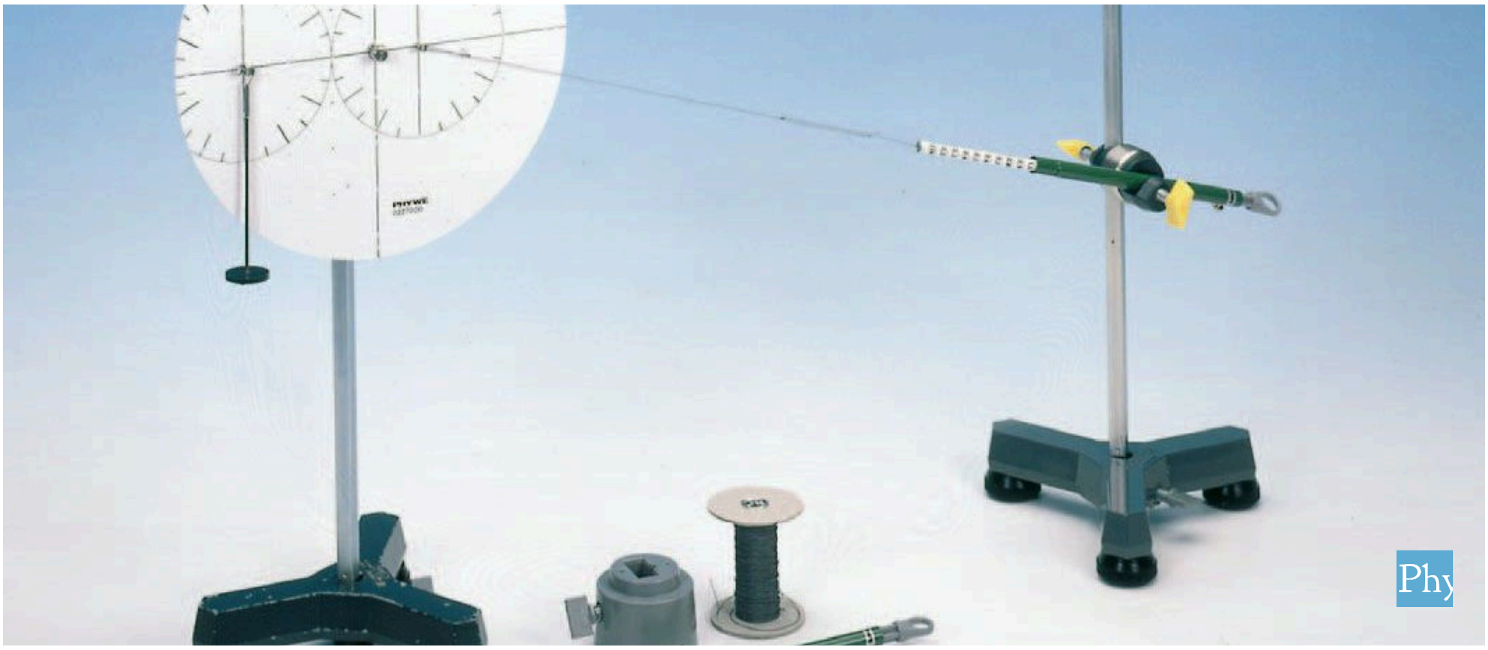
Moments



The goal of this experiment is to determine the dependency behaviour of the moment in regards to different properties.

Physics	Mechanics	Circular motion & rotation	
Applied Science	Engineering	Applied Mechanics	Statics
Applied Science	Engineering	Materials Science	Mechanical Properties
Applied Science	Medicine	Biomechanics	

Difficulty level	Group size	Preparation time	Execution time
easy	2	10 minutes	10 minutes

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General information

Application

Setup

Moments have many applications everywhere where there are rotations, such as in material testing, steel manufacturing and other production industries, as the moment determines the rotation behaviour of any solid object.

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Other information (1/2)

Prior knowledge

There is no prior knowledge necessary.

Main principle

Coplanar forces (weight, spring balance) act on the moments disc on either side of the pivot. In equilibrium, the moments are determined as a function of the magnitude and direction of the forces and of the reference point.

Other information (2/2)

Learning objective

The goal of this experiment is to determine the dependency behaviour of the moment in regards to different properties.

Tasks

1. Moment as a function of the distance between the origin of the coordinates and the point of action of the force,
2. Moment as a function of the angle between the force and the position vector to the point of action of the force,
3. Moment as a function of the force.

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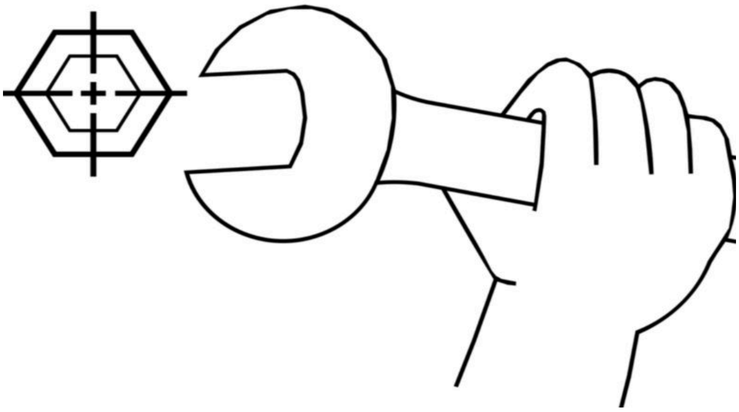
Theory

The equilibrium conditions for a rigid body, on which forces $\vec{f_i}$ act at points $\vec{r_i}$ are:

$\vec{F} = \sum \vec{f}_i = 0$

and $\vec{T} = \sum \vec{r}_i \times \vec{f}_i = 0$

$\vec{T}$ is the moment of torque.



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Equipment

Position	Material	Item No.	Quantity
1	Moments disk	02270-00	1
2	Spring balance,transparent, 1 N	03065-02	2
3	Tripod base PHYWE	02002-55	2
4	Support rod, stainless steel, 500 mm	02032-00	2
5	Right angle clamp expert	02054-00	1
6	Bosshead, turnable	02048-04	1
7	Barrel base expert	02004-00	1
8	Bolt with pin	02052-00	1
9	Weight holder, 10 g	02204-00	1
10	Slotted weight, black, 10 g	02205-01	4
11	Slotted weight, black, 50 g	02206-01	1
12	Fish line, l. 100m	02090-00	1
13	Ruler, plastic, 200 mm	09937-01	1
14	Universal clamp	37715-01	1

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Setup and Procedure

Setup and procedure (1/2)

The experimental set-up is arranged as shown in Fig. 1. The spring balance is adjusted to zero in the position in which the measurement is to be made in each case. The straight line from the push-in button to the pivot point is adjusted to the horizontal by moving the swivel clamp on the stand rod. The fishing line to weight pan then runs along a row of holes.

The spring balance should be mounted in the swivel clamp so that it forms an angle p with the fishing line.
For tasks 1 and 3, the spring balance is attached on one side of the pivot point of the moments disc and the weight pan on the other side. The force needed to adjust the line through the push-buttons and the pivot to the horizontal is read on the spring balance. (Spring balance vertical.)

Fig.1: Experimental set-up for investigating moments in equilibrium.

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Setup and procedure (2/2)

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For task 2, the weight pan should be replaced by the second spring balance. A fixed force, e.g. 1 N, is set on it while the angle between the line from push-button to pivot and the spring balance is varied. On the other, vertical, spring balance, the force needed to bring the push-button-pivot line horizontal is read. More conveniently, the angle and the fixed force are first adjusted on the clamped spring balance while the disc is released and the moment is compensated on the other spring balance.

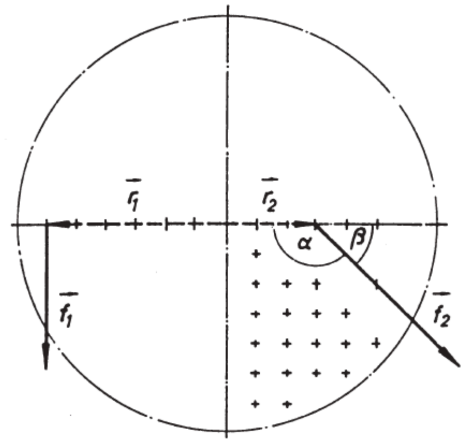

Fig. 2: Compensating moments.

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Evaluation

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Results (1/2)

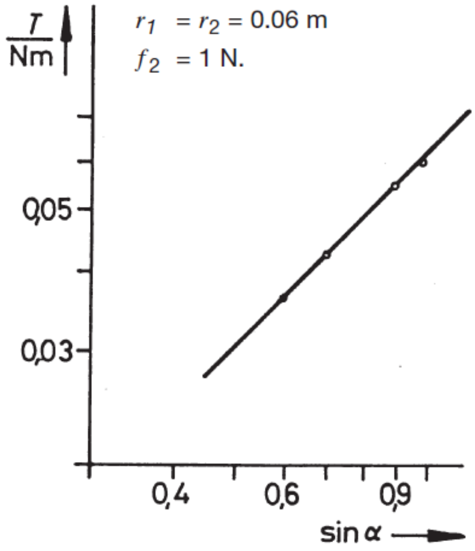

Fig. 3: Moment as a function of the distance between the origin of the coordinates and the point of action of the force.

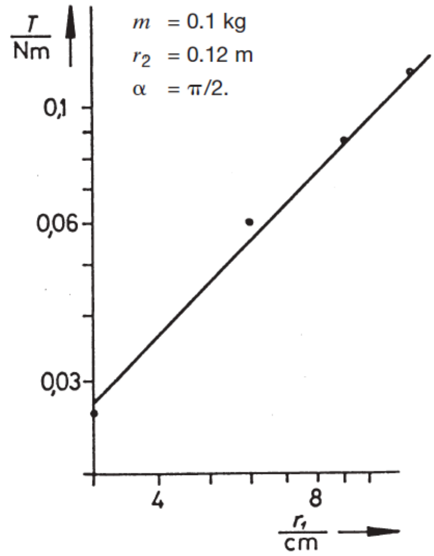

Fig. 4: Moment as a function of the angle between force and position vector to the point of action of the force.

Results (2/2)

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The origin of the coordinates, with reference to which the moments are defined, can be selected free in the equilibrium state.
In the present case, one obtains

$$\vec{r}_1 \times \vec{f}_1 = \vec{r}_2 \times \vec{f}_2$$

and for the magnitudes

$$T = r_1 \cdot f_1 = r_2 \cdot f_2 \cdot \sin\alpha \qquad (1)$$

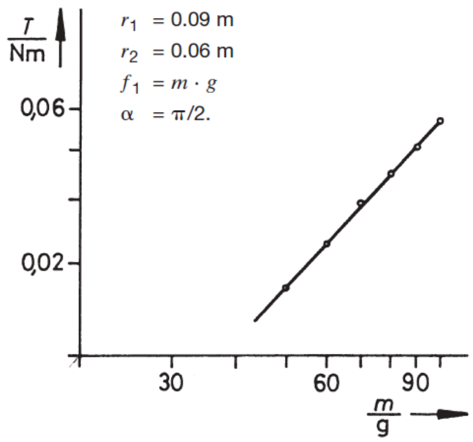

Fig. 5: Moment as a function of the force.

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