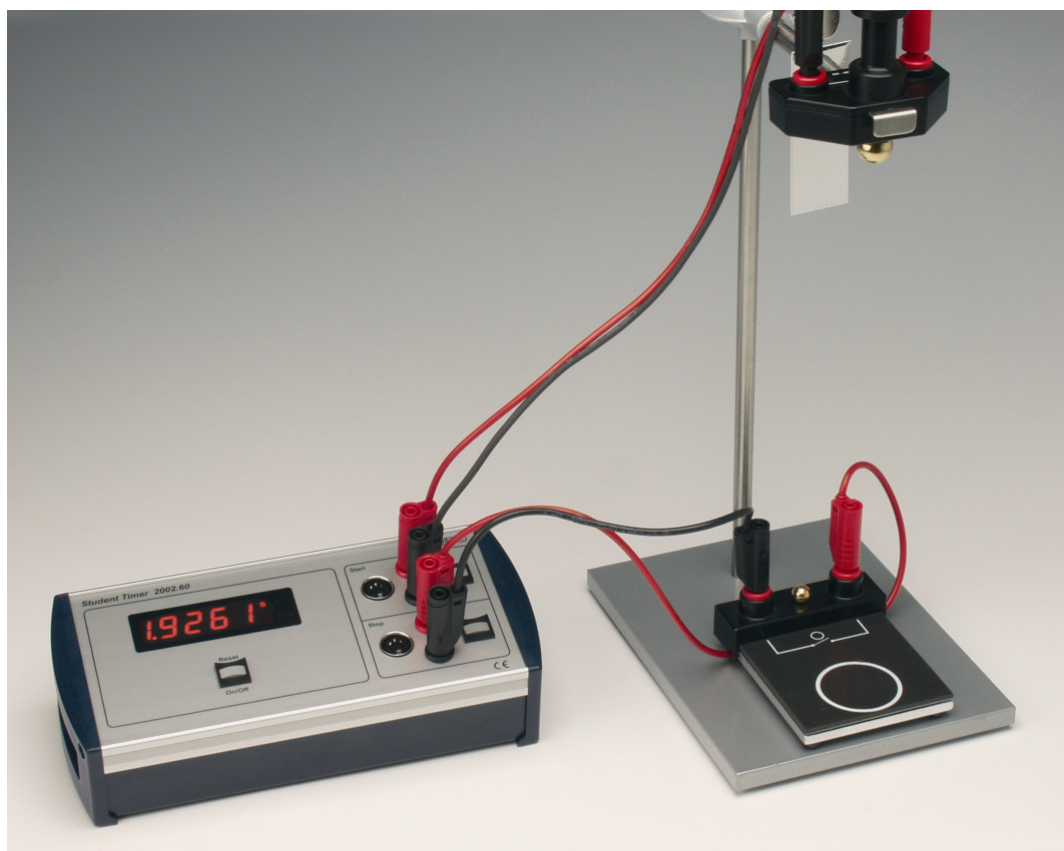


Number	134510-EN	Topic	Kinematics		
Version	2017.08.25 / HS	Type	Student exercise	Suggested for grade 10+	p. 1/4



Objective

Examining the laws of free fall; determining the acceleration of gravity.

Principle

A metal ball is held by a magnet and creates electric contact between the two connectors in the release device at the top.

When the magnet is suddenly removed the ball drops which starts the timer.

The ball hits the plate at the bottom which sends a stop pulse to the timer.

The path length of the free fall is measured by a ruler or a tape measure.

Equipment

(See Detailed List of Equipment at the last page)

200280 Student timer.

(Photo shows older model 200260)

198010 Free Fall Apparatus consisting of release mechanism, strike plate, two sizes of gilded steel balls and a ping pong ball with electric contact surfaces.

Lab leads and stand material.

Procedure

The button *Reset, On/Off* is used for turning on and zeroing. Furthermore, a long press will turn off the instrument.

Connect the *Start* sockets of the timer to the release mechanism and the *Stop* sockets to the strike plate.

To let the release mechanism hold the ball in place, press down the black button till a "click" is heard. Now the magnet will hold the ball.

To release the ball, press the blank button on the front.

Measurements are performed at various drop heights. The height is measured from the lowest point of the ball to the strike plate.

For determining the position of the bottom of the ball, aim horizontally from the ball to the metre scale. This is ensured using the accompanying mirror; the bottom of the ball should be seen coincide with its mirror image.

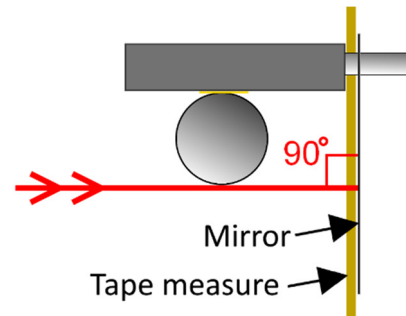
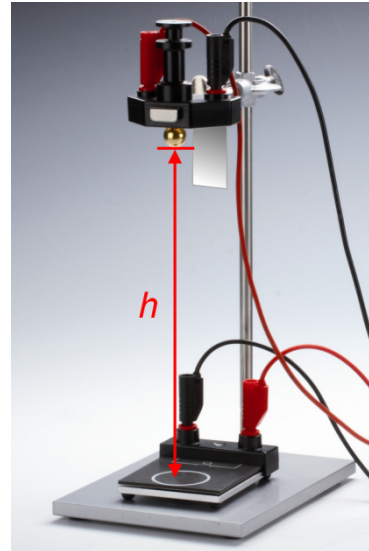
Begin with the largest of the balls (16 mm).

Vary the drop height between 2 and 125 cm. Repeat each experiment a number of times in order to identify and discard atypically large or small results.

Take the average of the remaining measurements,

Write down the height and time in a table.

Change to the small ball (12 mm) and repeat the whole measuring program.



Theory

When the initial speed is 0, the drop height h is

$$h = \frac{1}{2} \cdot g \cdot t^2$$

with g being the acceleration of gravity and t is time of flight.

When h is plotted as a function of t^2 , the result is a straight line. From the slope, g can be found.

The mass of the ball doesn't occur in the formula at all. This expresses that heavy and light objects fall equally fast in the gravitational field (as long as air drag can be ignored).

Calculations

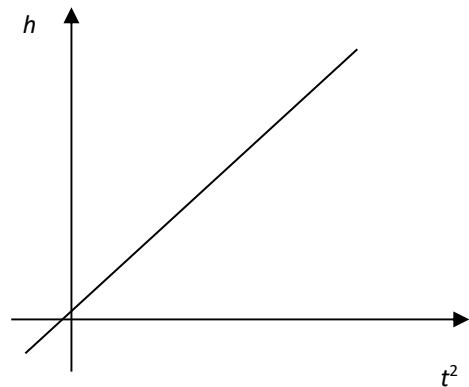
Present the results of the measurements in a table – a spreadsheet program is highly recommended.

For every drop height, calculate t^2 .

Plot the measuring points in a coordinate system with t^2 along the x axis and h along the y axis. Draw the straight line that best fits the dataset.

Find the acceleration of gravity from the slope of the line.

This procedure is carried out for each of the two balls independently.



Discussion and evaluation

The larger ball weighs more than twice the small. It would seem reasonable to assume, therefore, that it will fall twice as fast.

What do your measurements show?

Compare your results with a table value of g . Try to explain a possible deviation.

Teacher's notes

Concepts used

Acceleration of (due to) gravity
Galilei's law of free fall

Mathematical skills

Straight line, slope
Percent

About the equipment

When the free fall apparatus is stored, the spring should be released.

There is no difference between the two sockets on the release mechanism or on the strike plate. It is unimportant which one goes to the black socket on the timer and which one goes to the red.

The analysis method used compensates for eventual offset errors and is preferred over a direct calculation of g for each measuring point.

In order to examine the effect of air drag, a third measurement series can be added to the experiment using the ping pong ball supplied.

Instead of drawing the best straight line through the points, it is recommended in this case to draw the "expected" straight line based on a table value for g .

Detailed equipment list

Specifically for the experiment

200280 Student timer
(or older model 200260)
198010 Free Fall apparatus

Standard lab equipment

000800 Retort stand rod 150 cm
002310 Square bosshead
000100 Retort stand base 2.0 kg
140010 Tape measure 200 cm
105750 Lab lead 200 cm, black
105751 Lab lead 200 cm, red
105740 Lab lead 100 cm, black
105741 Lab lead 100 cm, red

Spare parts and consumables

351005 Battery LR6 1,5V [AA] (200260 uses
6 pcs. at a time – included)