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Conservation of momentum and energy (collision)

Alternatively (with linear air track):

Experiment description

On a track, the velocities $v$ of two trolleys before and after their collisions can be measured from the obscuration times of two light barriers. By this means, it is possible to verify the law of conservation of momentum for elastic and inelastic collision, as well as that of conservation of energy for elastic collision.

can also be carried out with Pocket-CASSY
Equipment list

1. Sensor-CASSY 524 010 or 524 013
2. CASSY Lab 2 524 220
3. Timer box or Timer S 524 034 or 524 074
4. Track 337 130
5. Trolleys 337 110
6. Pair of additional weights 337 114
7. Impact spring for trolley 337 112
8. Combination light barriers 337 462
9. Multi-core cables, 6-pole, 1.5 m 501 16
10. PC with Windows XP/Vista/7

Alternatively (with linear air track)

1. Sensor-CASSY 524 010 or 524 013
2. CASSY Lab 2 524 220
3. Timer box or Timer S 524 034 or 524 074
4. Linear air track 337 501
5. Track support 337 45
6. Air supply 337 53
7. Power controller 667 823
8. Forked light barriers 337 46
9. Multi-core cables, 6-pole, 1.5 m 501 16
10. PC with Windows XP/Vista/7

Experiment setup (see drawing)

First put the track into operation and position the two light barriers (at inputs E and F of the timer box) so that the trolleys collide between the light barriers. The flags of the two trolleys must interrupt the light barriers when they pass through.

Carrying out the experiment

- Load settings
- Enter masses \( m_1 \) and \( m_2 \) in the table (activate keyboard input in the cells beneath \( m_1 \) and \( m_2 \) with the mouse).
- Enter the trolley arrangement before collision in relation to light barriers E and F (Settings \( v_1, v_2, v_1' \) or \( v_2' \)). There are four different arrangements:
  - Both trolleys outside of light barriers.
  - Left trolley between light barriers, right trolley outside.
  - Right trolley between light barriers, left trolley outside.
  - Both trolleys inside (explosion).
- Enter the flag width (also in Settings \( v_1, v_2, v_1' \) or \( v_2' \)).
- Initiate the collision (if velocities are displayed before the collision, you can clear these with → 0 ←) and watch to make sure that the light barriers do not register any extra pulses (e.g. due to reflection of a trolley at the end of the track).
- Terminate the measurement with End of Collision (the measurement is terminated automatically after four measured velocities).
- Transfer the measured values to the table for evaluation with or initialize the next measurement with → 0 ←.

Evaluation

Tables have been pre-defined for momentum before and after collision, total momentum, energy, total energy and energy loss; you can transfer measured values to these tables with . Click on the table tabs to display these. If you want these quantities to be visible immediately after collision, open the corresponding display instruments.

You can also define additional formulas to compare your results with theory. For elastic collision, we say that

\[
\begin{align*}
v_1' &= \frac{(2m_2v_2 + (m_1-m_2)v_1)}{(m_1+m_2)} \\
v_2' &= \frac{(2m_1v_1 + (m_2-m_1)v_2)}{(m_1+m_2)}
\end{align*}
\]

For inelastic collision, the following applies:

\[
v_1' = v_2' = \frac{(m_1v_1 + m_2v_2)}{(m_1+m_2)}
\]