The central component of a Cavendish torsion balance is a sensitive torsional pendulum with a pair of small lead spheres attached to it. Two larger lead spheres are then placed near these two small balls in order to attract them. The position of the large spheres thus determines the equilibrium position of the torsional pendulum. If the two large spheres are then moved to a second position which is symmetrical with the first with respect to the two small balls, the torsional pendulum will adopt a new equilibrium position after a short period of settling. By measuring the geometry of the set-up in both positions, it is possible to determine the gravitational constant. The decisive factor in this is the equilibrium between the gravitational force and the restoring torque of the torsional pendulum.

The gravitational force is given by the following:

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

$G$: Gravitational constant,
$m_1$: Mass of one small lead sphere,
$m_2$: Mass of one large lead sphere,
$r$: Distance between small and large lead spheres at the position where the measurement is made.

This does not take into account that the two small spheres are also attracted by the more distant large sphere, so that the torque on the torsional pendulum is somewhat reduced in comparison with the calculations made so far. It is not difficult to introduce correction for this into equation (2), since all the distance are known.

The moment of inertia $J$ comprises the moment of inertia $J_1$ of the two small spheres and the moment of inertia $J_2$ of the supporting beam.

$$J = 2 \cdot m_1 r^2 + \frac{m_2 b^2}{12}$$

In the course of the experiment the oscillations of the torsional pendulum are measured using a capacitive differential sensor, which suppresses noise and vibrational components of the signal to a large extent. The tungsten wire from which the support beam of the torsional pendulum is suspended. In the equilibrium position, this acts due to the tungsten wire between the two small balls. The moment of inertia $J$ of the torsional pendulum comprises the moment of inertia $J_1$ of the two small spheres and the moment of inertia $J_2$ of the supporting beam.

$$J = 2 \cdot m_1 r^2 + \frac{m_2 b^2}{12}$$

This acts due to the tungsten wire from which the support beam of the torsional balance is suspended. In the equilibrium position, equations (2) and (3) therefore imply the following:

$$D = \frac{J_1}{J_2} \cdot \frac{m_2 b^2}{12}$$

The moment of inertia $J_1$ comprises the moment of inertia $J_2$ of the two small spheres and the moment of inertia $J_3$ of the supporting beam.

$$D = \frac{m_2 b^2}{12}$$

For the two large lead spheres, there should be two symmetrical positions where measurements are made. The angles of deflection in these two positions are $\phi$ and $\phi'$ and the two corresponding deflecting torques are equal but in opposite directions. In equation, (2) and (3) therefore imply the following:

$$J = 2 \cdot m_1 r^2 + \frac{m_2 b^2}{12}$$

The moment of inertia $J$ comprises the moment of inertia $J_1$ of the two small spheres and the moment of inertia $J_3$ of the supporting beam.