Adjust the zero point of the light pointer in accordance with the torsion balance instructions for use.

After adjusting the zero point, place the lead balls in position and move to one limit position (position I or II, Fig. 1). You must not touch the housing with your fingers or with the lead balls under any circumstances. Allow the apparatus to stand for at least two hours without touching it.

Before starting measurement, observe the stability of the zero point for at least 10 minutes and record this.

Carrying out the experiment:

Measurement must always be carried out by at least two people; one of these should exclusively follow the light pointer on the scale, and the other should displace the lead balls, call out the measurement times ("READY - NOW") and record the measurements made.

At the time t = 0, move the lead balls quickly from one limit position to the other, but ensuring that the housing is not touched by either your fingers or the lead balls. At the same time, start the stop-clock.

Read off the pointer position every 5 seconds and note this. After one complete oscillation period, increase the measurement interval to 10 seconds, and after two further periods to 30 seconds. The total measurement time must be at least 3 oscillation periods.

Then measure the distance L between the light pointer mirror and the scale using a tape measure.

Measurement example:

Technical data of the torsion balance need not be checked and are as follows:

m = 1.5 kg
d = 0.05 m (see Fig. 1)
b = 0.0465 m

Note:

b = 0.0465 m as the distance between the center points of the large and small balls is an approximate value. The distance is smaller in the initial and final equilibrium position if the small balls are exactly in the center of the metal housing of the torsion balance for the selected zero point.

Initial position x_0 of the pointer before the start of measurement:

x_0 = 60.4 cm
L = 437 cm

Fig. 4: Measurement example - oscillation of the gravitation balance about the final equilibrium position.

Evaluation and results:

From the graph, we can see that one oscillation period T = 245 seconds.

The equilibrium position x_∞ of the light pointer after oscillation has died out is determined from three successive amplitudes, e.g. x_1 ... x_3 in accordance with the algorithm (approximate value)

$$x_\infty \approx \frac{x_1}{4} + \frac{x_2}{2} + \frac{x_3}{4} = 58{,}1 \text{ cm}$$

It is possible to check this by means of the amplitudes x_2 ... x_4 and x_3 ... x_5.

In accordance with this, the pointer deflection S is equal to
$S = x_0 - x_\infty = 2{,}3$ cm

By inserting this in equation (1) we obtain the gravitation constant:

$$G = \frac{\pi^2 \cdot (0{,}045)^2 \cdot 0{,}05 \cdot 0{,}023}{1{,}5 \cdot (245)^2 \cdot 4{,}37}$$

$$= 6{,}237 \cdot 10^{-11} \text{m}^3\text{kg}^{-1}\text{s}^{-2}$$

Fig. 4 Deflection S of the light pointer as a function of time