

Centrifugal force unit

The centrifugal force instrument (Evers principle) is used in conjunction with the newtonmeter (314 25) to investigate the centrifugal force F of a rotating body. The force F is measured as a function of the mass m , the angular speed ω , and the path radius r , and is read off directly from the newtonmeter. The measurement series produce the proportionalities

$$\begin{aligned} F &\sim m \\ F &\sim \omega^2 \\ F &\sim r \end{aligned}$$

so that the relationship

$$F = m \omega^2 r$$

can be derived by experiment.

Measuring principle:

A rotary arm with test specimen is set in rotation by an integrated motor. The centrifugal force F acting on the test specimen is transmitted via an angled lever and a toe bearing along the vertical rotation axis to a leaf spring with extensometer. The good transmission ratio of the lever system keeps the distance alteration of the rotating specimen at a negligible level during force measurement. The resistance change at the extensometer, which is proportional to the force causing it, is processed in the newtonmeter (314 25) and displayed in newtons.

1 Safety Instructions

- Always fix the instrument in the table clamp (301 06).
- Stand well back, and never reach into the rotating apparatus.
- Position any other instruments required at not less than twice the distance of the rotating arm from the rotation axis.
- Position the test specimen so that the fastening screw engages in the hole (3.1) of the rotary arm ③.
- Do not set the instrument in rotation before the screws (4.1), (4.2), and (5.1), (5.2) have been carefully locked.
- Apply no more than 12 V dc/1 A to the motor.
- Switch on the newtonmeter with connected centrifugal force instrument at least 15 mins. before measurement starts.
- Only use screws (5.1), (5.2) and potentiometer screws (7.1), (7.2) for calibration of the instrument.
- If wrong values are measured despite of correct handling, recalibrate the unit as described in section 3.1.

2 Description, specifications, scope of supply

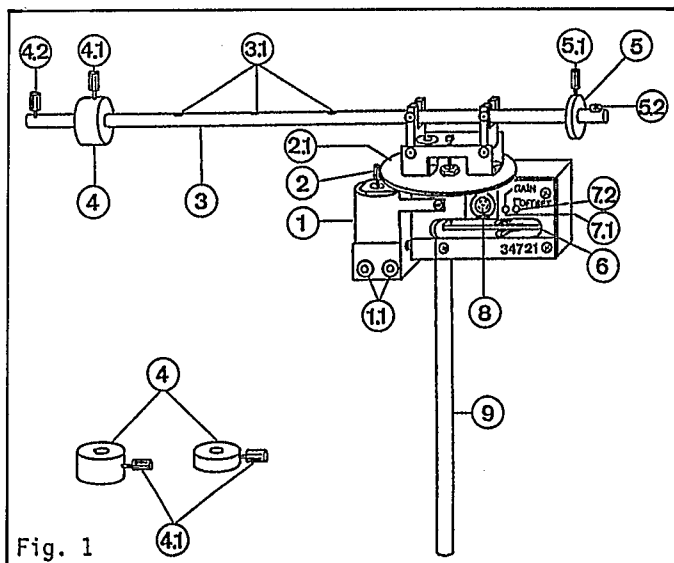


Fig. 1

- ① Drive motor 12 V/1 A
Connecting jacks 4 mm;
blue jack: -;
red jack: +
- ② Friction gear unit with rotary plate (2.1);
Diameter of rotary plate: approx. 8 cm
Transmission ratio to friction wheel of
tachymeter: approx. 4 : 1
- ③ Rotary arm with holes (3.1) for positioning
the test specimen
Distance of holes from rotary axis: 5 cm,
10 cm, 15 cm, 20 cm and 25 cm
- ④ Test specimen with locating screw (4.1) and
securing screw (4.1);
Weights: 50 g, 75 g and 100 g
- ⑤ Balancing weight with locating screw (5.1)
and securing screw (5.2)
Weight: 25 g
- ⑥ Leaf spring with extensometer
- ⑦ Potentiometer for calibration of the force
measurement instrument:
(7.1) for amplification/gain
(7.2) for zero point/offset
- ⑧ 6-pin jack for connecting the newtonmeter
- ⑨ Rod stand, 20 cm x 12 mm dia.

Overall dimensions: 38 cm x 32 cm x 8 cm
Weight: approx. 0.8 kg

3 Operation

Important: follow safety instructions.

3.1 Calibration before commissioning

Required in addition (see Fig. 2):

Newtonmeter	314 25
Connecting cable, 6-pin, 1.5 m	501 16
Calibration weight of 2.0 kg	e.g. 315 40
Stand material	

- Loosen securing screws (4.2) and (5.2); remove test specimen and balancing weight from rotary arm; refit securing screws.
- Fit centrifugal force instrument as shown in Fig. 2.
- Switch on newtonmeter and set to zero if necessary using the tare button.
- Connect the newtonmeter to the centrifugal force instrument using the 6-pin cable and warm up the apparatus by operating it for about 15 minutes.
- Set the zero point/offset using potentiometer (7.2) so that the newtonmeter displays the minimum value.
- Set the newtonmeter to zero using the tare button.
- Attach 2.0 kg to the rotary arm.
- Set the amplification/gain using potentiometer (7.1) so that the newtonmeter displays 19.62 N.
- Loosen the securing screws (5.2); slide test specimen or balancing weight (5) onto the rotary arm and re-fix the screw (5.2); Horizontally align the rotary arm and set its balance position by shifting the balancing weight (5); then tighten screw (5.1).

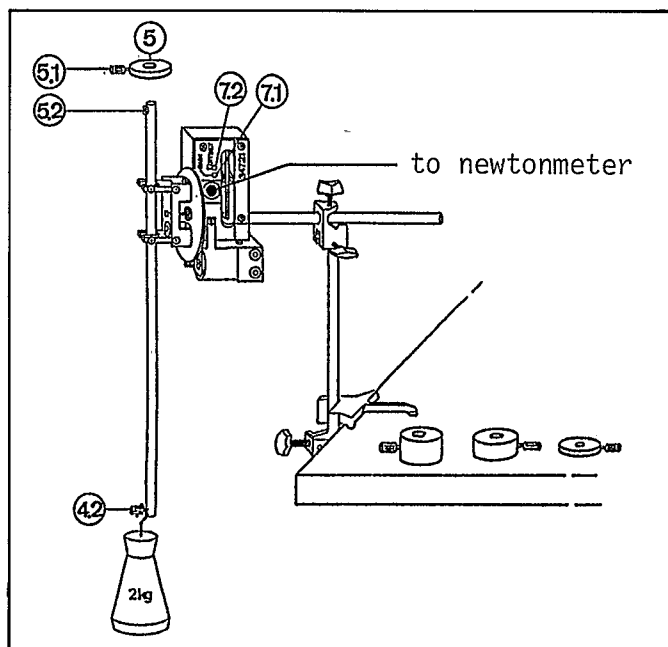


Fig. 2

Apparatus for calibration of force measuring instrument

3.2 Test preparation

Required in addition:

Newtonmeter	314 25
Connecting cable, 6-pin, 1.5 m	501 16
DC voltage source, 0...12V, continuous setting, 1 A, e.g. regulated power supply, ± 15 V, 1.2 A	522 30

To determine the angle velocity, optionally (see Figs. 3.1/3.2)

Tachymeter with work projector or	337 41
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U-shaped light barrier 337 46
 with pulse counting unit e.g.
 Counter P 575 45
 with stopwatch e.g. 313 05
 or
 Digital counter e.g. 575 40

For plotting ω -F graphs (Fig. 3.1)
 XY-recorder e.g. 575 662
 or
 Interface with computer measuring
 station and software. e.g.
 CAP-CS2 (hard and software) for Apple IIe S534 10
 Apple IIe computer with periphery

Stand material

Set up the apparatus according to Fig. 3.1 or 3.3,
 taking into account the safety instructions
 (Section 1).

For direct measurement of the angle velocity using
 the tachymeter (see Fig. 3.1), screw its holding
 clamp (a) into hole; align the tachymeter so
 that perfect contact is ensured between its wheel
 and the O-ring of the rotary plate (2.1).

Set the newtonmeter to zero using the tare button
 before starting each measuring series and - if
 necessary - after the 1st measurement (see note).

To measure the centrifugal force F as a function
 of the radius r and the mass m, fix the test
 specimen in the rotary arm at a distance r of
 0.05 m, 0.10 m ... 0.25 m from the pivot point;
 set the same angle velocity ω each time with the
 motor voltage and measure force F; carry out this
 measurement series for each of the available
 masses (see Figs. 4/5).

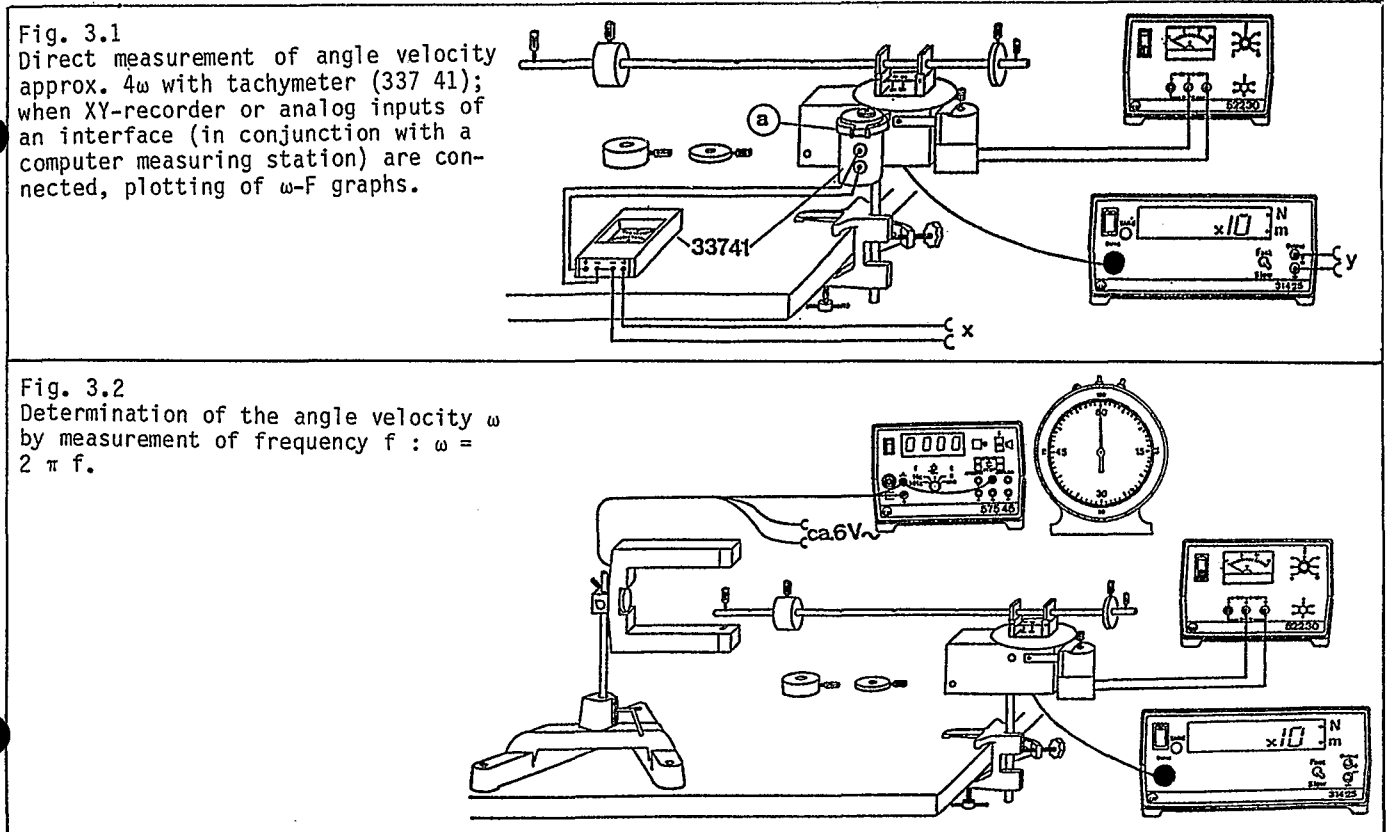
To measure the centrifugal force F as a function
 of radius r, position and fix test specimen of
 mass m at the required distance r from the rotary
 axis;
 vary the voltage at the power supply (or increase
 it slowly and steadily to a max. of 12 V dc after
 starting the recorder) and determine the paired
 ω -F values (or record measurement curve); cf.
 Figs. 6.1/6.2).

For measurement requiring greater precision,
 determine the diameters of friction wheels of
 tachymeter and centrifugal force instrument using
 a vernier caliper (e.g. 311 54) and determine from
 this the precise transmission ratio specific to
 the instrument.

Note:

Handling the instrument when setting it up and
 when attaching the test specimen may cause a
 slight maladjustment of the rotary arm bearing.
 The newtonmeter display then does not return to
 zero (± 3 digits) after the first rotation, in
 which the maladjustment is automatically remedied,
 when the rotary arm is stationary (if necessary
 compensate for this using the tare button). The
 measured value for the centrifugal is not
 affected.

Fig. 3
 Apparati for measuring centrifugal force F as a function of angle velocity ω
 and mass m of a test specimen and of its distance r from the pivot point.



Measuring example:

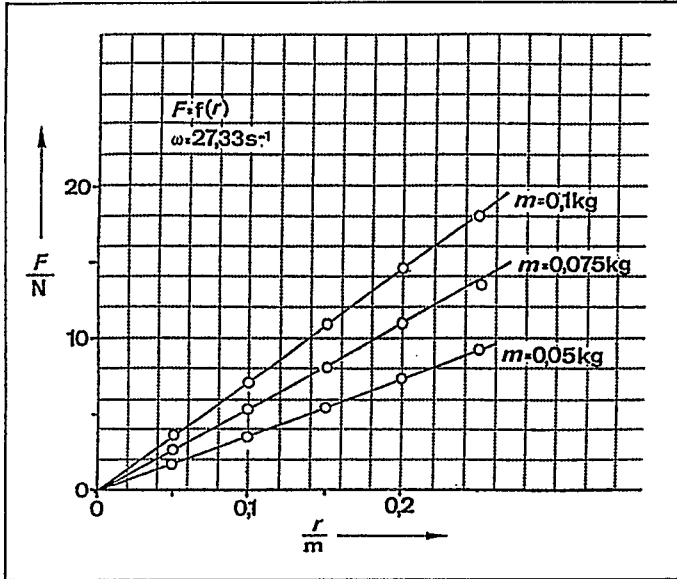


Fig. 4
Force F as a function of radius r for various masses m with constant angle velocity ω .

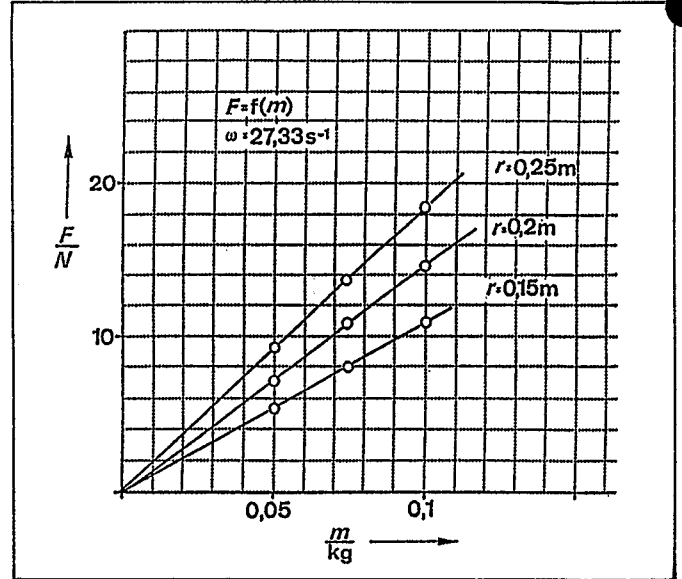


Fig. 5
Force F as a function of mass m for various radii r with constant angle velocity ω (m - F paired values from Fig. 2).

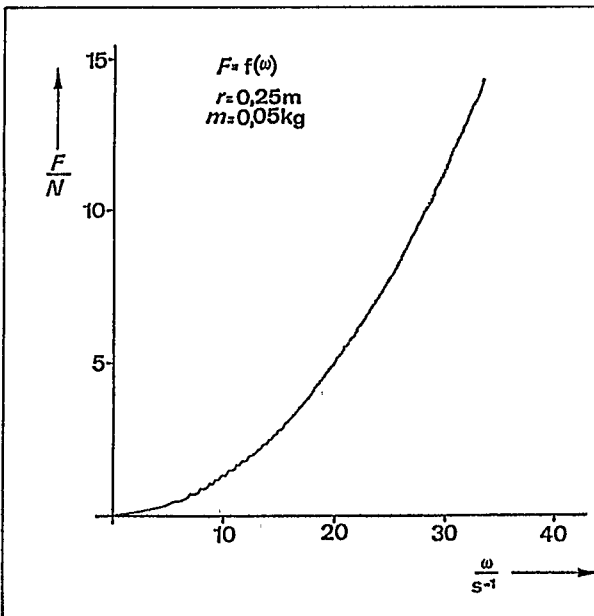


Fig. 6.1
Force F as a function of angle velocity ω ; radius r and mass m constant.

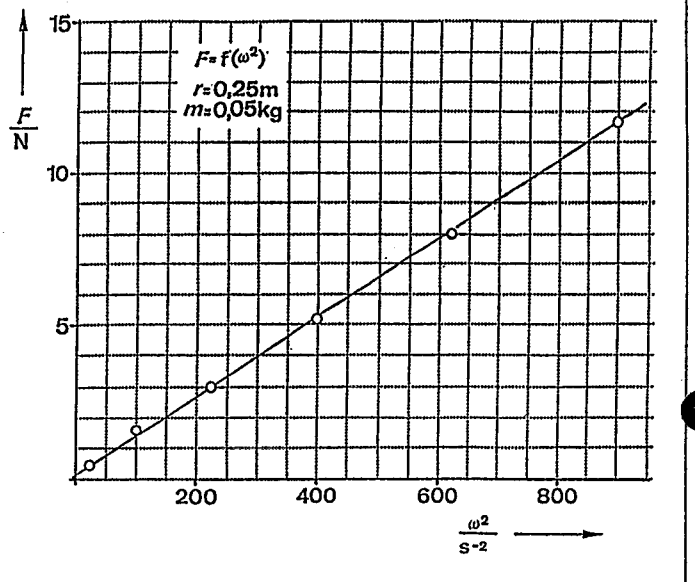


Fig. 6.2
Linearization of measurement curve from Fig. 6.1: $F \sim \omega^2$

Physics

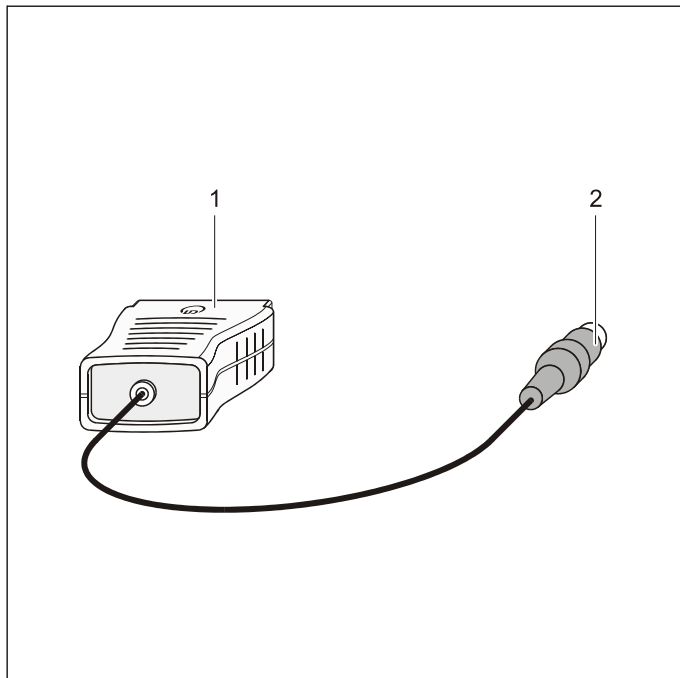
Chemistry · Biology

Technology



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06/05-W97-Sel



Operating instructions 524 0681

Centrifugal force adapter S (524 0681)

- 1 Sub D-15 plug
- 2 DIN plug

1 Description

The centrifugal force adapter S is used in conjunction with the computer-aided measuring system CASSY®. It allows the connection of the centrifugal force apparatus (347 21) for measuring the centrifugal forces acting on rotating masses.

2 Useable sensor

Centrifugal force apparatus (347 21)

3 Value to be measured

Value to be measured	CASSY Lab ^{/1/} (524 200)	CASSY Display ^{/2/} (524 020)	Mobile-CASSY (524 009)	Measuring range
Centrifugal force	F	✓	F	±0.500 N ±5.00 N ±50.0 N

^{/1/} for Sensor-CASSY (524 010), Pocket-CASSY (524 006) or Mobile-CASSY (524 009) on the PC

^{/2/} in conjunction with Sensor-CASSY (524 010)

4 Operation

4.1 Starting up:

- Insert the centrifugal force adapter S into the CASSY module by means of the sub-D-15 plug and connect via the 6-pole plug to the centrifugal force apparatus.
- Allow to run for approx. 15 min. to warm the device up.

4.2 Zero point calibration:

- Set up the centrifugal force apparatus in its horizontal working position.
- Select the measuring range ± 5 N.
- Set the measuring value display with the "Zero/offset" screw on the centrifugal force apparatus to zero (see operating instructions for the centrifugal force apparatus).

4.3 Calibration of the amplifier:

- Set up the centrifugal force apparatus with the rotary arm pointing vertically downwards (see operating instructions for the centrifugal device).
- Select the measuring range ± 50 N.





CASSY Lab:

- In the "Settings for sensor input" dialogue window click onto the " $\rightarrow 0 \leftarrow$ " button.

CASSY-Display:

- Press the OFFSET key twice.

Mobile-CASSY:

- In the "Properties" menu for the value F to be measured select the "Correct offset" menu item by pressing the  or  key.
- By pressing the right-hand  button set the offset to zero.
- Return to the display of the measured value by pressing the left-hand  key,
- Suspend the 2 kg mass from the rotary arm of the centrifugal force apparatus.
- Set the display for the measured value with the "Amplification/Gain" screw of the centrifugal force apparatus to 19.62 N.

4.4 Carrying out the measurement:

- Set up the centrifugal force apparatus in its horizontal working position.
- Carry out the experiment as described in the operating instructions for the centrifugal force apparatus.
- Read the measured value.

5 Technical data

Sensor connection:	DIN plug, 6-pole
Measuring fault:	< 5 %
Measuring range compensation (tare):	± 50 N

6 Compatibility

The centrifugal force adapter S can be used in conjunction with the following CASSY modules:

	Sensor-CASSY (524 010)	Pocket-CASSY (524 006)	Mobile-CASSY (524 009)
with PC	Software CASSZ Lab from version 1.31		
without PC	with CASSY-display (524 020) from firmware 1.13	—	from firmware 1.00

Being a member of the CASSY family the adapter has the properties listed below:

- The adapter may be connected at any time.
- The connected adapter will be identified automatically.
- The values to be measured and the measuring ranges are set via a menu interface.

7 Updates

If the software of firmware used is older than that specified above, a software or firmware update is required. The current version of the CASSY Lab software is available on the Internet at <http://www.ld-didactic.com>.

- Install the current version of the CASSY Lab software and start it up.
- Connect all available CASSY modules to the PC one after the other.
- As soon as you are prompted by "Update CASSY module" update the CASSY module to the status of CASSY Lab.

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