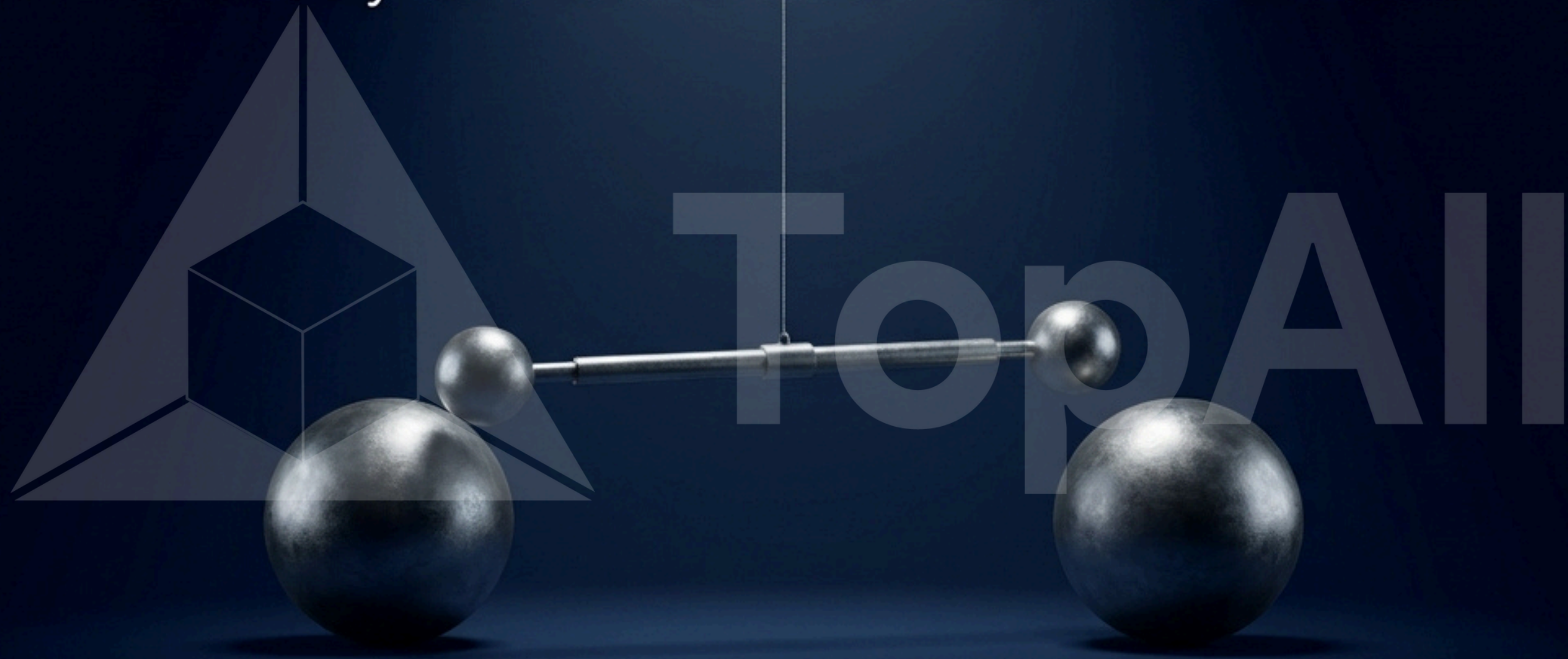


The Gravitational Constant

How Henry Cavendish Measured the Unmeasurable



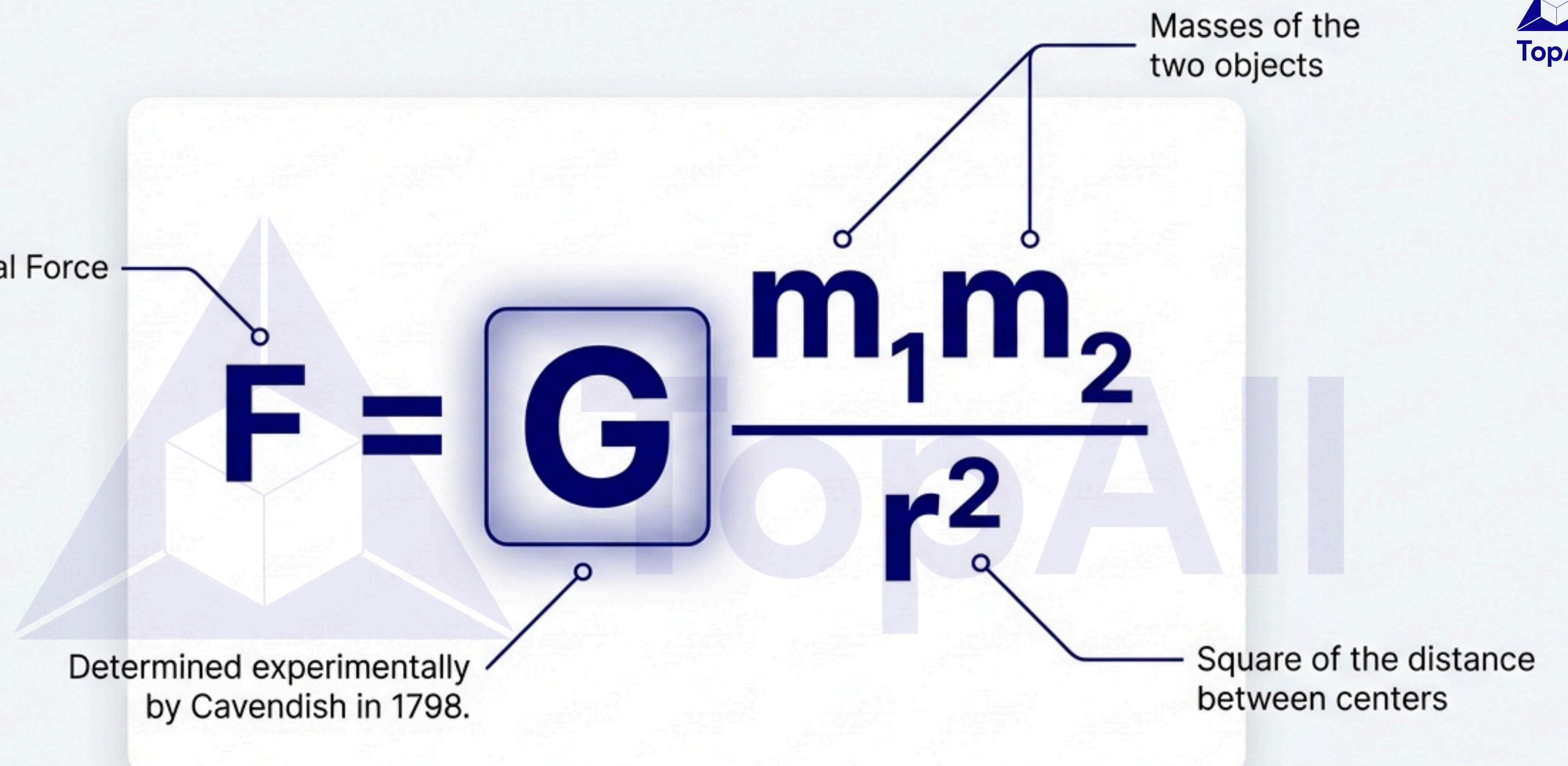
Gravitational Force

Masses of the two objects

$$F = G \frac{m_1 m_2}{r^2}$$

Determined experimentally by Cavendish in 1798.

Square of the distance between centers

The diagram features the equation $F = G \frac{m_1 m_2}{r^2}$ centered on a white rectangular background. To the left of the equation is a 3D wireframe cube. Four labels with leader lines point to specific parts of the equation: 'Gravitational Force' points to 'F', 'Masses of the two objects' points to 'm1' and 'm2', 'Determined experimentally by Cavendish in 1798.' points to 'G', and 'Square of the distance between centers' points to 'r^2'.

Knowing G unlocks the ability to calculate mass and gravity across the entire universe.

The Problem with Measuring Gravity

The Macro Scale



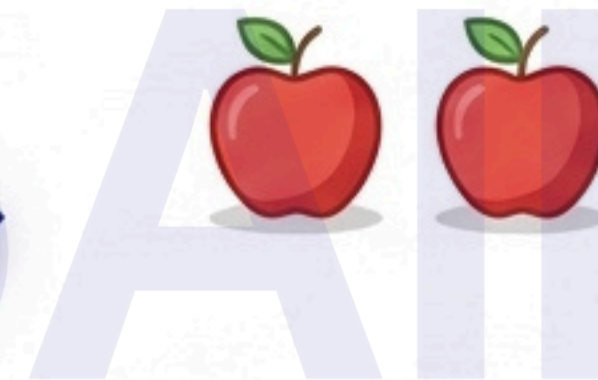
Earth & Apple

Force ≈ 1 Newton

Easily measurable everyday force.

The Central Challenge:
How do you measure
a force this small?

The Micro Scale



Apple & Apple

Force ≈ 0.000000000001 Newtons

Easily overpowered by friction or
air currents.



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$$E=mc^2$$



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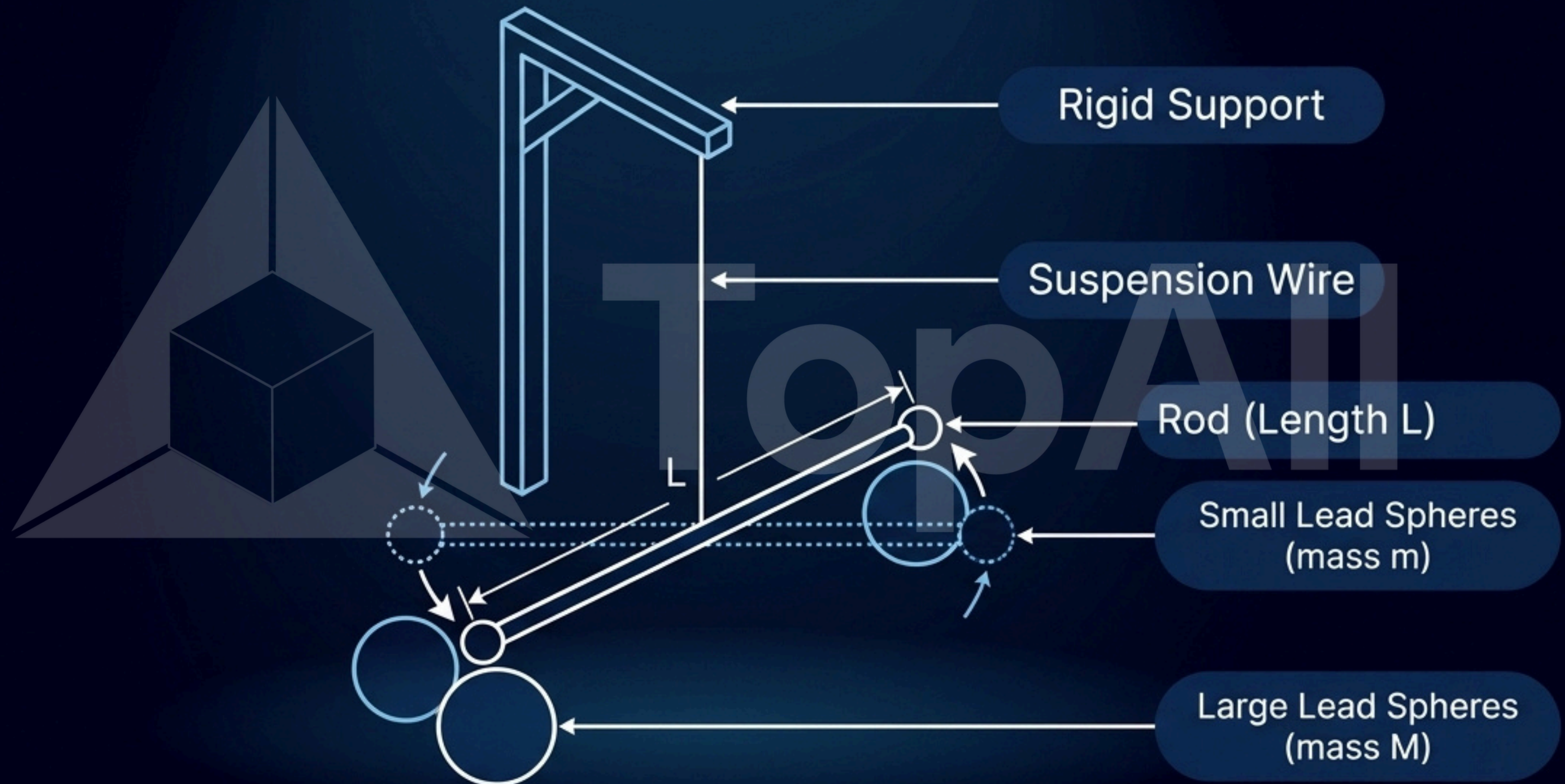
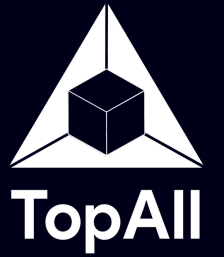
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- » Climb the Leaderboard Among Fellow Aspirants
- » Practice Unlimited MCQs for NEET & JEE
- » Get Clear Explanations, Not Just Marks
- » Track Your Performance Smarter



The Torsion Balance Apparatus



Balancing the Torques

Gravitational Torque

The large spheres attract the small spheres, creating a rotational force.

$$\text{Gravitational Torque} = G \frac{Mm}{d^2} L$$

Restoring Torque

The twisting suspension wire creates an opposing torque to resist the spin.

$$\text{Restoring Torque} = \tau \theta$$

(τ = restoring couple per angle, θ = angle of twist)

Equilibrium

The rod stops moving when the two torques are perfectly equal.

$$G \frac{Mm}{d^2} L = \tau \theta$$

By independently measuring the twist angle (θ), Cavendish solved the equation for G !

The Legacy of 'G'

Universal Constant

$G = 6.67 \times 10^{-11} \text{ N m}^2/\text{kg}^2$. This value applies everywhere in the universe, from apples to galaxies.

Ingenious Method

Cavendish successfully bypassed the sheer weakness of gravity by utilizing the extreme sensitivity of a twisting wire.

Weighing the Earth

Once G was known, scientists used $g = (G M_E) / R_E^2$ to calculate the exact mass of the Earth (M_E) for the very first time.





You've Learned the Theory.

Now Let's Test It.

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