

Weighing Time

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Problem Statement

- It is commonly known that an hourglass changes its weight (as measured by a scale) while flowing. Investigate this phenomenon.

Outline of the Report

**Explanation of the
Phenomenon**

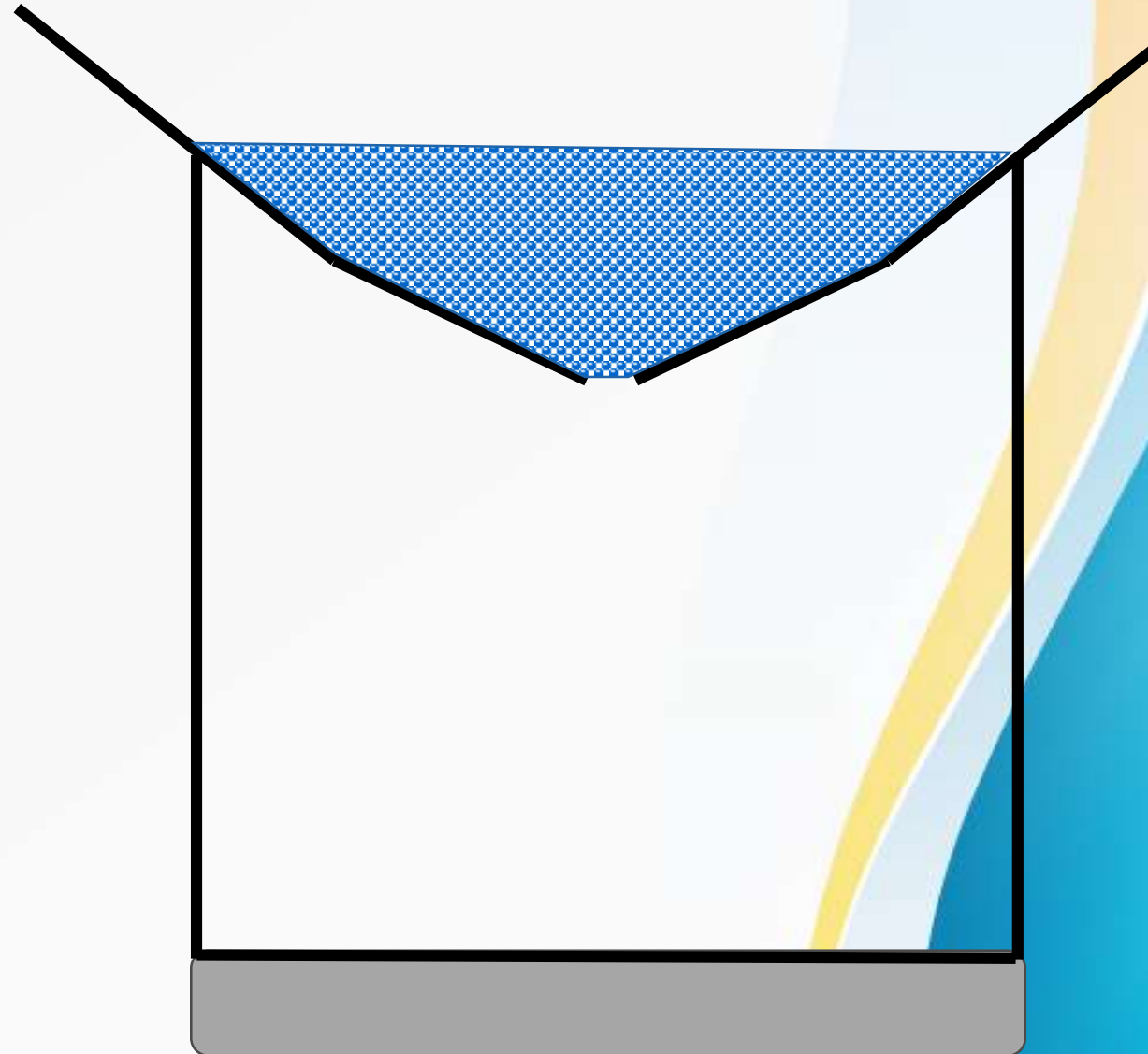
**Preliminary
observations**

Theory

Data

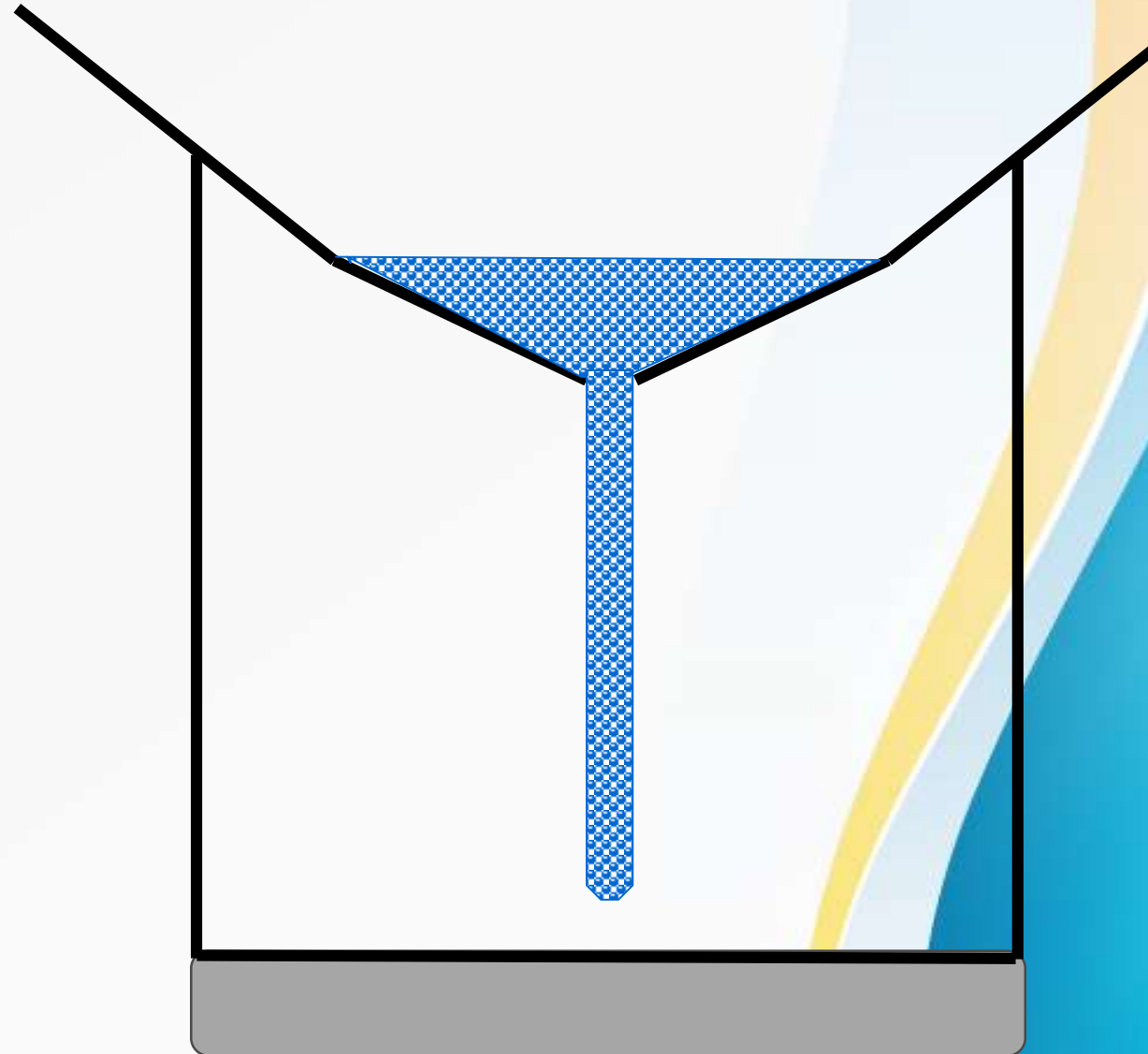
Explanation of the Phenomenon

- When the sand in the hourglass starts flowing it's weight changes.
- This occurs because the particles hit the bottom with the force which gravity exerts on them.



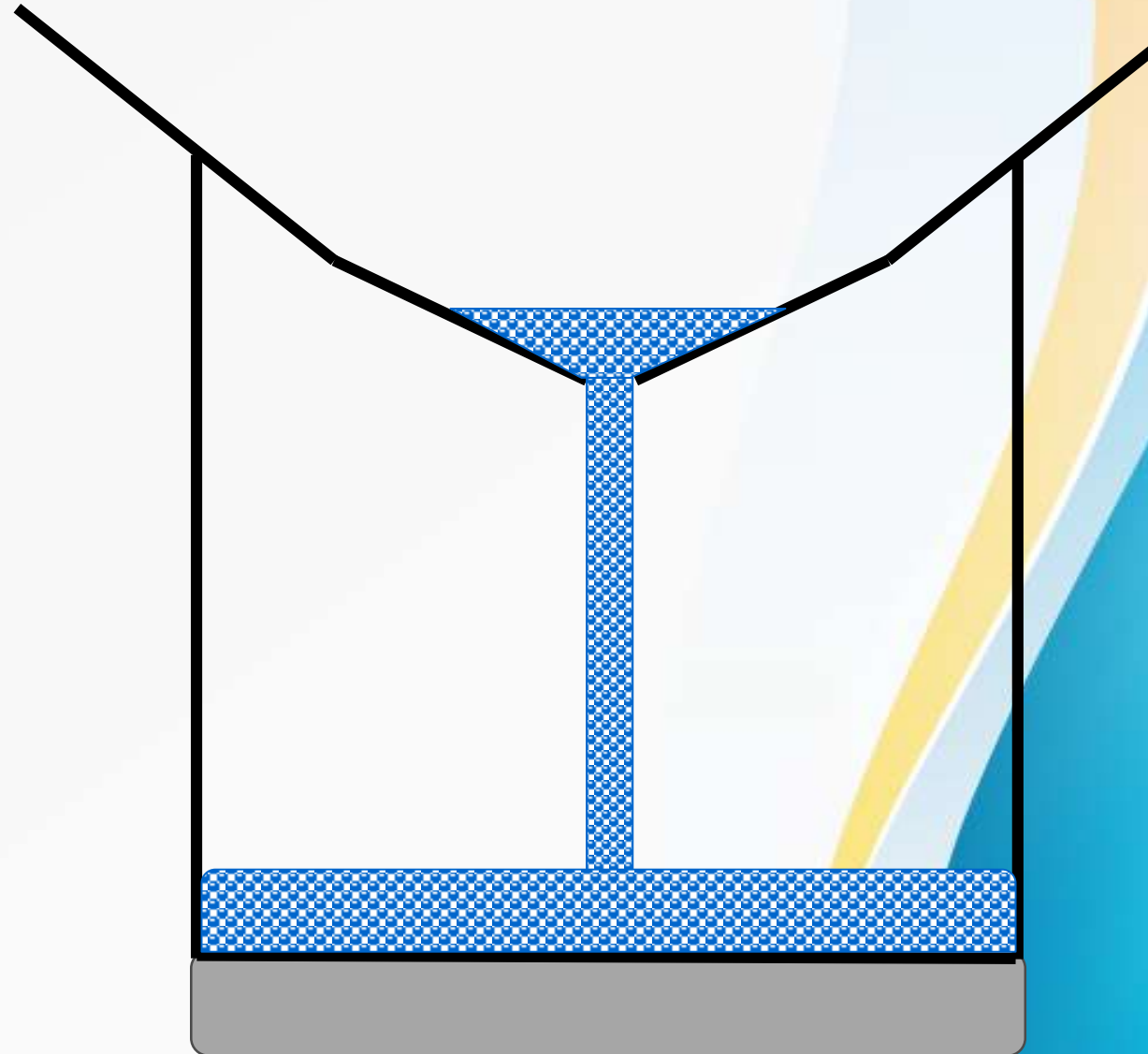
Explanation of the Phenomenon

- When the particles are released and are in the air, they decrease the weight of the hourglass.



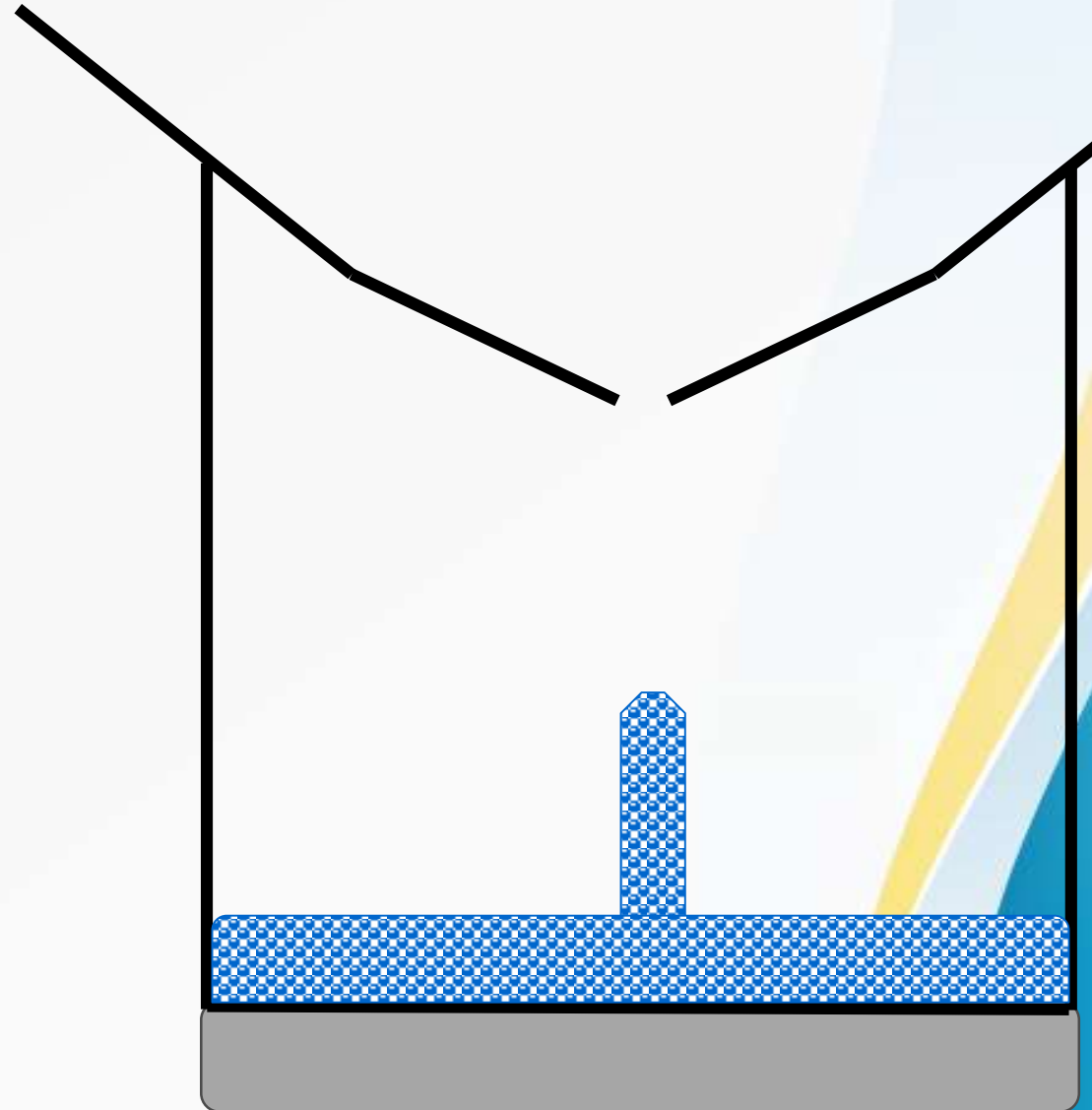
Explanation of the Phenomenon

- After the released particles hit the base they contribute an extra weight to the hourglass due to the kinetic energy they possess.



Explanation of the Phenomenon

- After the particles at the top are empty the amount of the sand in the air starts to decrease but the particles are still exerting the same amount of force.



Preliminary Observations

- The weight change is affected by :
 1. The Height of the falling particles.
 2. The diameter of the opening

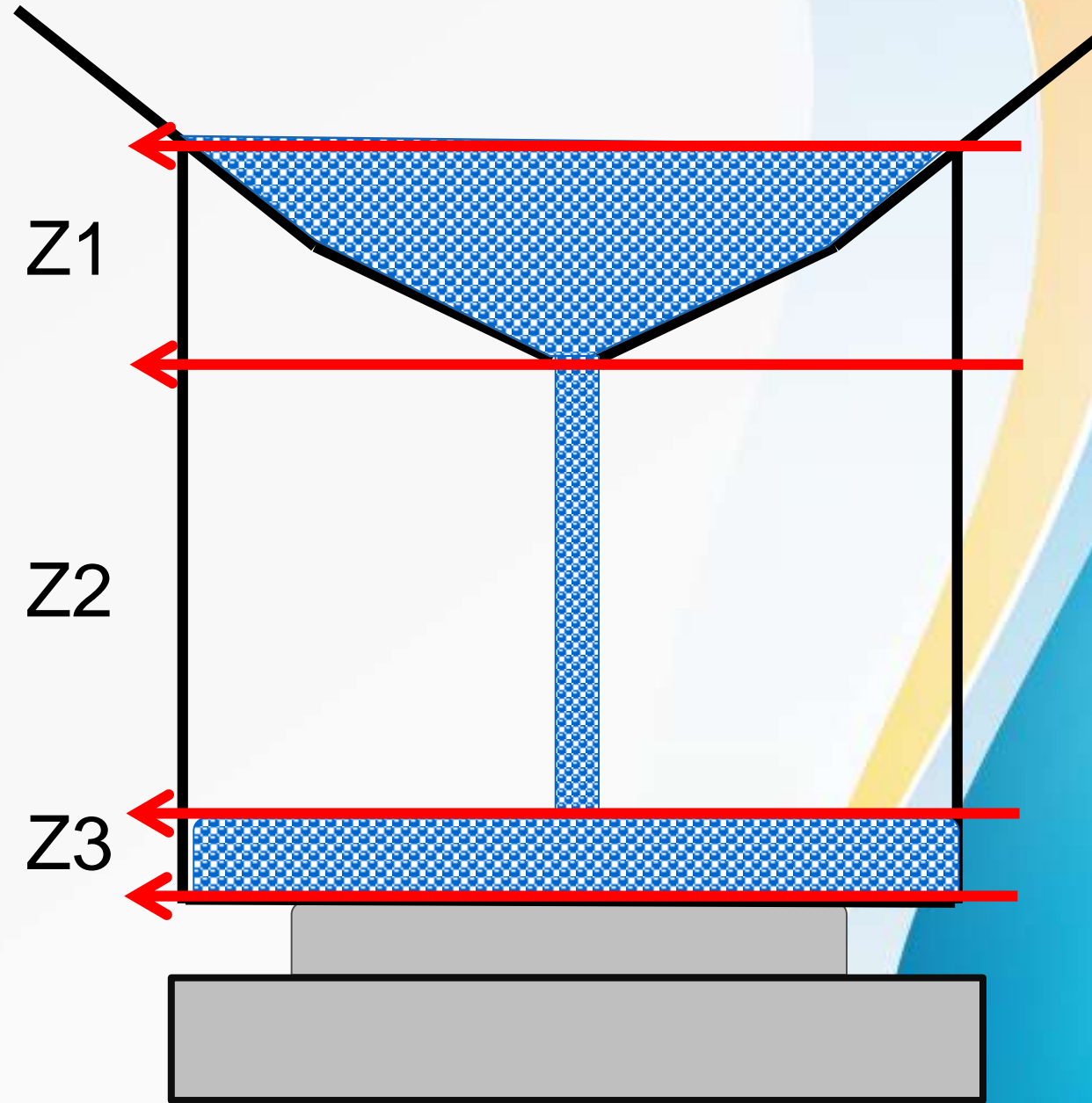
Theory

- Weight machines measure mass by first calculating the weight and then dividing it by the gravitational constant.
- The particles possess potential energy which is then converted kinetic energy which applies downwards force.

Theory

$$Z(t) = \frac{\sum_{i=1}^{III} Z_i(t) m_i(t)}{\sum_{i=1}^{III} m_i(t)}$$

The center of mass
can be calculated
using This Equation

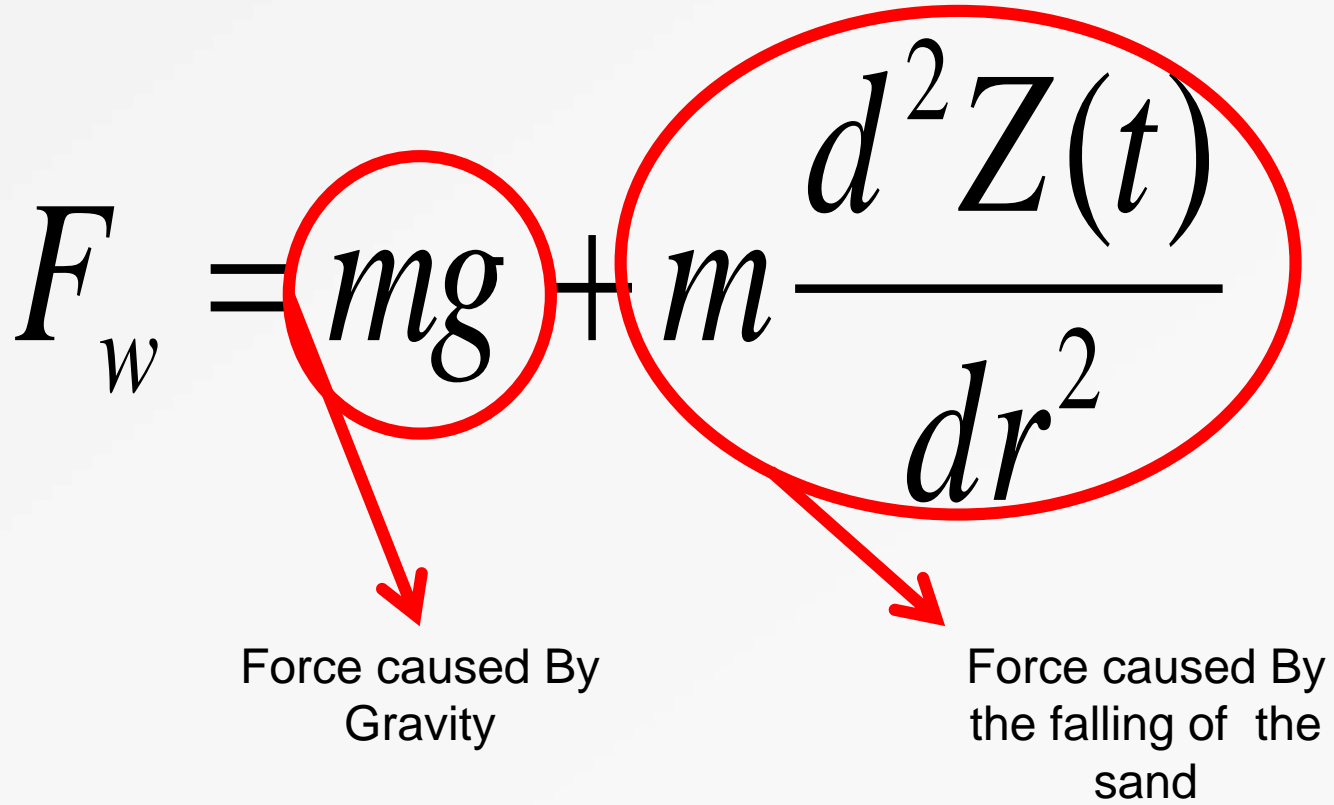


Theory

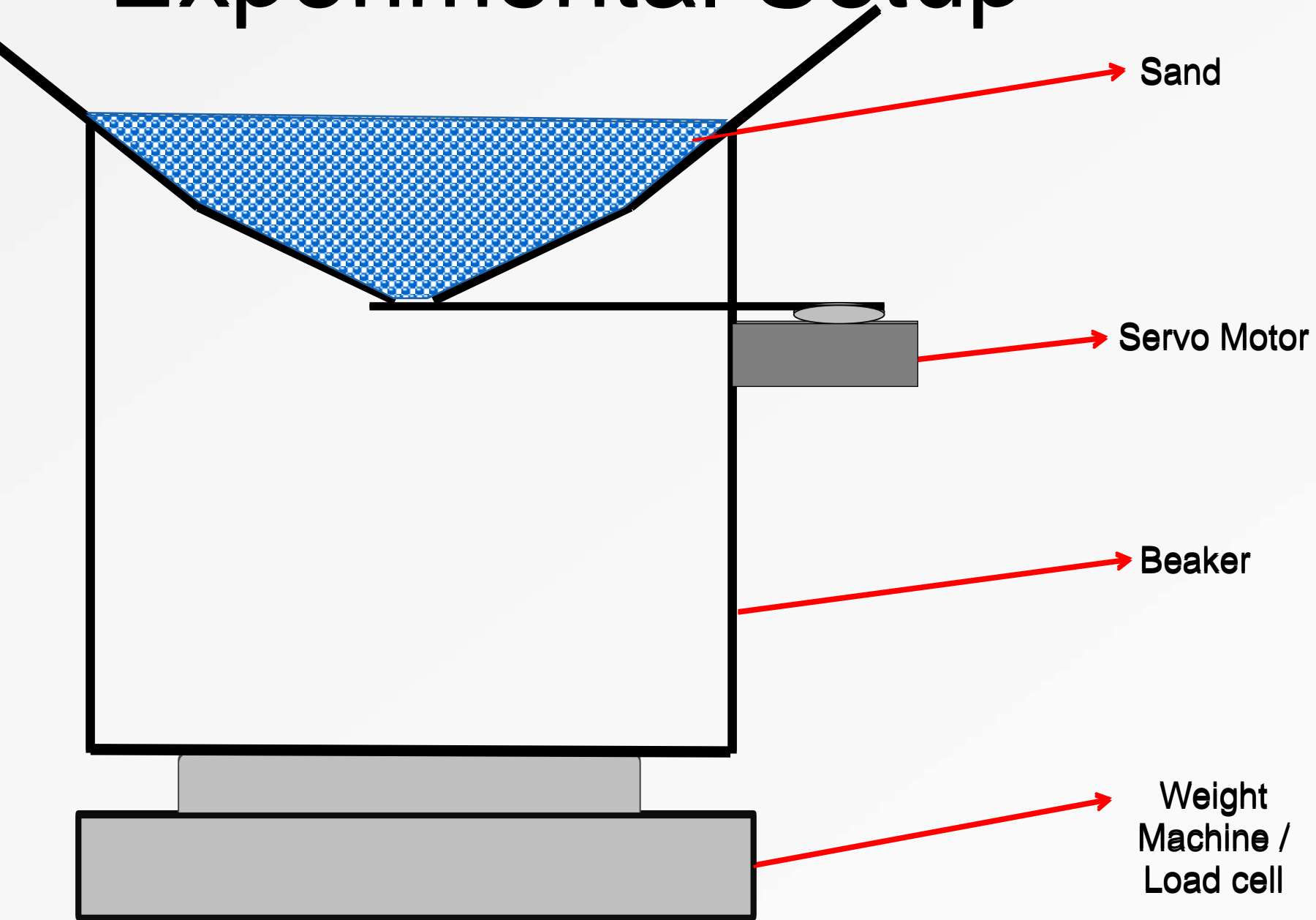
$$F_w = mg + m \frac{d^2 Z(t)}{dr^2}$$

Force caused By Gravity

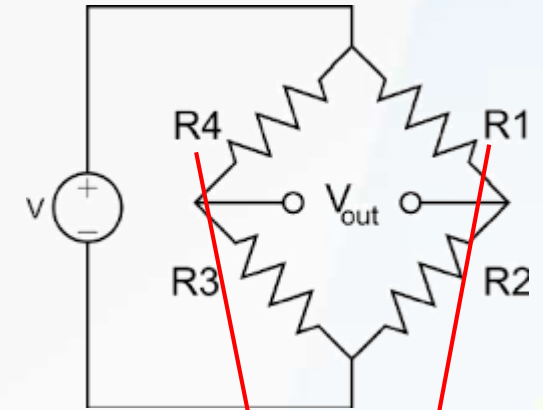
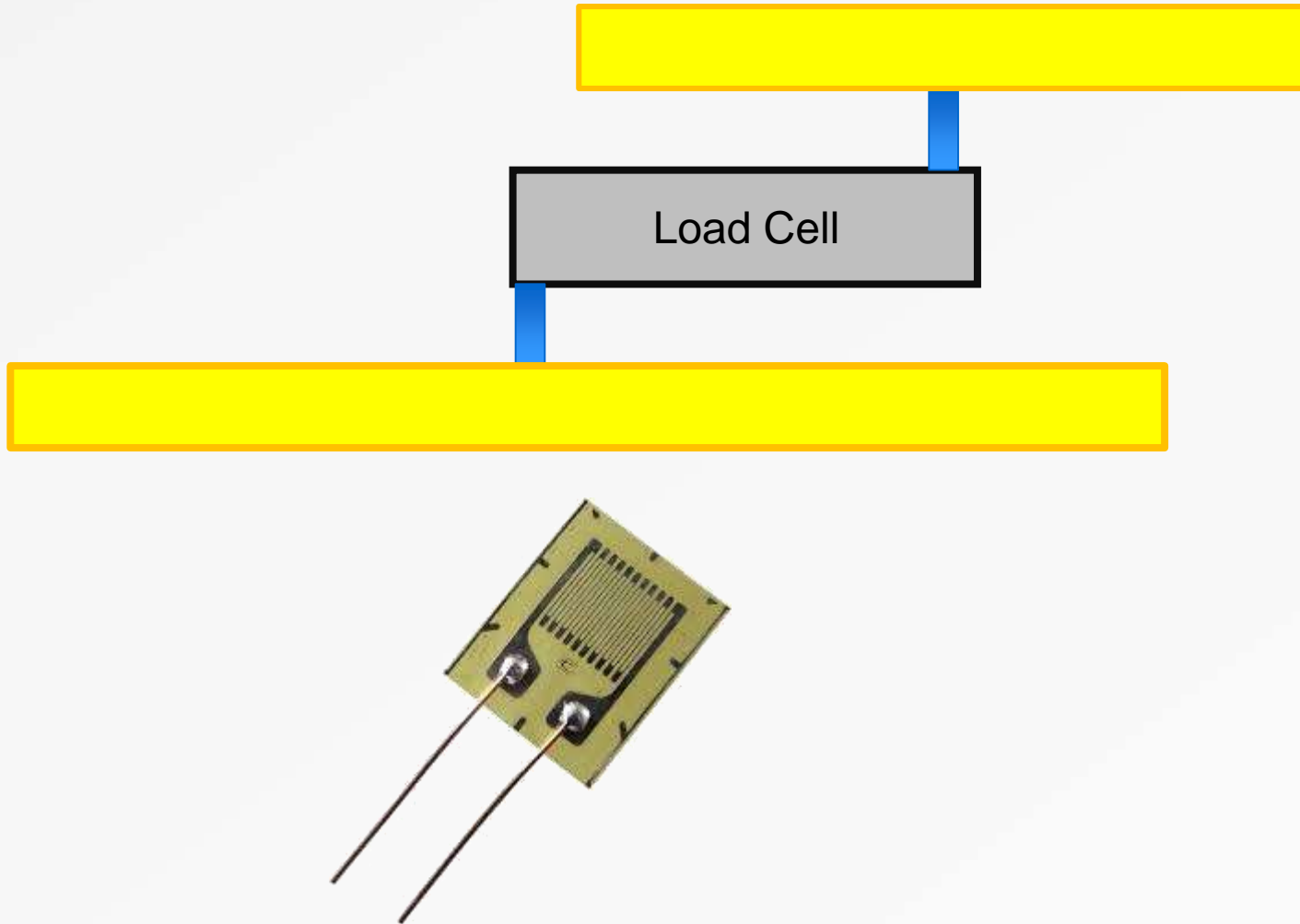
Force caused By the falling of the sand



Experimental Setup

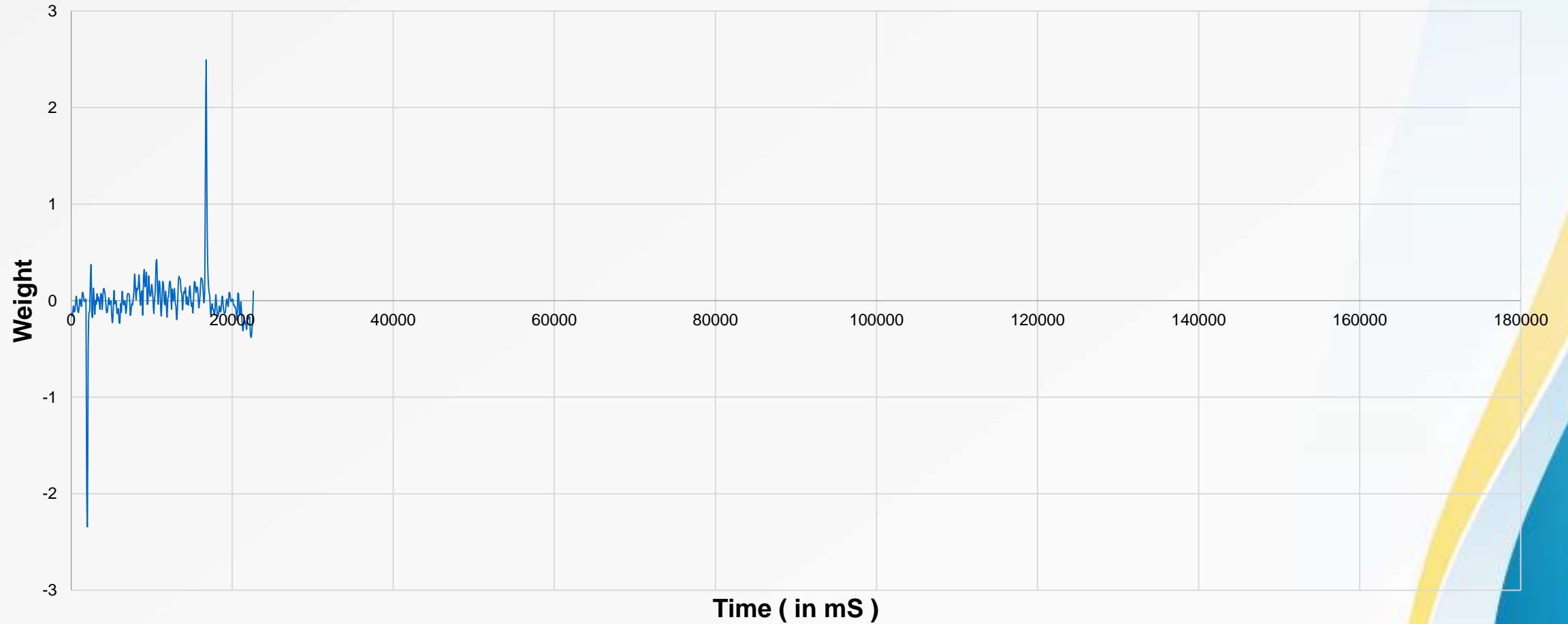


Experimental Setup - Load Cell



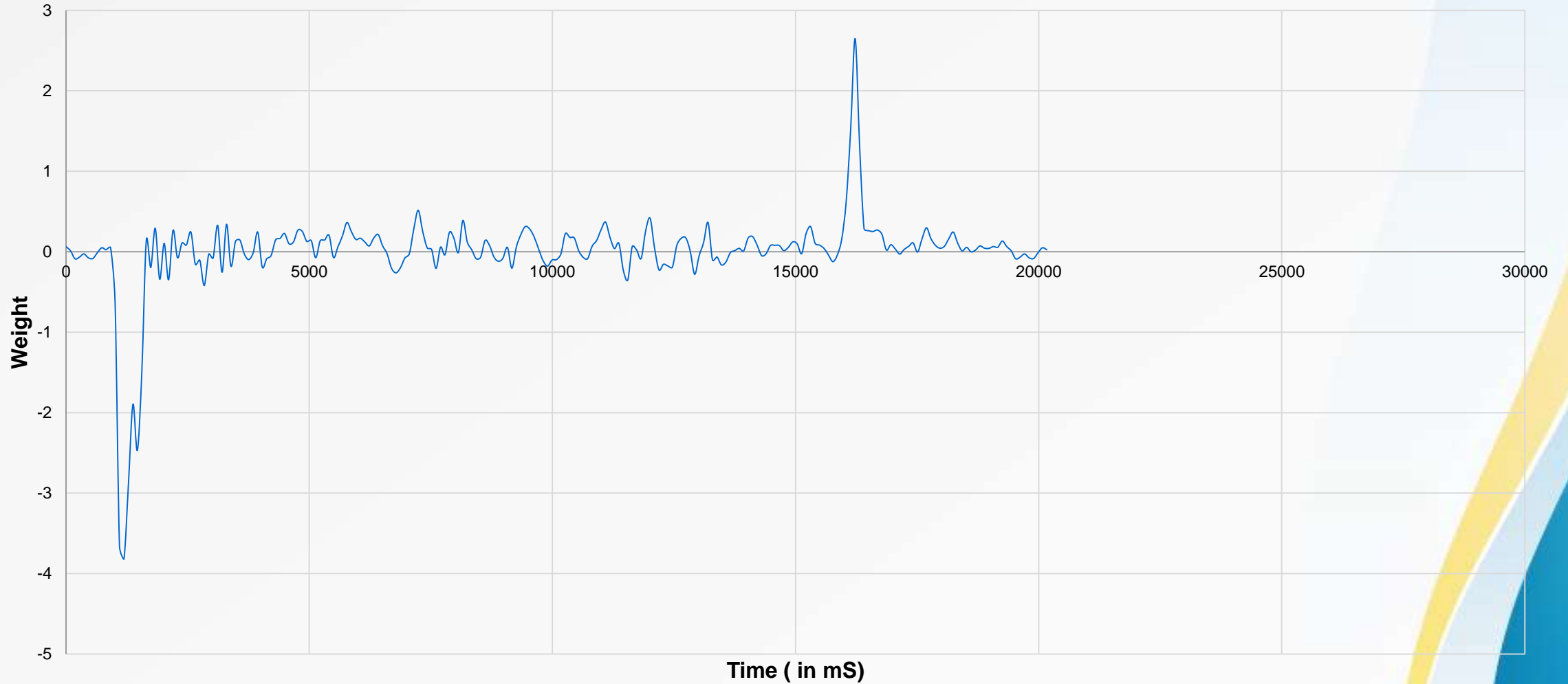
Strain Gauge

Experimental Data - Height



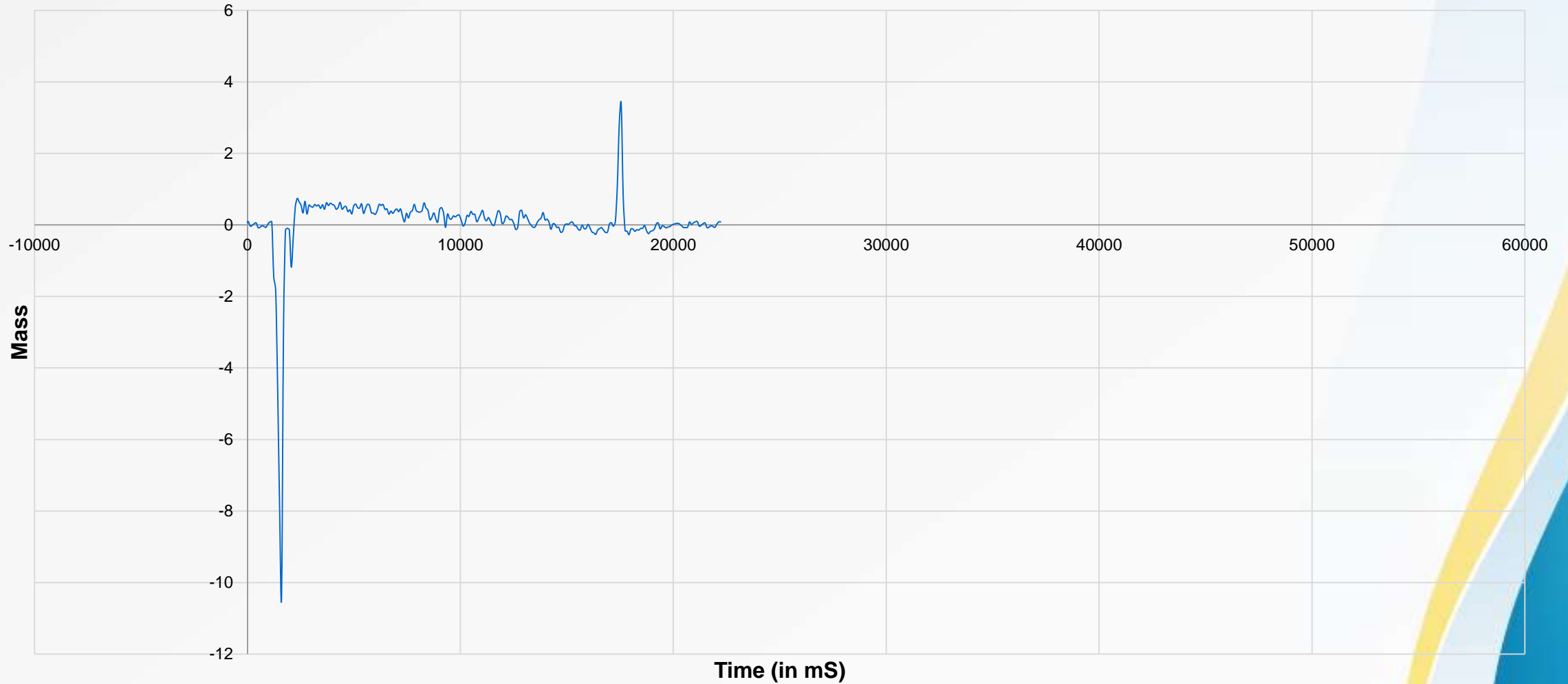
10.25mm opening - 15cm height - 210cm³

Experimental Data - Height



10.25mm opening - 25cm height - 210cm³

Experimental Data - Height



10.25mm opening - 50cm height - 210cm³

Thank You

