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Accelerated Motion Kit
#ACCMT

Warning:

- **Not a toy; use only in a laboratory or educational setting.**
- **Choking hazard – small parts**
- **California Proposition 65 Warning: This product can expose you to chemicals including nickel and lead, which are known to the State of California to cause cancer, birth defects, or other reproductive harm. For more information go to www.P65Warnings.ca.gov.**

Introduction

Galileo Galilei, who lived from 1564 to 1642, is sometimes called, among many other accolades, the "father of modern physics." His study of the motion of falling bodies was a precursor for Newton's first law of motion which states that an object at rest will stay at rest unless acted upon by a force and that an object in motion will not change in velocity unless acted upon by a force. Galileo's law of falling bodies explains that the distance **(d)** a falling object travels is related to the acceleration of gravity **(g)** and the time **(t)** the object spends falling. This observation has been described algebraically below:

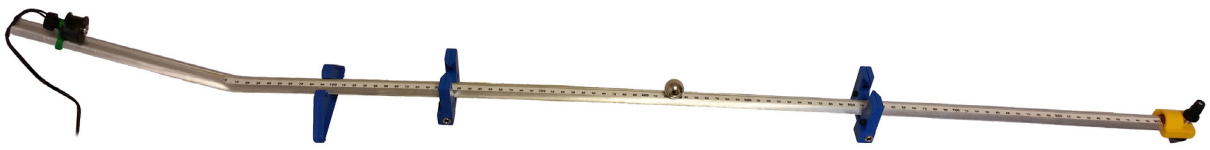
$$d = \frac{1}{2} g t^2$$

Galileo lacked the technology to time and measure free falling bodies, let alone account for air resistance. To get around these limitations, he assumed that he could simulate similar conditions by rolling a ball down an inclined plane. This would make it easier to time the movement of the ball across varying distances. He observed **uniform acceleration by gravity,** meaning he saw that the ball would travel a distance proportional the square of the time it spent falling. In other words, if a ball falls for twice as long, it will move four times as far

Your Accelerated Motion Kit will allow you to replicate the experiment Galileo used to come to these conclusions. Its ability to simulate a flat plane will also allow you to observe how Newton refined Galileo's observations into his first law by describing how friction will decelerate a body in motion. It comes with the following pieces:

- Track with feet, two photogates, and an angle adjuster
- Steel Ball
- Solenoid (5V)

A timer with solenoid and photogate support is **required, but not included,** for full usage of your kit.



How to Use

Your kit will allow you to replicate the same experiment used by Galileo to observe uniform acceleration by gravity. It will also allow you do observe deceleration from friction as described in Newton's first law. You will need an additional timer with solenoid and photogate support (not included) to get full use out of your kit. Below are instructions on how to set up you kit and test these fundamental principles:

Setting Up Your Incline Plane

1. Place your track on a flat, level surface.
2. Inset the curved end of your track into the slide piece of your solenoid. It should be placed about an inch from the curve in the track. Make sure that the magnetic end of your solenoid faces down the track, and to tighten its screw piece for a secure attachment.
3. Plug the lead cord from your solenoid into your timer. Use the two separate lead cords to connect each of the photogates to your timer.
4. Turn the solenoid on with you timer.
5. Place the metal ball next to the magnetic end of you solenoid.

Galileo's Falling Bodies Experiment

1. Set up your experiment as explained. Twist the angle adjuster knob so that your track's angle of incline is as steep as possible.
2. Place your first photogate at the 100 mark on your track. Place the second photogate at the 400 mark.
3. Set your timer so that your photogates record the time it takes the marble to pass through them.
4. With your timer, release the ball from your solenoid.
5. Observe on your timer the relationship between the time it took the ball to roll through each photogate. It only took twice as long for the marble to roll through the second photogate as it did for it to roll through the first one despite being four times farther away from the starting point.
6. Confirm the proportionality of gravity's acceleration at different angles of incline.

Observing Deceleration from Friction

1. Set up your experiment as explained. Twist the angle adjuster knob so that your track has no angle of incline and it is parallel to the table.
2. Place your first photogate at the 100 mark on your track. Place the second photogate at the 600 mark.
3. Set your timer so that your photogates will record the marble's velocity.
4. With your timer, release the ball from your solenoid.
5. Observe that your ball decelerates as it travels down the track. This is because, on a level track, the friction between the track and the marble acts as a great enough force to slow down the marble's inertia. It was this observance of friction's effect on motion that allowed Galileo to set the stage for Newton.