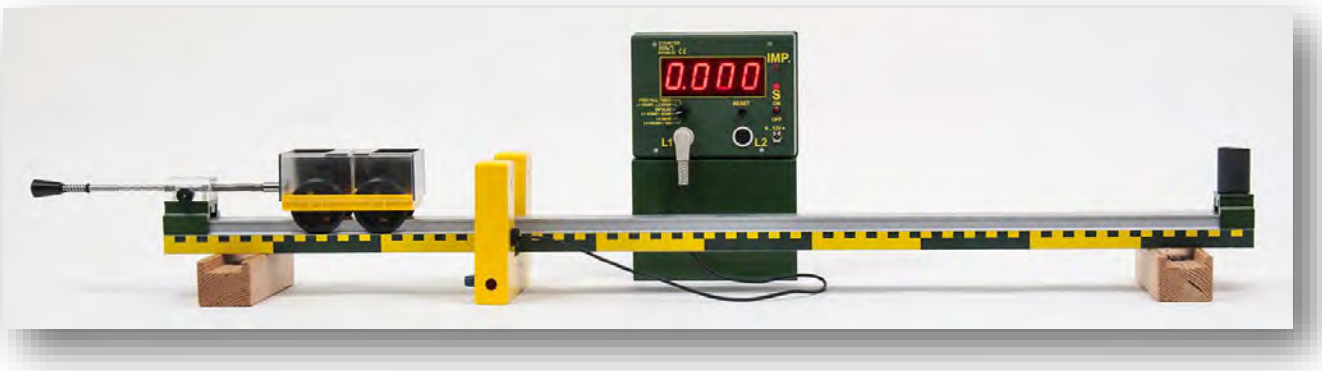
# ACCELERATION WORK - TENSIONAL ENERGY

MED 10.02




*Material*

| Item-no. | Qty. | Description |
|---|---|---|
| DS101-3B | 1 | Stand rail with scale, L=1000 mm |
| DM300-2A | 1 | Dynamics trolley, demo, 50 g |
| P1312-2A | 1 | Car body for trolley SE |
| P3120-2Z | 1 | Universal timer "inno" |
| P3120-5B | 1 | S-shaped assembly platform |
| P1320-4A | 1 | Light gate "demo" 04 |
| P1321-3K | 2 | Block for light gates |
| DS103-1H | 1 | Holder for guide rail |
| DM362-1E | 1 | Baffle block |
| DM344-1S | 1 | Projectile launcher 02 |


| | | |
|---|---|---|
| DS101-1G | 1 | Support base, large, L=500 mm |
| DS141-1R | 1 | Sliding saddle with bosshead |
| DM725-ND | 1 | Newtonmeter "inno" 20 N / 2000 g |
| DE535-1K | 1 | Capacitor plate on plug |

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Purpose
How can acceleration work be determined?

Preparation – Experiment 1
Position the two blocks for light gates at a distance of 90 cm on the table and place the light gate in between the blocks as shown on the image to the left.

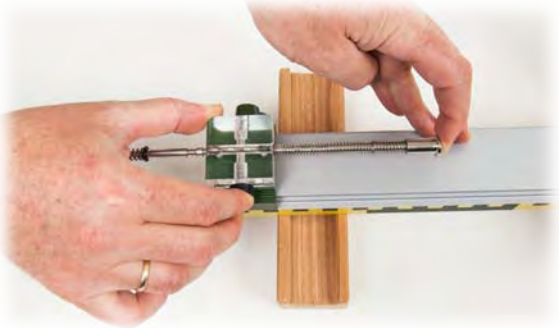
Place the stand rail with scale on the blocks for light gates.

Mount the projectile launcher on the left end of the stand rail. Afterwards mount the holder for guide rail on the right end of the stand rail and fix the baffle block on the holder.

Place the car body on the dynamics trolley; make sure that the small rod of the trolley points through the hole of the car body.

Initially the launching piston of the projectile launcher is fully extended; place the dynamics trolley at the end of the launching piston.

Position the light gate so that the diodes of it are just in front of the dynamics trolley (approximately at the 32 cm mark).



Push the launching button of the projectile launcher in and pull up the launching piston, fix the piston at the 4$^{th}$ or 5$^{th}$ notch.

Place the universal timer on the S-shaped assembly platform.

Connect the light gate with the “L1”-socket of the universal timer and set the switch on the universal timer to “L1 Gate”.

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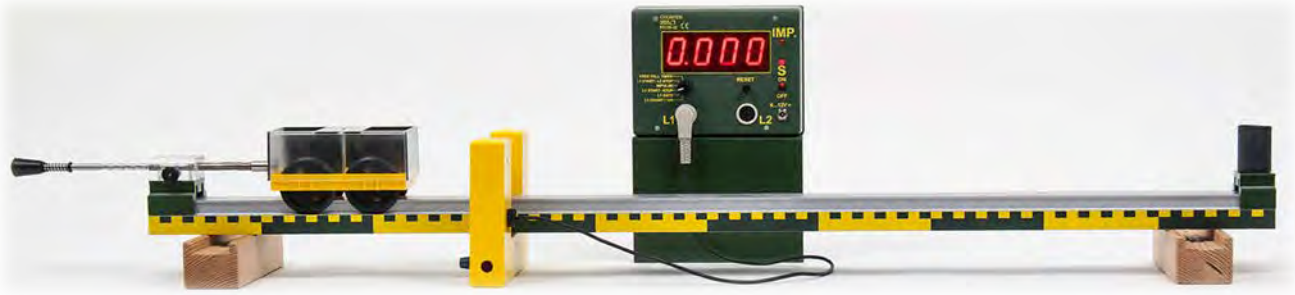
Experiment 1




Push the dynamics trolley completely against the launching piston.
By pushing the launching button the dynamics trolley gets pushed away.

The universal timer measures the "darkening time" - the time in which the trolley moves through the laser barrier of the light gate.


Based on the length of the dynamics trolley (125 mm) and the darkening time the current speed of the dynamics trolley can be calculated

0.125 m / ……. s = ……. m/s

The size of the acceleration work can be determined from the mass of the dynamics trolley and the speed achieved by the acceleration work.

$$W_{Acc} = m \times \frac{v^2}{2}$$

The acceleration work for two or three different launch forces is determined;
make a note of the notch that has been used.

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Experiment 2
The acceleration work can also be determined in another way:

$$W_{Acc} = F \times s$$

The span of the spring of the projectile apparatus is the acceleration distance.
A force acts along this path which is not constant due to the different spring tension.


With the following setup the pressure force of the piston can be measured throught the spring.

Press the piston in and set it at different notches. The pressure plate of the Newtonmeter is mounted shortly after the piston.

Afterwards the piston is released and the pressure force is measured.


The following values have been determined:

| Notch | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| Pressure force (in N) | 0,7 | 1,4 | 1,9 | 2,4 | 3 | 3,5 | 4 | 4,5 | 5 |
| Pressure force / 2 | | | | | | | | | |
| Distance (in mm) | 5 | 15 | 25 | 35 | 45 | 55 | 65 | 75 | 85 |
| Work | | | | | | | | | |

The pressure at each notch has been determined.
At the end of the acceleration process however, the spring is no longer compressed and the pressure force is zero. If one assumes that the spring force is linear to its extension, the total pressure force can be halved in order to determine the acceleration work.

Conclusion
At an acceleration a force ($m \times a$) acts along an acceleration distance. $s = \frac{a}{2} \times t^2$

This results in the acceleration work: $W_{Acc} = F \times s = m \times \frac{(a\,x\,t)^2}{2} = m \times \frac{v^2}{2}$

With stronger spring tension, force and distance and thus the work become larger, which is shown by increased speed.