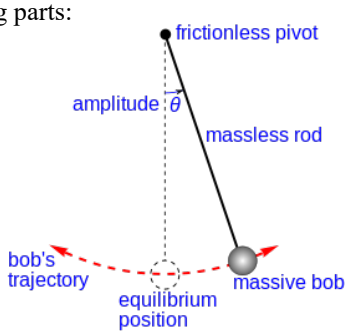
6.4 - Simple Pendulum Systems

The path of a complex pendulum.

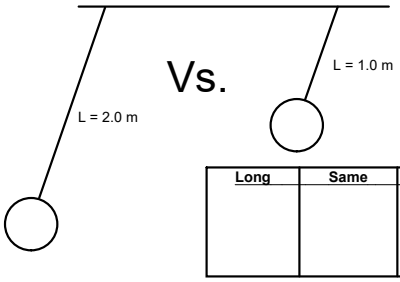
1. Pendulum Dissection

Pendulums (Plural = pendula) are contraptions with the following parts:



Physics Democracy!

2. Which pendulum system will have a shorter period (T), one with a short arm or one with a long arm? Explain why you voted how you did.



Long	Same	Short

Pendulum Fight!

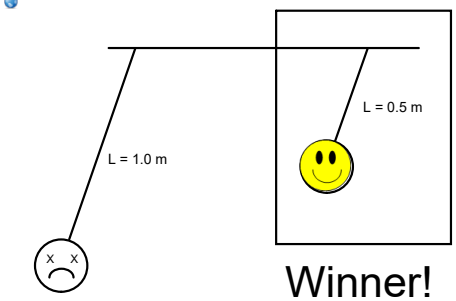
Ceiling Demo.

Physics Democracy Ballot			
2. Length	Long	Same	Short
3. Mass	Large	Same	Small
4. Angle	5°	Same	10°

Democracy Results

The one with a short arm has a shorter period.

https://www.youtube.com/watch?v=yVkdfJ9PkRQ

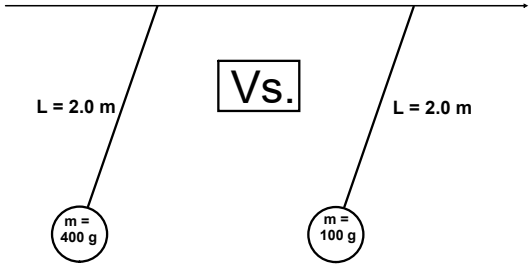


Winner!

Another Physics Democracy!

3. Which pendulum has a greater period (T), one with a large mass or a small mass? Same amplitude and length.

Large	Same	Small



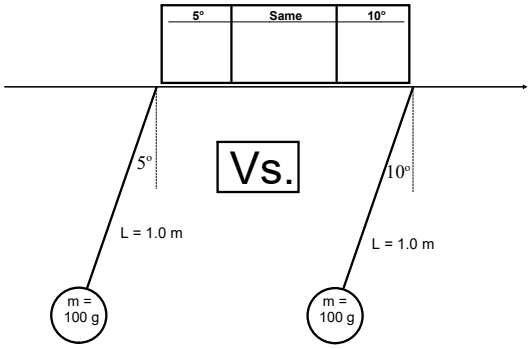
Democracy 2's Answer:

They're the same!

Gravity is the restoring force of this type of system, and it provides 9.81 m/s^2 acceleration to any mass.

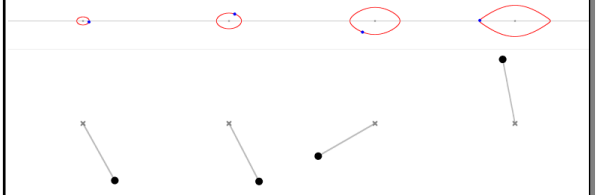
One More Ballot!

4. Which pendulum has a greater period (T), one pulled back 5° or one pulled back 10°? Same length.



Period of a Pendulum

At small swings (< 10°), the period of a pendulum is independent of amplitude.
At larger swings, however, that's not the case:



Graph represents velocity (y-axis) vs. position (x-axis).

Period of a Pendulum

A pendulum's period (T_p) (on Earth, in seconds) is:

AP Equation $T_p = 2\pi\sqrt{\frac{l}{g}}$	l = Length (m) g = 9.81 m/s^2)

Pendulum Examples:

5. What is the period of a pendulum with a length of 4.3 meters?

Answer: 4.2 seconds.

6. How about the ceiling pendulum? l = 2.64 m
T = 3.3 seconds.

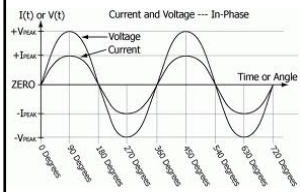
Phase Shifting

This does not entail passing through solid walls.

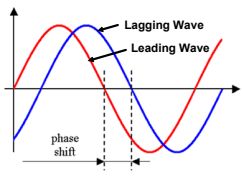
When waves of the <u>same</u> frequency are plotted on the same graph, they may be more or less 'in sync' with each other. The phase shift is the measured offset.

Phase Shifting.

In-phase: (in sync)



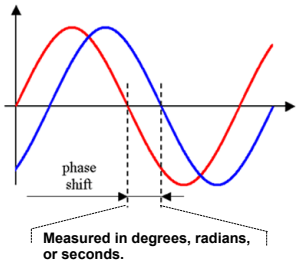
Out-of-phase:



Measuring Phase

Phase shift is measured in degrees, radians, or time units.

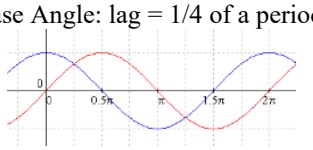
Pendulum demo: time-lag.



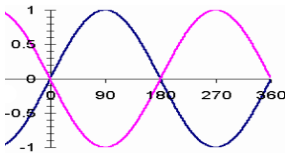
Phase Angles

A complete cycle is 360º (2π radians). I won't go into details of how to compute phase angle, BUT RECOGNIZE THESE COMMON ONES:

7. 90º (π/2 rad) Phase Angle: lag = 1/4 of a period
Pendulum Demo



8. 180º (π rad) Phase Angle: lag = 1/2 of a period
Pendulum Demo



Homework

6.4 Problems
Due: Next Class

Finish Unit 6 Review Problems
Scanned: Tuesday, December 11th

AND: Movie clips Due Tuesday the 11th too!
Presentations Start Friday, 12/14

Rabbit Hole!
Complex Pendulum

https://www.youtube.com/watch?v=U39RMUzCjiU