

Mathematical modeling of a marble Stirling engine

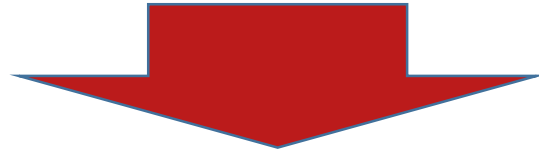
Team 2



- Constant heat supply \rightarrow oscillation
- There are few mathematical models

Motivation and purpose

- Constant heat supply → Oscillation
- There is no model (Not mathematized)



- Explain the oscillation
- Get ideas about how to control the engine



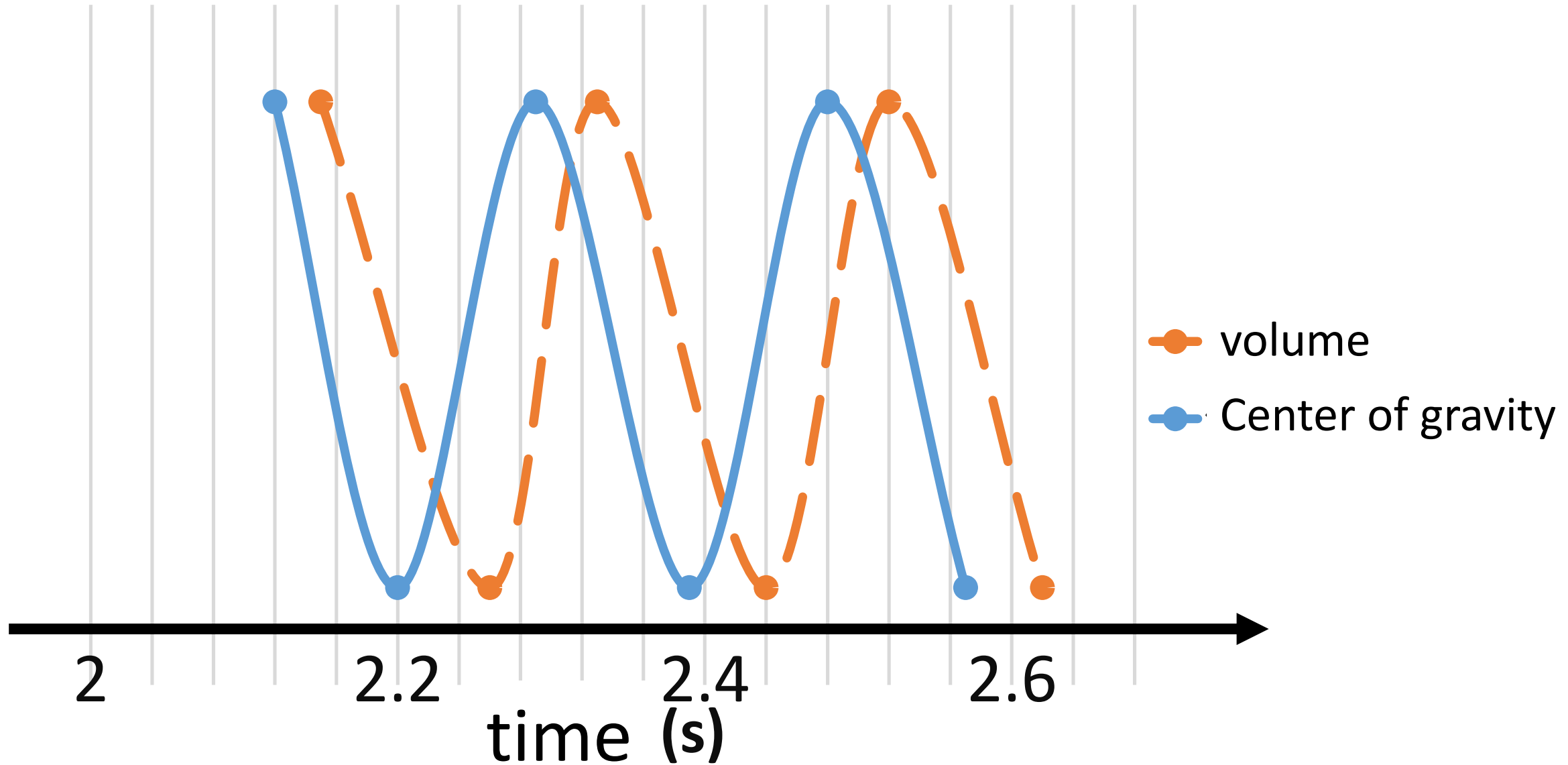
Things found from experiment

Center of gravity and
air volume are related

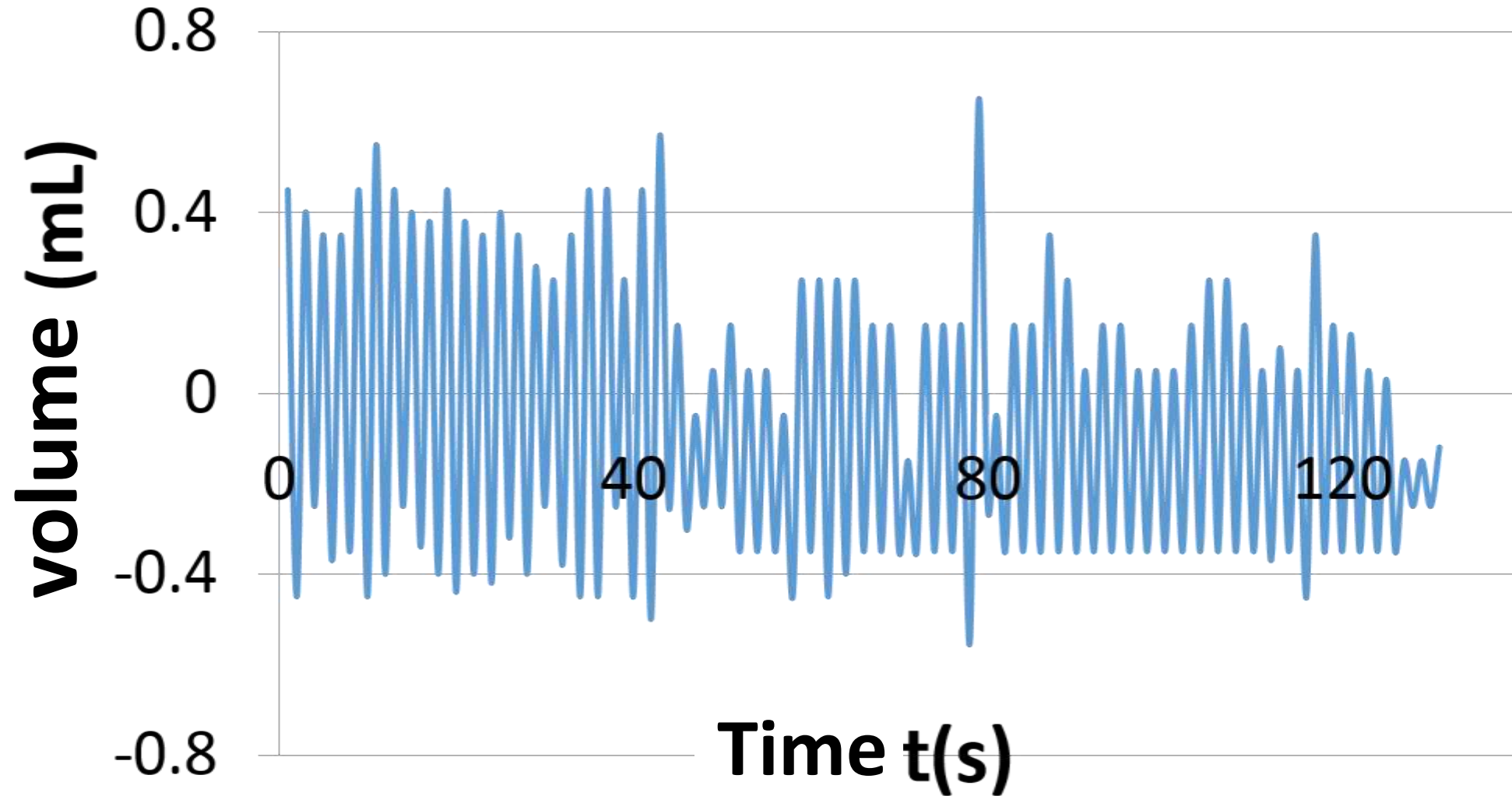


State variables in the mathematical model

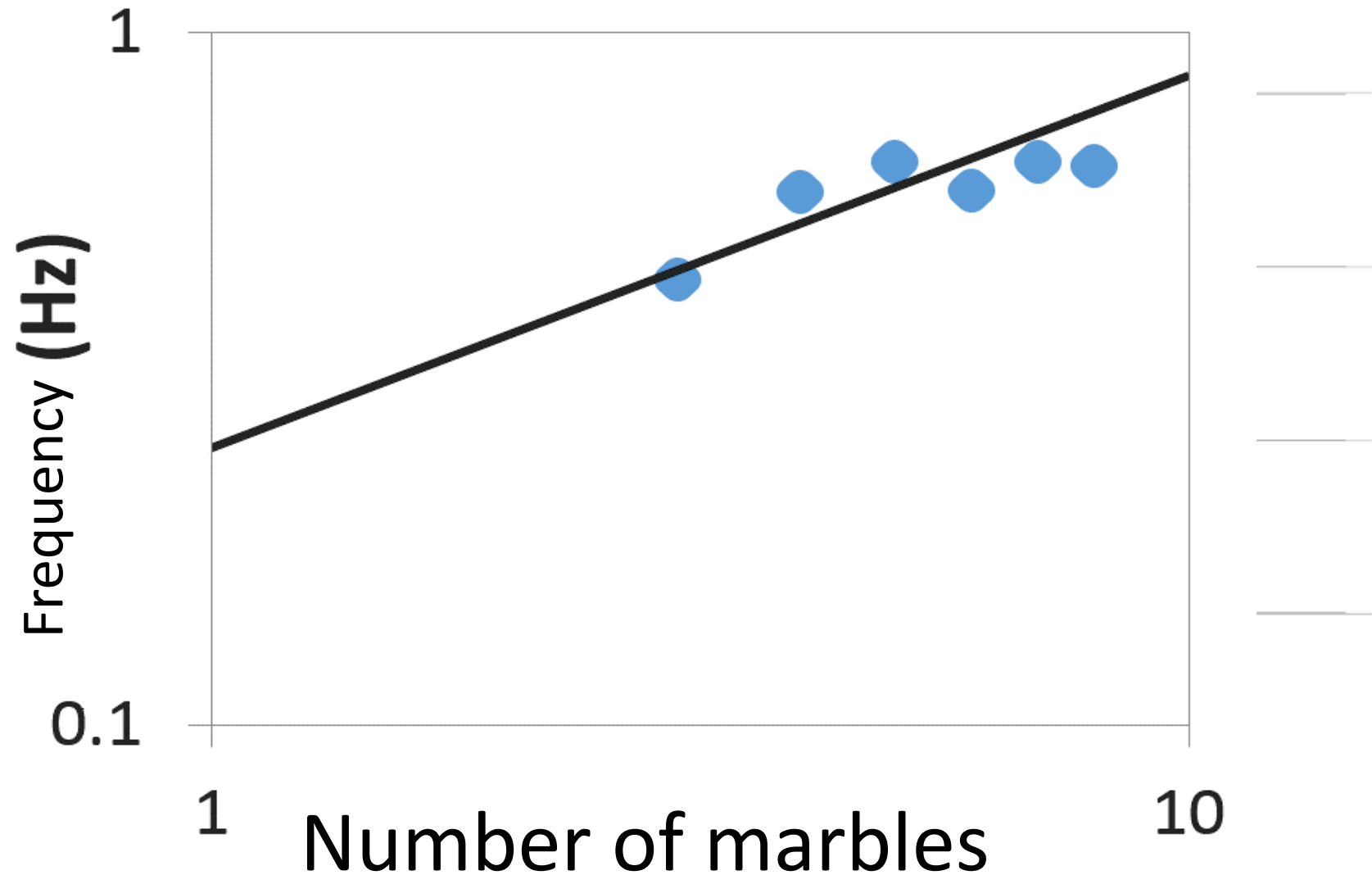
1. The two cycles are out of phase by $\pi/2$



2. Oscillation decays over time

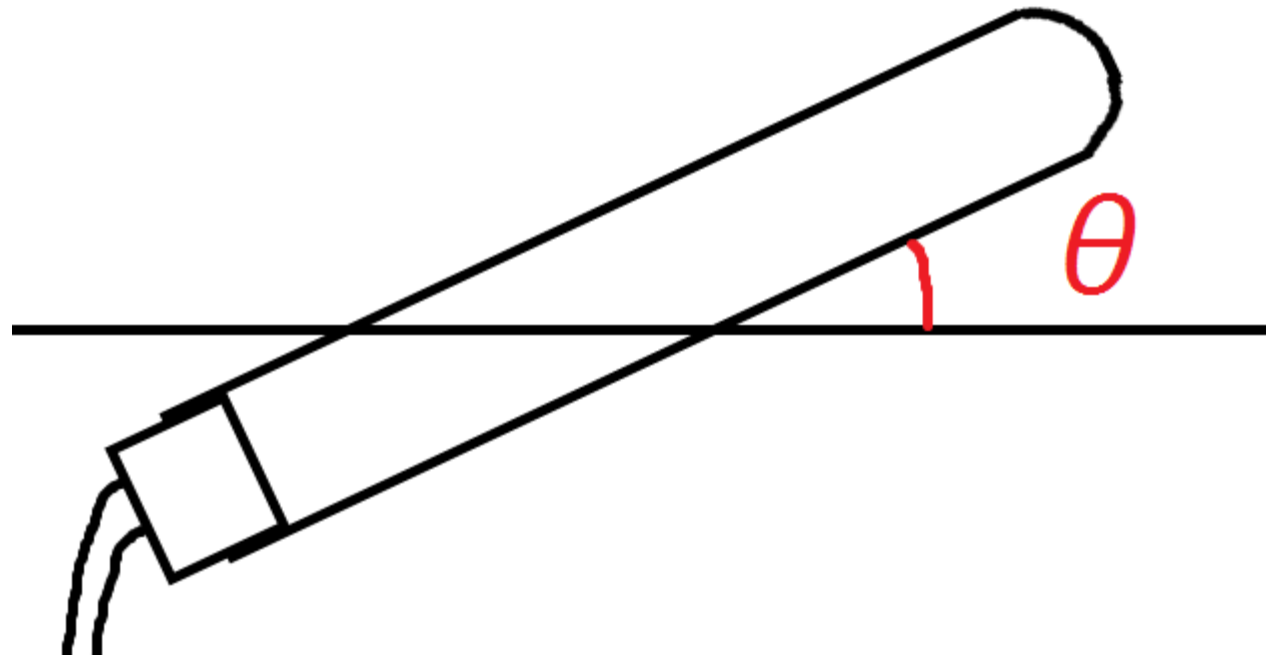


3. Frequency is proportional to the square root of the mass



Modeling

Let the inclination of test tube be θ



- x
- y
- m
- Δt

Modeling

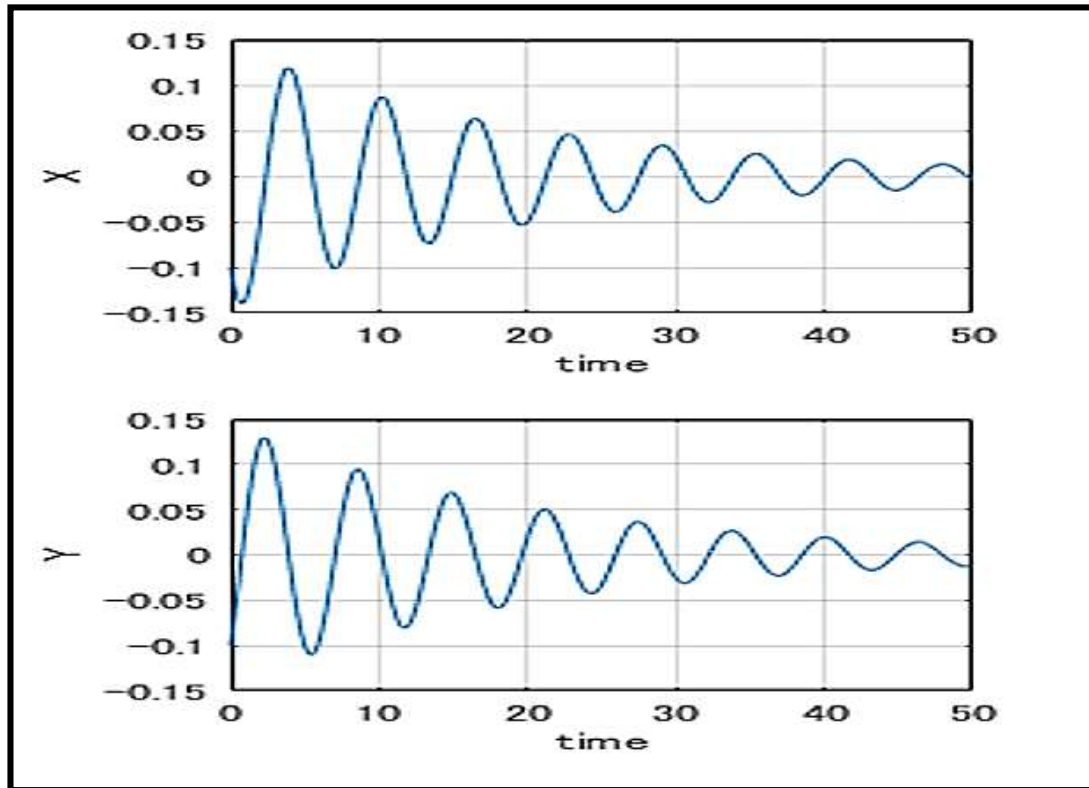
Equations for the model

$$\dot{x} = m\gamma$$

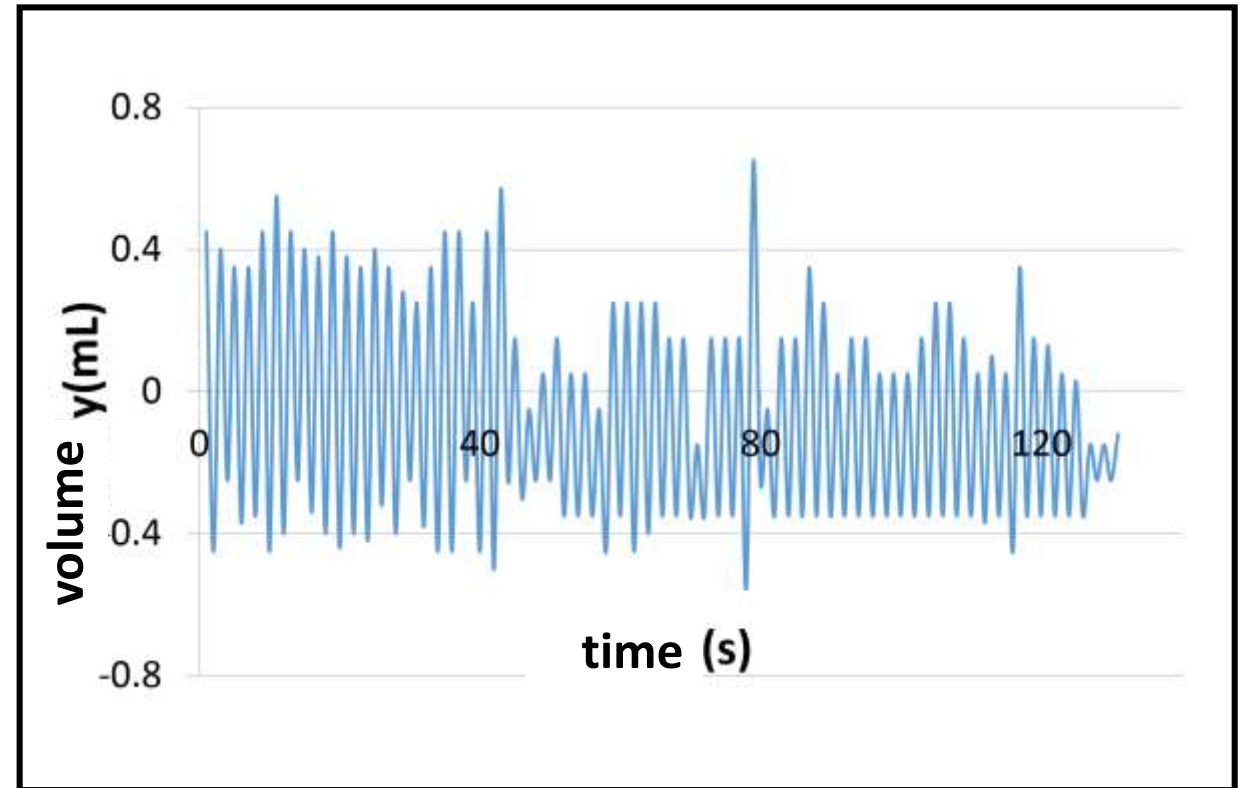
$$c\dot{y} = -\gamma x - \varepsilon y$$

Consideration

calculation



experiment

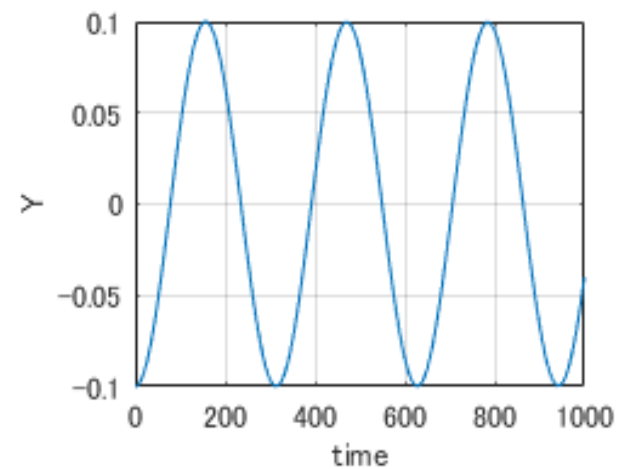
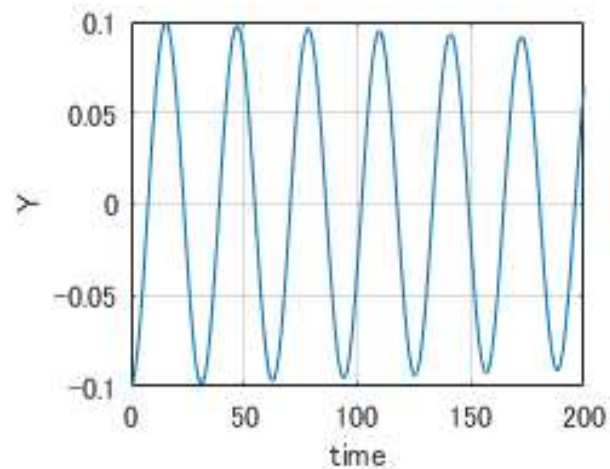
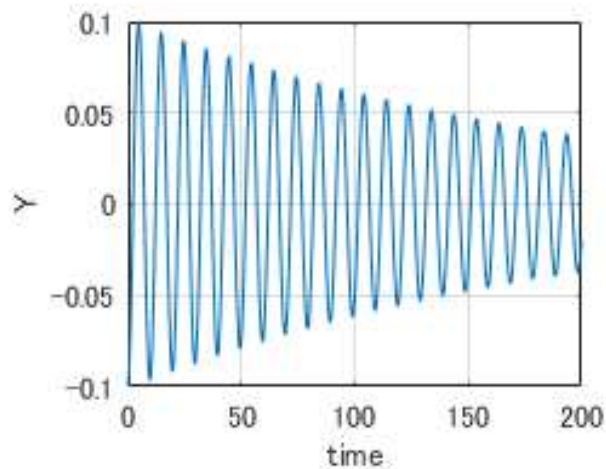
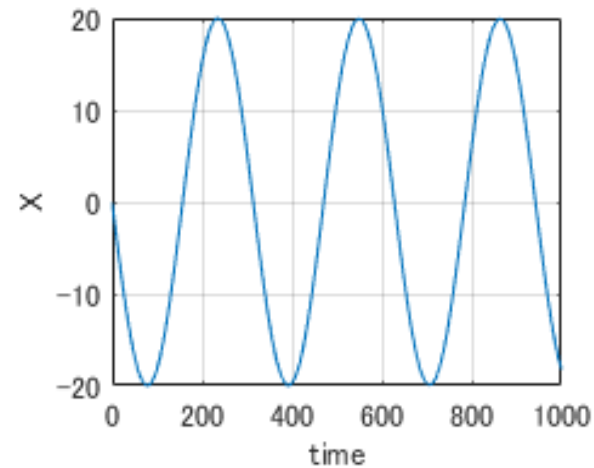
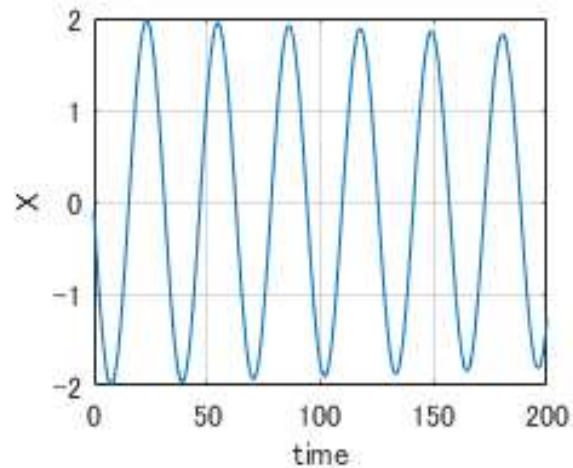
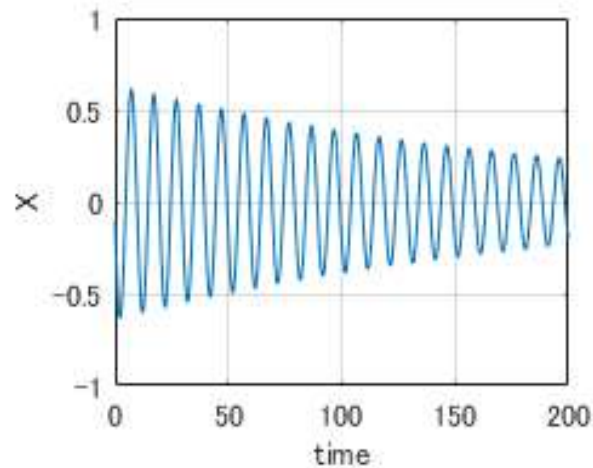


Oscillation is attenuate

Summary

- Variables
 - Center of gravity and volume of airCreated a mathematical model
- Oscillation attenuates
- Oscillation is connected to the number of marbles

$m=4$



Heat capacity

Low



High

Future tasks

- Improve model equations
- Improve the device to keep oscillation active

references

- 1) **Kazuhiro Abiko · Takami Tashiro**
(Report from the Hokkaido Section)
Thermodynamic Study of Marble Stirling Engine
- 2) 『Physics』 (Sukenishuppan)

Special thanks

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