

Mechanics

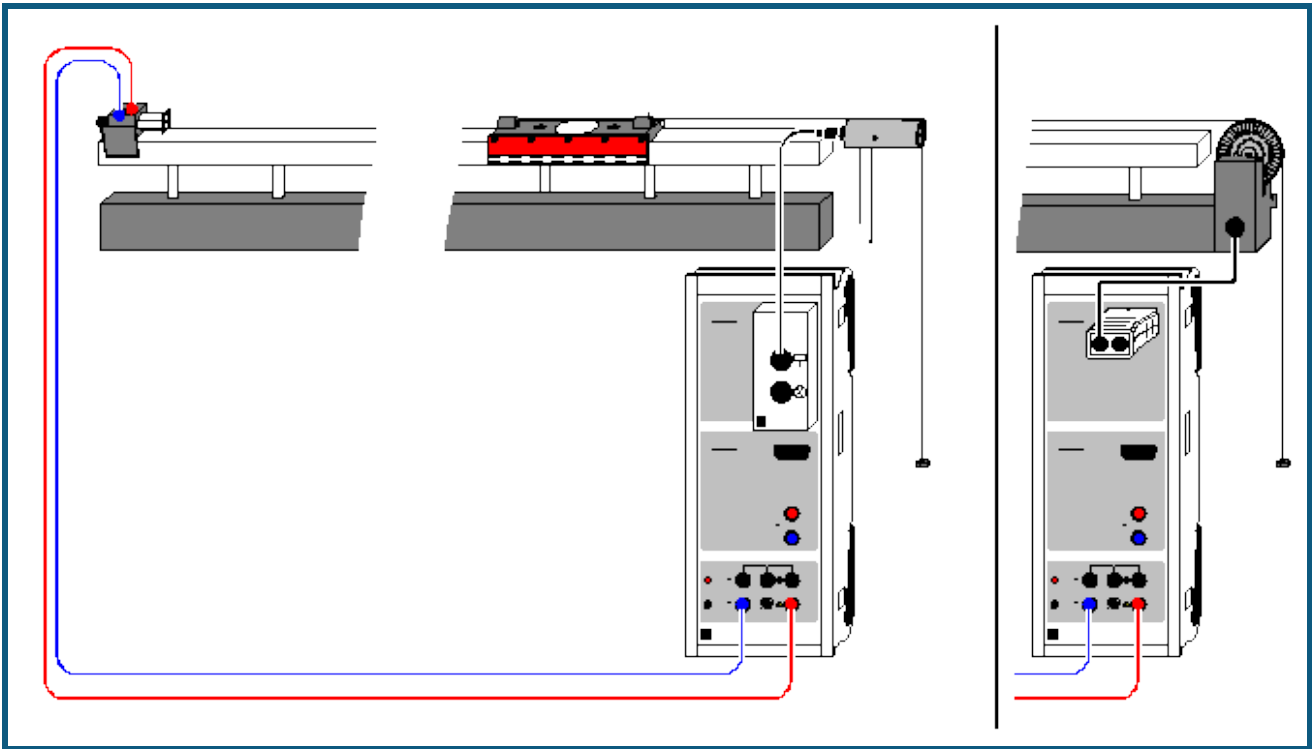
Translational motions of a mass point
One-dimensional motions on the linear air track

Path-time and velocity-time
diagrams of straight motion
- Recording and evaluating
with CASSY

Description from CASSY Lab 2

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

Motions on the linear air track (Newton's equation of motion)



Experiment description

A trolley with a constant mass m is accelerated with different forces F . When the accelerations a determined in the experiment are plotted as a function of the accelerating forces F , F is found to be proportional to a (with m as the proportionality factor), thus confirming Newton's equation of motion $F=m \cdot a$.

Alternatively, the accelerating force can also be kept constant and the mass m can be varied. The result here is m proportional to $1/a$ (with F as the proportionality factor).

Equipment list

1	Sensor-CASSY	524 010 or 524 013
1	CASSY Lab 2	524 220
1	BMW box	524 032
1	Motion sensing element	337 631
	or	
1	Timer S	524 074
1	Combination light barrier	337 462
1	Combination spoked wheel	337 464
1	Linear air track	337 501
1	Air supply	337 53
1	Power controller	667 823
1	Multi-core cable, 6-pole	501 16
1	Pair of cables, 100 cm, red and blue	501 46
1	PC with Windows XP/Vista/7/8	


Experiment setup (see drawing)

First put the linear air track into operation; adjust the holding-magnet voltage so that it just holds the trolley. The trolley is accelerated by means of weights suspended from the transmission cord. The transmission cord passes around the motion sensing element, which is connected to the top socket of the BMW box on Sensor-CASSY.

The small weights are also accelerated, and thus are considered part of the accelerated mass m . If the mass is to be kept constant, then the weights not suspended from the cord must be placed on the trolley.

Carrying out the experiment

■ Load settings

- Enter the maximum travel path s_{A1} as the stop condition in the [Measuring Parameters](#) (**Window** → **Show Measuring Parameters**); current setting: $s_{A1} > 0.8$ for 0.8 m
- You may want to modify the time interval (currently 200 ms) in the [Measuring Parameters](#) window; a longer interval means fewer measured values and less scattering in $a(t)$.
- You may need to invert the sign of path measurement ($s \leftrightarrow -s$ in [Settings sA1](#)).
- Hold the trolley in place with the holding magnet.
- Define the path zero point ($\rightarrow 0 \leftarrow$ in [Settings sA1](#))
- Start the measurement with . You can delete a faulty measurement series from the table with [Measurement → Delete Current Measurement Series](#).
- Repeat the measurement with different parameters (different accelerating force or accelerated mass). Be sure to redefine the path zero point.

Evaluation

In addition to the $s(t)$ diagrams, the software also calculates the $v(t)$ and $a(t)$ diagrams. You can see these simply by clicking on the tabs of the other displays. Suitable evaluation functions include [parabola and line fits](#) and [calculation of mean value](#).

To confirm Newton's equation of motion, you need to fill out a further table, which has already been prepared on the Newton display tab. After determining an acceleration value as the mean of an $a(t)$ diagram or the slope of a $v(t)$ diagram, you can use the mouse to drag this value from the [status line](#) and drop it into the table (drag & drop). Enter the parameter force F or mass m directly via the keyboard. The desired diagram is generated as you enter the values. You can easily convert or rescale the axes by clicking on them (e.g. $a \rightarrow 1/a$).

As a further evaluation, you can e.g. compare the kinetic energy with the work performed using [formulas](#). The kinetic energy is

$$E = 0.5 \cdot m \cdot v^2 \text{ (type in the numerical value for } m \text{)}$$

and the work performed is

$$W = F \cdot s_{A1} \text{ (type in the numerical value for } F \text{)}.$$