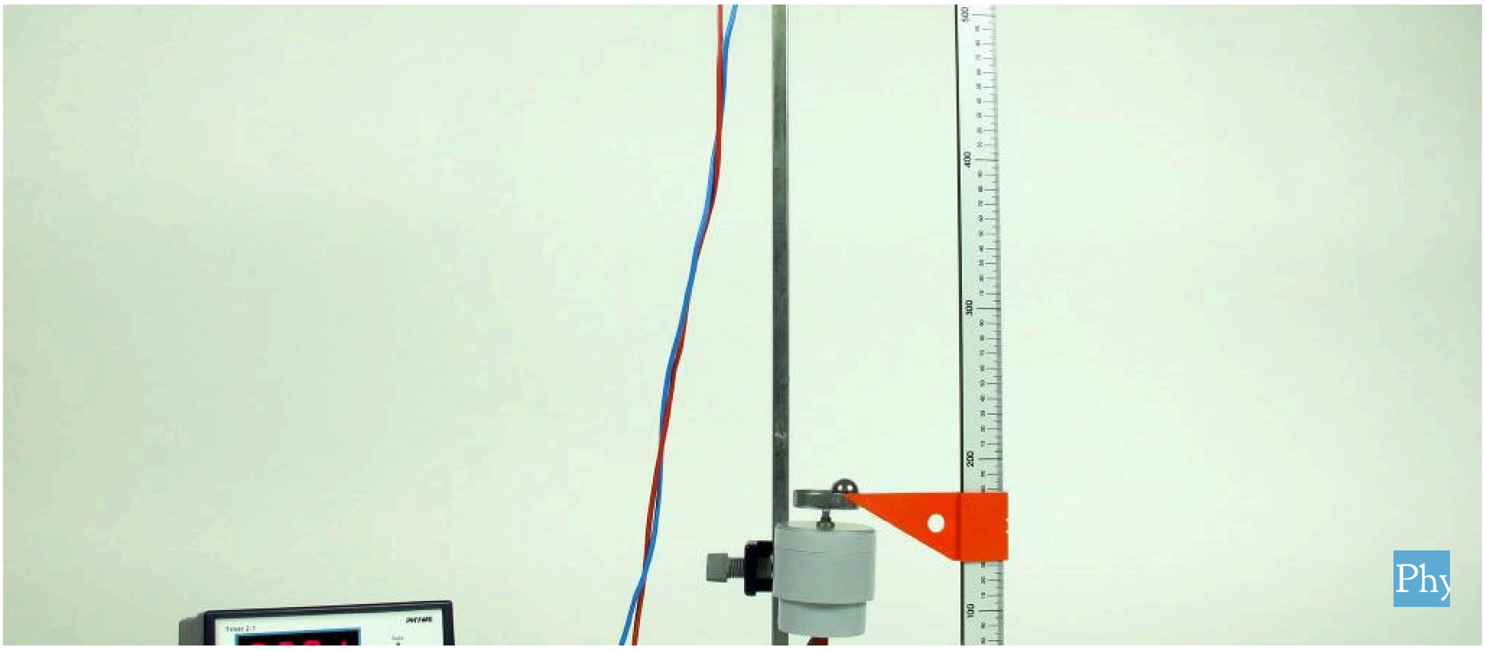
Free Fall with timer 2-1



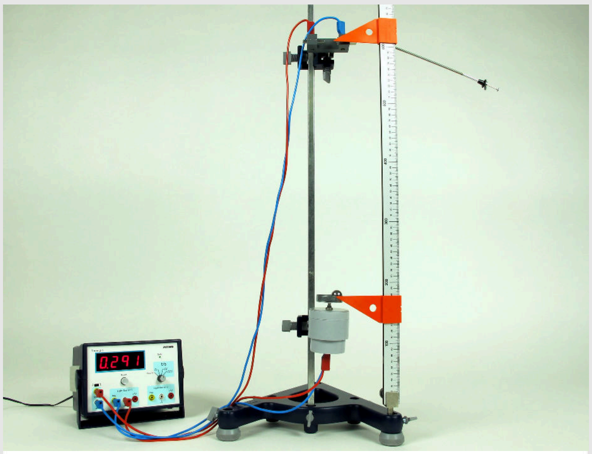
The goal of this experiment is to understand the phenomena of the free fall and determine the acceleration due to gravity.

Physics › Mechanics › Dynamics & Motion

Difficulty level	Group size	Preparation time	Execution time
easy	2	10 minutes	10 minutes

General information

Application



Setup

An understanding of the free fall offers a first introduction to the fundamental laws of motion, which govern all phenomena in physics.

Additionally, the free fall can be used to demonstrate gravity.

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Other information (1/2)

Prior knowledge

There is no prior knowledge necessary.

Main principle

A sphere falling freely covers certain distances. The falling time is measured and evaluated from diagrams. The acceleration due to gravity can be determined.

Other information (2/2)

Learning objective

The goal of this experiment is to understand the phenomena of the free fall and determine the acceleration due to gravity.

Tasks

1. Determine the functional relationship between height of fall and falling time $(h = h(t) = 1/2g \cdot t^2)$
2. Determine the acceleration due to gravity.

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Theory

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If a body of mass m is accelerated from the state of rest in a constant gravitational field (gravitational force $F_g = m \cdot \vec{g}$), it performs a linear motion.

By applying the coordinate system in a way that the x-axis indicates the direction of motion and solving the corresponding one-dimensional equation of motion, we get:

$$m\frac{d^2h(t)}{dt^2}(1)$$

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Equipment

Position	Material	Item No.	Quantity
1	PHYWE Timer 2-1	13607-99	1
2	Support base DEMO	02007-55	1
3	Release unit	02502-00	1
4	Impact switch	02503-00	1
5	Support rod, stainless steel, 1000 mm	02034-00	1
6	Right angle clamp expert	02054-00	2
7	Plate holder	02062-00	1
8	Meter scale, l = 1000 mm	03001-00	1
9	Cursors, 1 pair	02201-00	1
10	Connecting cord, 32 A, 1000 mm, red	07363-01	2
11	Connecting cord, 32 A, 1000 mm, blue	07363-04	2

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Setup and Procedure

Setup and procedure (1/2)

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The setup is shown in Fig. 1.

Connect the release unit to the “Start” sockets of the timer 2-1 and set the slide switch to rising edge (Fig. 2). Connect the impact switch to the “Imp.” and the ground socket associated with “Light barrier 1”. Set the rotary switch to mode for time period measurement.

Fig. 1: Experimental setup

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Setup and procedure (2/2)

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To adjust the pan of the impact switch, use the adjusting screw under the arrest switch. A downward motion of a few tenths of a millimetre should close the stop circuit. The pan is raised by hand after each single measurement (initial position). For the effective determination of the height of fall using the marking on the release mechanism, the radius of the sphere must be taken into account (diameter 3/4 inch, approx. 19 mm). The aerodynamic drag of the sphere can be disregarded.

Press the “Reset” button anew for every measurement.

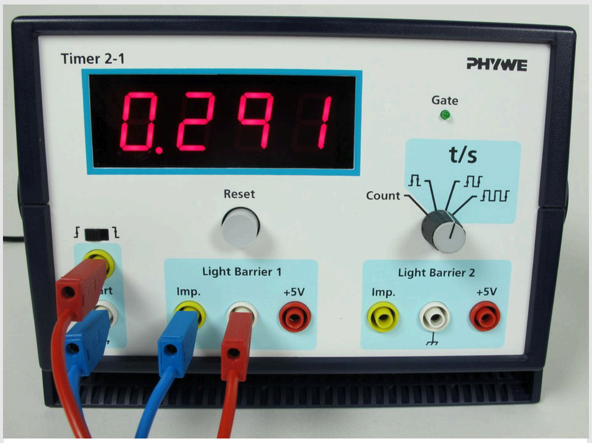

Fig. 2: Settings and connection to timer 2-1

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Evaluation

Evaluation (1/3)

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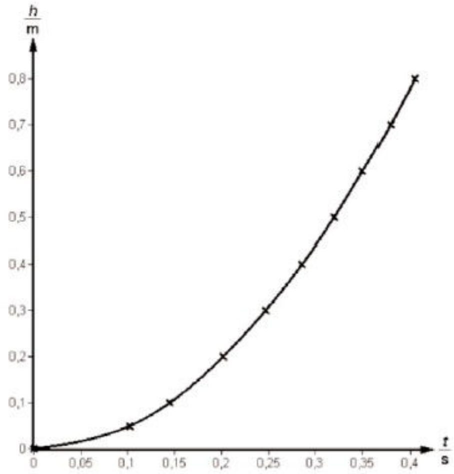

Fig. 3: Height of fall as a function of falling time.

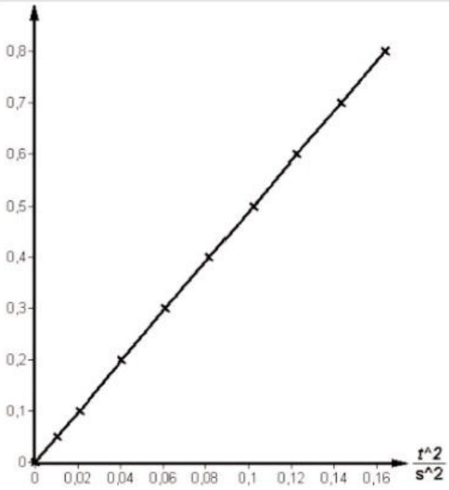

Fig. 4: Height of fall as a function of the square of falling time.

Evaluation (2/3)

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We obtain for the initial conditions $h(0) = 0$

$\frac{dh(0)}{dt} = 0$ (2)

the coordinate h as a function of time (see Fig. 3):

$h(t) = \frac{1}{2}gt^2$ (3)

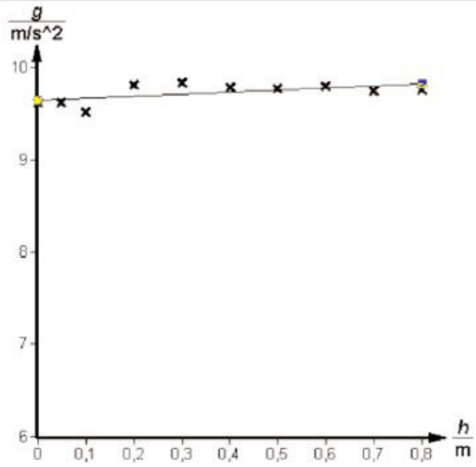

Fig. 5: Measured values of the gravitational acceleration.

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Evaluation (3/3)

The height is directly proportional to the square of time. This can be displayed by a representation of $h(t_2)$ as shown in Fig. 4.

From the regression line of the data, we can calculate the gravitational acceleration because the slope is equal to $\frac{1}{2}g$ according to equation (3).

For this measurement, we receive:

$g = 9.77\,\mathrm{m(s^2}$ (theoretical value: $g = 9.81\,\mathrm{m(s^2)}$)

Fig. 5 shows the values of the gravitational acceleration for different measurements (with different heights of fall).

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