

## Mechanics

Translational motions of a mass point

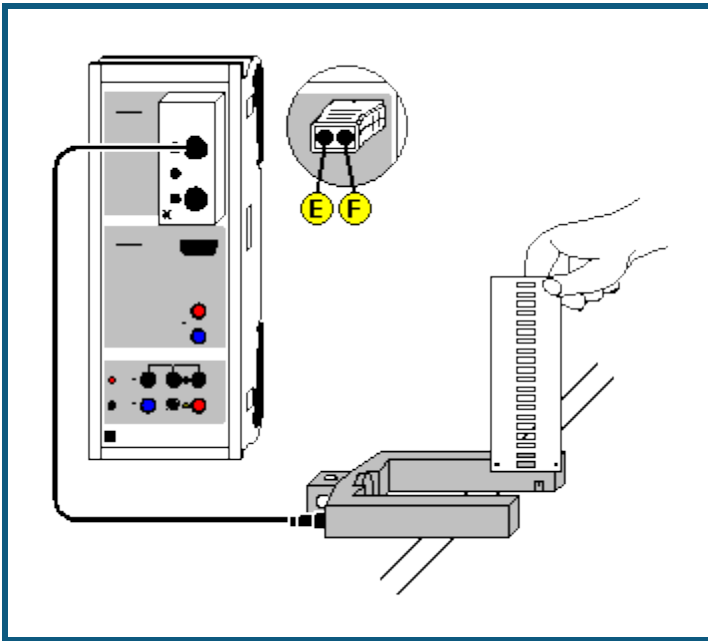
*Free fall*

Free fall: multiple  
measurements with the g-  
ladder

### Description from CASSY Lab 2

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

## Free fall with g-ladder



can also be carried out with [Pocket-CASSY](#)

### Experiment description

When a ladder falls through a light barrier, the software registers the times of the obscurations of the light barrier caused by the rungs of the ladder. The known rung spacing together with the time information gives us the  $s(t)$  diagram of the fall. This is then used to calculate the  $v(t)$  and the  $a(t)$  diagram. Each of the three diagrams can be used to determine the gravitational acceleration  $g$ .

### Equipment list



1	<a href="#">Sensor-CASSY</a>	524 010 or 524 013
1	<a href="#">CASSY Lab 2</a>	524 220
1	<a href="#">Timer box</a> or <a href="#">Timer S</a>	524 034 or 524 074
1	g-ladder	529 034
1	Forked light barrier	337 46
1	Multi-core cable, 6-pole	501 16
1	Set of weights, 50 g, optional	342 61
1	PC with Windows XP/Vista/7/8	

### Experiment setup (see drawing)

Suspend or hold the g-ladder above the light barrier so that its rungs interrupt the light beam when falling. The light barrier is connected to Sensor-CASSY via input E of the timer box. The independence of gravitational acceleration from mass can be verified by suspending weights from the ladder. Moreover, the aerodynamic drag of the g-ladder can be increased or decreased by sticking small wings or transparent plastic sheets to it.


### Carrying out the experiment

#### ■ Load settings

- Start the measurement with .
- Allow the ladder to fall through the light barrier so that all 21 rungs pass the beam.
- The measurement stops automatically 0.2 seconds after detection of the first rung, or after 21 rungs. You can delete a faulty measurement series from the table with [Measurement → Delete Current Measurement Series](#).
- You can repeat the measurement with different masses or falling heights. Simply restart it with .

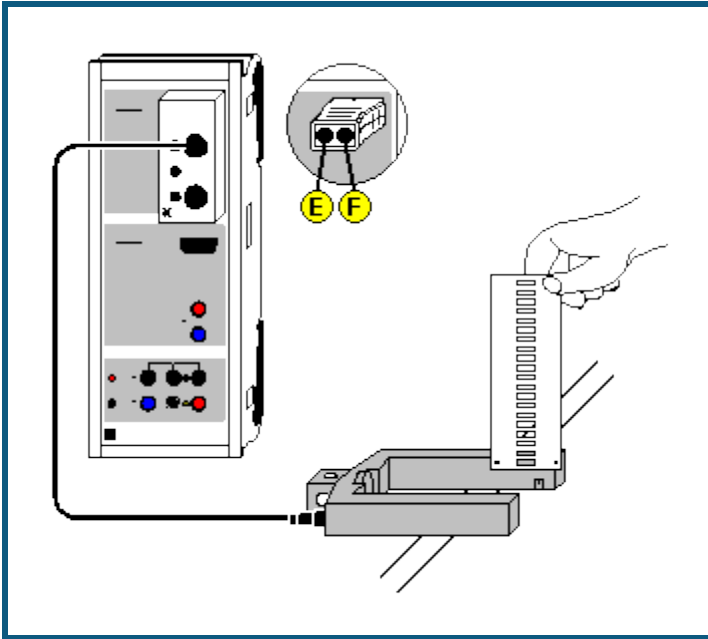
### Evaluation

This example contains prepared display tabs for path  $s(t)$ , velocity  $v(t)$  and acceleration  $a(t)$  which can be accessed by clicking on them. The gravitational acceleration  $g$  can be determined in the  $s(t)$  diagram by fitting a [parabola](#), in the

$v(t)$  diagram by fitting a [straight line](#) and in the  $a(t)$  diagram by finding the [mean value](#). You can enlarge display of the numerical values of the evaluation shown in the [status line](#) with .

As the ladder had an initial velocity when the light barrier was interrupted by the first rung, the peak of the  $s(t)$  parabola is not visible, and the  $v(t)$  straight line does not pass through the origin. However, to better illustrate the matter, you can move e.g. the  $t$  and  $s$  axes with the mouse so that after fitting a parabola its peak is also visible.

## Free fall with g-ladder (with modeling)



can also be carried out with [Pocket-CASSY](#)

### Experiment description

When a ladder falls through a light barrier, the software registers the times of the obscurations of the light barrier caused by the rungs of the ladder. The known rung spacing together with the time information gives us the  $s(t)$  diagram of the fall.

As a supplement to the [previous experiment](#), the measured motion is now compared with the motion described by the equation

$$s'' = a = g.$$

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### Experiment setup (see drawing)

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### Carrying out the experiment

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- Allow the ladder to fall through the light barrier so that all 21 rungs pass the beam.
- The measurement stops automatically 0.2 seconds after detection of the first rung, or after 21 rungs. You can delete a faulty measurement series from the table with [Measurement → Delete Current Measurement Series](#).
- You can repeat the measurement with different masses or falling heights. Simply restart it with .

## Modeling

In the present example, the two initial conditions  $s(t=0)=0$  and  $v(t=0)=v_0$  and the acceleration  $g=9.81 \text{ m/s}^2$  were chosen, whereby  $g$  and  $v_0$  can be altered by dragging the pointer of the corresponding display instrument (or by clicking to the left or to the right of the pointer) until the [model](#) agrees with the measurement.