Mechanics

Rotational motions of a rigid body

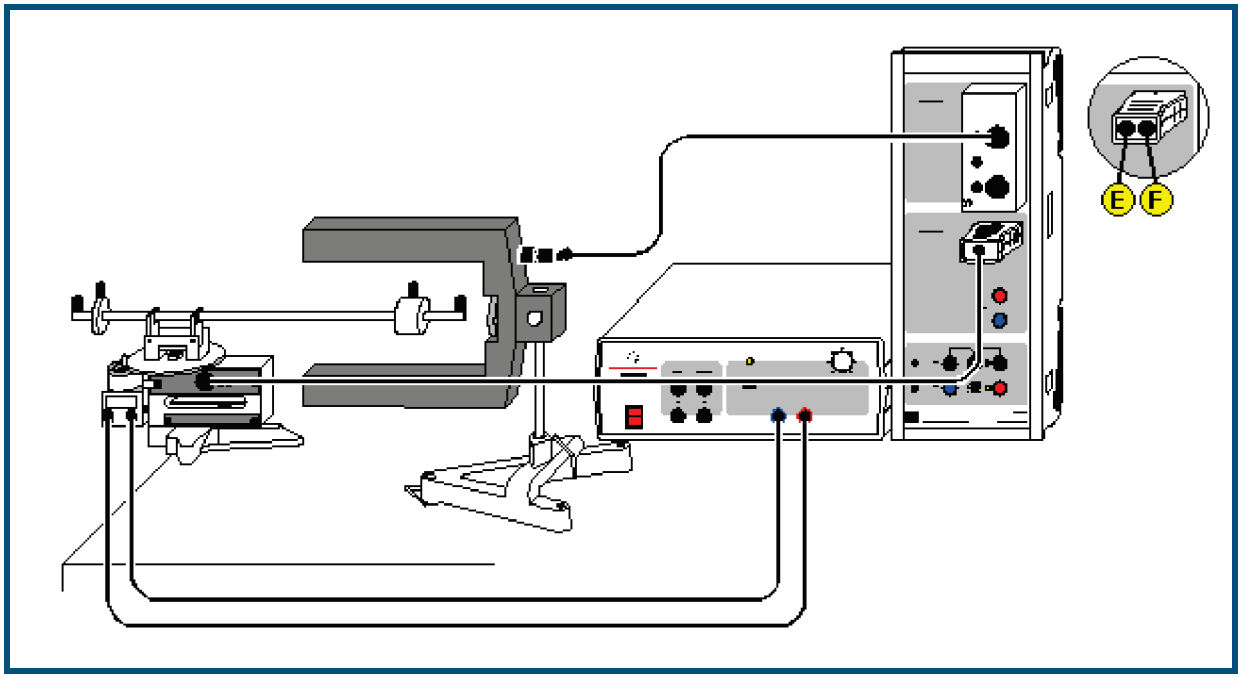
Centrifugal force

Centrifugal force of an orbiting body - Measuring with the central force apparatus and CASSY

Description from CASSY Lab 2

For loading examples and settings, please use the CASSY Lab 2 help.

Centrifugal force (centrifugal force apparatus)



can also be carried out with Pocket-CASSY

Experiment description

The centrifugal force apparatus enables experimental investigation of the centrifugal force F as a function of the rotating mass m, the distance r of the mass from the center of rotation and the angular velocity ω, thus making it possible to confirm the relation $F = m \cdot \omega^2 \cdot r$ for the centrifugal force.

In the centrifugal force apparatus, the force F acting on a rotating mass m is transmitted via a lever with ball-and-socket joint and a push pin in the axis of rotation to a leaf spring, whose deflection is measured electrically by means of a bridge-connected strain gauge. In the measuring range relevant for the experiment, the deformation of the leaf spring is elastic and thus proportional to the force F.

Equipment list

1	Sensor-CASSY	524 010 or 524 013
1	CASSY Lab 2	524 220
1	Timer box or Timer S	524 034 or 524 074
1	Centrifugal force apparatus S	524 068
1	Power supply	521 49
1	Forked light barrier	337 46
1	Multi-core cable, 6-pole	501 16
1	Bench clamp	301 06
1	Stand base, V-shape, 20 cm	300 02
1	Stand rod, 10 cm	300 40
1	Pair of cables, 50 cm, red and blue	501 45
1	PC with Windows XP/Vista/7	

If there are centrifugal force apparatus (347 21) available, they can be upgraded by means of the centrifugal force adapter (524 0681). Handling and measuring results of this combination do not differ from those of the centrifugal force apparatus S (524 068). Before the centrifugal force apparatus (347 21) is used with the centrifugal force adapter (524 0681) for the first time, the zero and the gain at the centrifugal force apparatus should once be readjusted according to the instruction sheet of the centrifugal force adapter.

Experiment setup (see drawing)

Use the bench clamp to fix the centrifugal force apparatus to the table. The light barrier is set up by means of the stand rod and the stand base so that the rotating arm can freely rotate between the legs of the light barrier; the light beam should not be interrupted by the weight. The centrifugal force apparatus is connected to Input B and the light barrier via the 6-pole cable to the timer box at Input A of the Sensor-CASSY. The power supply is connected to the

driving motor of the centrifugal force apparatus via two connecting leads. The maximum voltage for driving the motor should be selected so that the force measuring range does not exceed 15 N.

Carrying out the experiment

Load settings

- Set the force display to 0 while the rotating arm is at rest. For this set the centrifugal force apparatus to → **0** ← in Settings Force FB1 (right mouse button).
- Adjust the compensating weight on the short arm of the apparatus so that no force F is measured when the measurement is made without additional weight m but with the safety screw.
- Starting with low angular velocities ω, store the measured force manually with ⏱ in the table.
- Repeat the measurement with higher angular velocities ω.
- After finishing a measurement series, repeat the measurements with other masses m (r=constant) or radii r (m = constant). For this select **Measurement** → **Append New Measurement Series** and restart at low angular velocities.

Evaluation

Each individual measurement series immediately confirms the proportionality between the force F and ω^2 by a fit to a straight line. If you want to confirm the two other proportionalities between F and m (ω,r constant) and between F and r (ω,m constant), the forces F have to be determined for constant angular velocities ω. To do this, draw a vertical line at a value of ω^2 in the diagram and read the coordinates of the intersections with the F(ω^2) line (switch the coordinate display on). Enter these coordinates manually into the prepared second display F(m) or F(r) (click the field in the table with the mouse). There the desired proportionality eventually shows up.

$F = m \cdot \omega^2 \cdot r$ is confirmed by determining the proportionality factors.