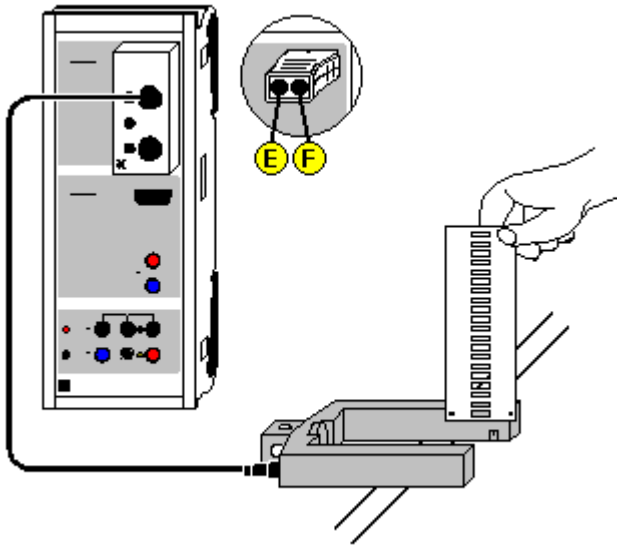


Free fall with g-ladder



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

■ Load example

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	Sensor-CASSY	524 010
1	CASSY Lab	524 200
1	Timer box or Timer S	524 034 or 524 074
1	g-ladder	529 034
1	Forked light barrier	337 46
1	Multicore cable, 6-pole	501 16
1	Set of weights, 50 g, optional	342 61
1	PC with Windows 98/2000/XP/Vista	

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 **F9**.
- 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 [Delete Last Measurement Series](#) (click right mouse button over table).
- You can repeat the measurement with different masses or falling heights. Simply restart it with **F9**.



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 **F6**.

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.

Remark

The individual velocity values $v(i)$ are calculated as

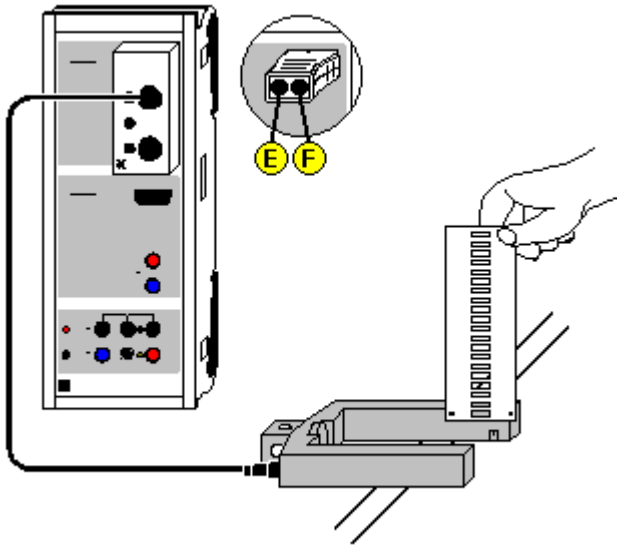
$$v(i) = (s(i+1) - s(i-1)) / (t(i+1) - t(i-1))$$

This is the average velocity in the interval $[t(i-1), t(i+1)]$ and an initial approximation of the instantaneous velocity at the time $\frac{1}{2}(t(i-1) + t(i+1))$, i.e. not at time $t(i)$. The same is true for the acceleration values:

$$a(i) = (v(i+1) - v(i-1)) / (\frac{1}{2}(t(i+2) - t(i-2))).$$

However, this has already been taken into consideration in the $v(t)$ and $a(t)$ displays by means of suitable conversion of the time axis.

Free fall with g-ladder (with modelling)



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

■ Load example

Experiment description

During a free fall of a ladder 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

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

Equipment list

1	Sensor-CASSY	524 010
1	CASSY Lab	524 200
1	Timer box or Timer S	524 034 or 524 074
1	g-ladder	529 034
1	Forked light barrier	337 46
1	Multicore cable, 6-pole	501 16
1	Set of weights, 50 g, optional	342 61
1	PC with Windows 98/2000/XP/Vista	

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.

Carrying out the experiment

■ Load settings

- Start the measurement with **F9**.
- 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 [Delete Last Measurement Series](#) (click right mouse button over table).
- You can repeat the measurement with different masses or falling heights. Simply restart it with **F9**.

**Modelling**

In the present example, the two initial conditions $s(t=0)=0$ and $v(t=0)=v_0$ and the acceleration $g=9.81$ 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.