INSTRUCTIONS FOR USE

Air track

DM241013 (Track+ accessories)

DM241014 (Air blower)

DM241016 (Electromagnetic launcher)

TWINSE
School Equipment for Science Education

Composition

DM241013 - Air track + accessories

- 1 aluminium track, 1.85 m long, with scale and adjustable feet
- 2 plastic gliders (45 g)
- 10 additional 5 g masses
- 1 hook accessory for accelerometer (0.8 g)
- 1 spring accessory for elastic collisions (0.7 g)
- 2 hook and loop for inelastic collisions (2x2 g)
- 2 photogate brackets
- 2 barrier rods for photogates (0.8 g)
- 1 pulley holder with thread for accelerometer
- 1 elastic launcher
- 1 brake
- 1 connection hose
- 1 spirit level

DM241014 - Air track blower

- 1 variable speed blower
- 1 power lead

DM241016 - Electromagnetic launcher for air track

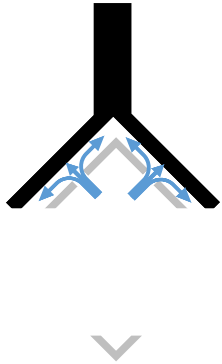
- 1 electromagnetic launcher
- 1 jack lead for connecting a timer
- 2 different calibrating springs
- 1 launcher accessory (16 g)

Recommended environment:

DM241012 - Timer + 2 photogates

Description

This apparatus allows single-direction motion to be studied whilst virtually eliminating friction thanks to the air cushion technique.
This consists of creating a thin cushion of air between 2 flat parts (track and glider) and raising the glider slightly, thereby eliminating friction. To achieve this, compressed air is injected into the cavity underneath the track, which has small holes all along its length (cf. diagram opposite).

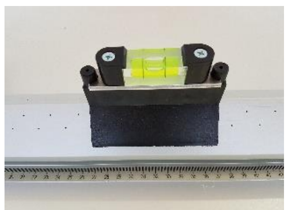


Setting up and use

1- Basic setup

- Take the track out of the cardboard tube. Fix the adjustable feet underneath the track at either end (foot alone on one side and adjusting bar on the other).

- Place the spirit level on the glider and place the glider on the track. Then adjust until the glider is perfectly horizontal by turning the adjusting screws.



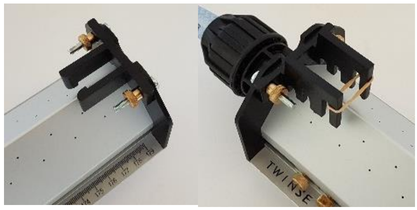
- Connect the hose to the track inlet.
  Unscrew the plug, slide it onto the hose with the white flange.
  Screw the plug onto the fitting.

- Take the air blower out of its packaging and connect the hose to the outlet in exactly the same way.

- Connect the power lead to blower.
  WARNING: Check that the variator switch is on the lowest setting.
  Start the blower.

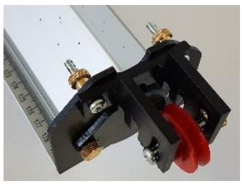
- Place a glider on the track and increase the blower power until it moves without any friction.
  Stop the glider and finely adjust the horizontality of the track so that the glider no longer moves.

- Fit the glider brake on the end (cover side).
  Fit the elastic launcher at the other end.

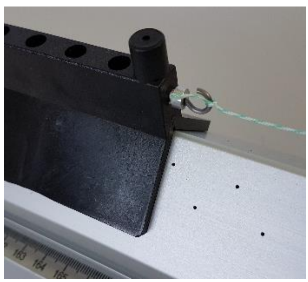


2- Setup for uniformly accelerated motion or as an inclined plane

- On the cover end replace the glider brake with the pulley holder.

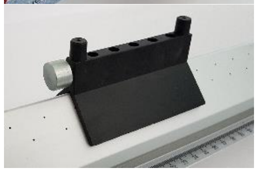


- Fit the hook accessory onto the glider. Attach the thread to the hook, then attach the other end to a mass.



3- Setup with electromagnetic launcher

- Replace the elastic launcher with the electromagnetic launcher.
  Connect the launcher to a 12V power supply.
  Place one of the springs at the front.



- Fit the launcher accessory on the glider.

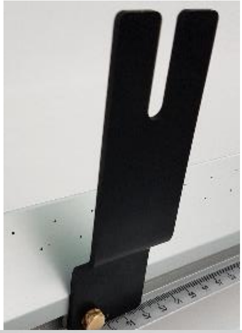
OPERATION:

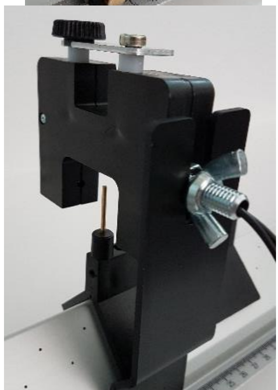
Place the launcher accessory against the launcher, compressing the spring. Press the button to hold the glider in position. When you let go of the button, the glider is released and propelled by the spring.

If using with a timer, it is possible to connect the launcher directly to the START socket on the timer to trigger the timer as soon as the button is released.

NB: START contact mode must be "closed" (LED off).

4- <u>Setup with timer</u>





- Fix the 2 photogate brackets onto the track using the nuts pre-mounted on the track.

- Unpack the timer and fit the 2 photogates onto the sensor brackets

- Put the photogate barrier rods on the gliders. Pass the glider under the photogate to check that it cuts through the beam without touching the sensor. If it does not, adjust the sensor height.

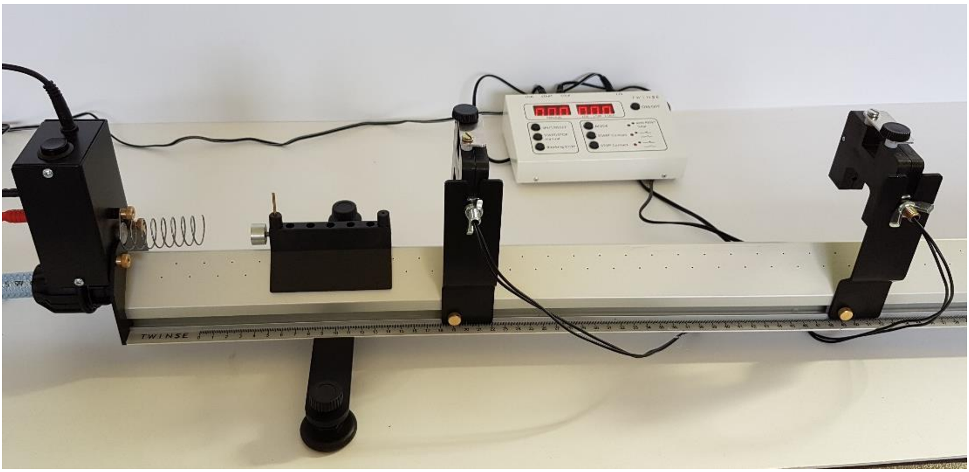
- Connect the photogates to the START and STOP terminals on the timer. Connect the timer.
  The timer will display the time the glider takes to cover the distance between the 2 photogates.

Experiments

1. Uniform rectilinear motion

- Launch the glider using the electromagnetic launcher and one of the springs in order to have a repeatable launch.
-
- Place the photogates x mm apart and measure the glider's travel time between the 2 photogates.
- Repeat the operation moving the 2 photogates further along the track (keeping the x mm gap between them).
- This demonstrates that the travel time between the photogates is the same whatever their position on the track.
  The velocity is therefore constant.

$$v = \frac{t_{chrono}}{x}$$



2. Uniformly accelerated rectilinear motion

- Equip the track with the pulley holder (see §3.2) and the glider with the hook accessory (0.8g).
- Fasten the string to the glider and place a hooked weight (mass M) at the other end (passing the thread over the pulley).
- Release the glider using the launcher (without a spring).
- Place the photogates x mm apart and measure the glider's travel time between the 2 photogates.
- Repeat the operation 3 times moving the 2 photogates X mm further along the track (keeping the x mm gap between them).
- This demonstrates that the travel time increases along the track.
  The velocity increases constantly.
  The acceleration is constant.

$$v = \frac{t_{chrono}}{x}$$

$$\vec{a} = \frac{\overrightarrow{v_2} - \overrightarrow{v_1}}{t_2 - t_1} = \frac{\overrightarrow{v_3} - \overrightarrow{v_2}}{t_3 - t_2}$$

- In addition, the force exerted on the glider is:

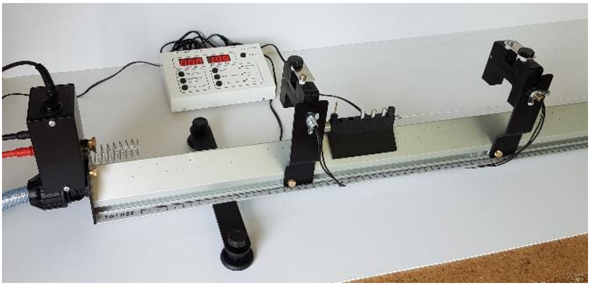
$$\overrightarrow{T_c} = m_c * \overrightarrow{a_c}$$

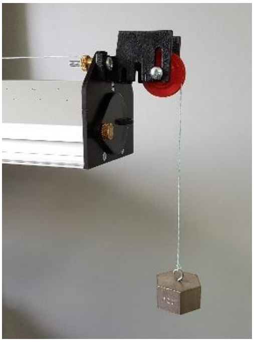
- If we balance the forces at the weighted mass, this gives:

$$M * \vec{g} + \overrightarrow{T_m} = M * \overrightarrow{a_m}$$

  With $\vec{g}$ and $\overrightarrow{T_m}$ with opposite directions
- Now $\overrightarrow{T_c} = -\overrightarrow{T_m}$ and as the acceleration of the glider is the same as that of the mass,

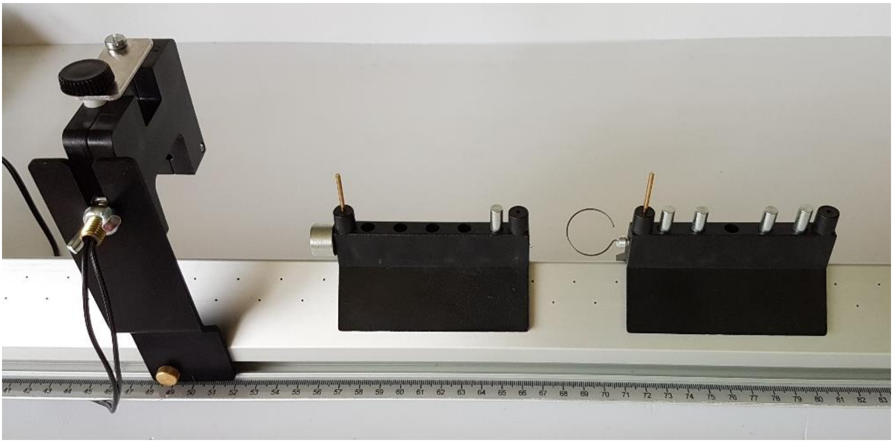
$$a = \frac{M*g}{M+m_c}$$





3. Elastic interaction

- Place approximately the same weight on the 2 gliders, remembering that the first glider is equipped with the launcher accessory (16 g) and the second with the spring (0.7 g).
- Position the first glider on the launcher and the second stopped in the middle of the track.



- Measure the velocity of the first glider (before the impact). This gives you the initial momentum:

$$\overrightarrow{p_0} = m_1 * \overrightarrow{v_0}$$

- Measure the velocity of the first glider after the impact. To do this, place the photogates after the second glider, from which barrier rod has been removed. You can then calculate the momentum of the 1st glider after the impact:

$$\overrightarrow{p_1} = m_1 * \overrightarrow{v_1}$$

- Measure the velocity of the second glider after the impact. To do this, place the photogates after the second glider. Remove the barrier rod from the first glider. You can then calculate the momentum of the 2nd glider after the impact:

$$\overrightarrow{p_2} = m_2 * \overrightarrow{v_2}$$

- This demonstrates that the momentum is conserved:

$$\overrightarrow{p_0} = \overrightarrow{p_1} + \overrightarrow{p_2}$$

- In addition, as the kinetic energy is conserved:

$$E_c = \frac{1}{2} * m * v^2$$

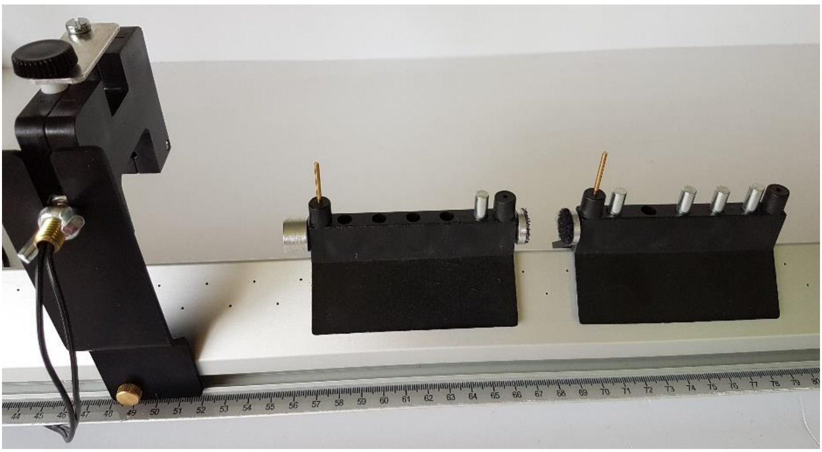
$$\frac{1}{2} * m * {v_0}^2 = \frac{1}{2} * m * {v_1}^2 + \frac{1}{2} * m * {v_2}^2$$

This gives:

$$v_1 = v_0 * \frac{m_1 - m_2}{m_1 + m_2} \qquad et \qquad v_2 = v_0 * \frac{2 * m_1}{m_1 + m_2}$$

4. Inelastic interaction

- Set up the same configuration as before, but this time equip the two gliders with the hook and loop accessories (2 x 2 g).
- Position the first glider on the launcher and the second stopped in the middle of the track.
- Measure the velocity of the first glider (before the impact).
  This gives you the initial momentum:
  $$\overrightarrow{p_0} = m_1 * \overrightarrow{v_0}$$
- Measure the velocity of the 2-glider assembly after the impact.
  To do this, place the photogates after the second glider, from which the barrier rod has been removed.
  You can then calculate the momentum of the 1st glider after the impact:
  $$\overrightarrow{p_1} = (m_1 + m_2) * \overrightarrow{v_1}$$
- This demonstrates that the momentum is conserved:
  $$\overrightarrow{p_0} = \overrightarrow{p_1}$$
- This gives:
  $$v_1 = v_0 * \frac{m_1}{m_1 + m_2}$$



5. Inclined plane

- Using a lab stand, raised the end equipped with the launcher until the track is at an angle α from horizontal.
- Release the glider using the launcher (without a spring).
- Place the photogates x mm apart and measure the glider's travel time between the 2 photogates.
- Repeat the operation 3 times moving the 2 photogates X mm further along the track (keeping the x mm gap between them).
- This demonstrates that the travel time increases along the track.
  The velocity increases constantly.
  The acceleration is constant.
- If we calculate the balance of forces at the glider in relation to axis of the track, this gives:

$$m_c * a_c = m_c * g * \sin \propto$$

Namely: $$a_c = g * \sin \propto$$