Moments

Related topics
Moments, Couple, Equilibrium, Statics, Lever, Coplanar forces.

Principle and task
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.

Equipment

Moments disk	02270.00	1
Spring Balance 1 N	03060.01	2
Tripod base -PASS-	02002.55	2
Barrel base -PASS-	02006.55	1
Support rod -PASS-, square, l 400 mm	02026.55	2
Right angle clamp -PASS-	02040.55	1
Swivel clamp -PASS-	02041.55	1
Bolt with pin	02052.00	1
Weight holder f. slotted weights	02204.00	1
Slotted weight, 10 g, black	02205.01	4
Slotted weight, 50 g, black	02206.01	1
Fish line, l 100 m	02090.00	1
Rule, plastic, 200 mm	09937.01	1

Problems
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.

Set-up and procedure
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.

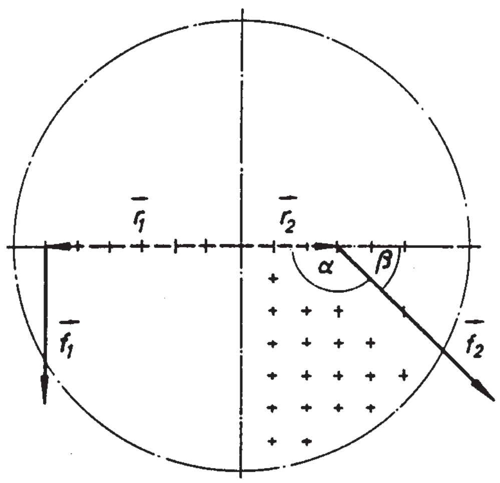
The spring balance should be mounted in the swivel clamp so that it forms an angle π with the fishing line.

For problems 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.)

For problem 2, the weight pan should be replaced by the second spring balance. A fixed force, e.g. 1 N, is set on it while

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

Fig. 2: Compensating moments.



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.

Theory and evaluation

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

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

and

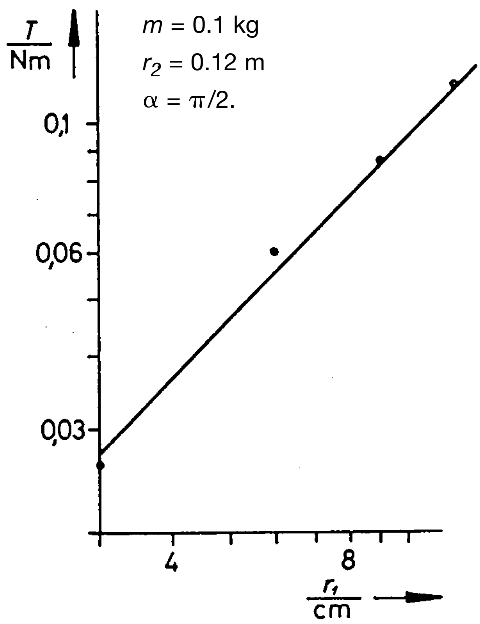
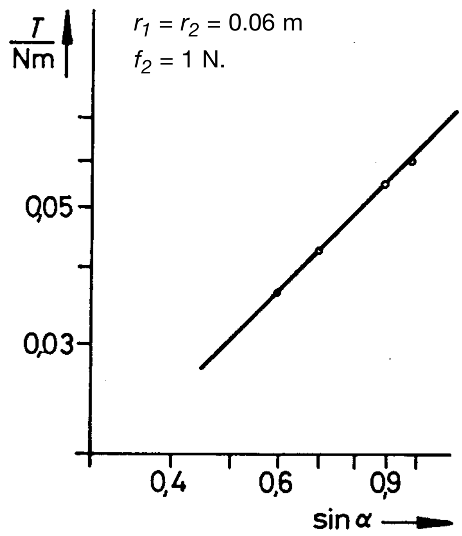


Fig. 3: Moment as a function of the distance between the origin of the coordinates and the point of action of the force.

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



$$\vec{T} = \Sigma \vec{r}_i \times \vec{f}_i = 0.$$

$\vec{T}$ is the moment, or torque.

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

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

(see Fig. 2).

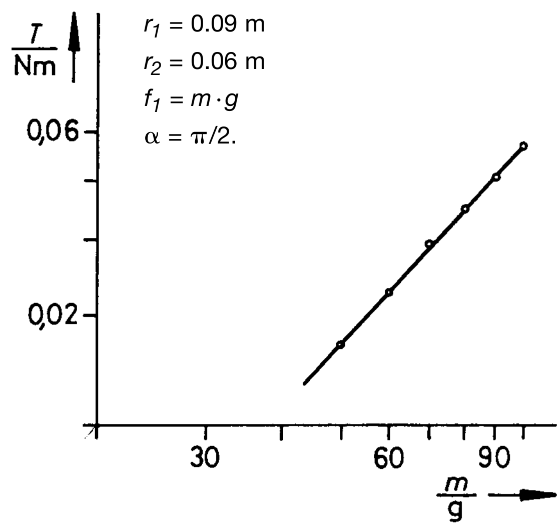


Fig. 5: Moment as a function of the force.