LASCELLS®

MANUFACTURED IN THE UK

# “g” by Free-fall System
# LA30-845

## INSTRUCTIONS FOR USE

# g by FREE FALL
# LA30-845

## INTRODUCTION

**By timing how long it takes an object falling under gravity to cover a measured distance an accurate value for the acceleration due to gravity can be calculated. This apparatus provides a reliable system for carrying out this type of investigation when used in conjunction with an accurate, electronic, millisecond timer.**


## THEORY

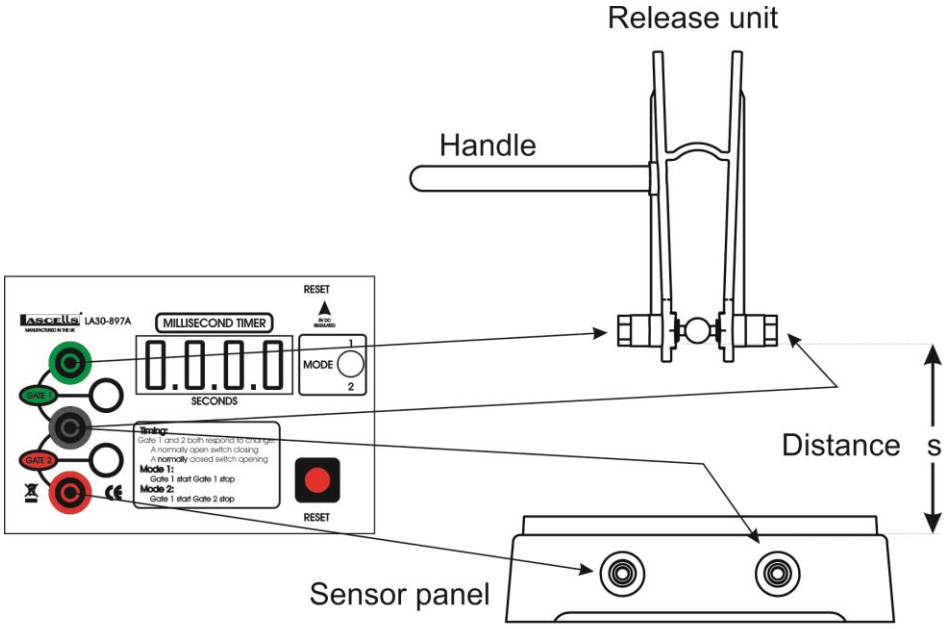
For a freely falling object, starting from a stationary position, the distance it falls in a given time can be calculated from a simple formula.

$2s = g \times t^2$ where s is the distance fallen measured in metres
g is the acceleration due to gravity measured in $m/s^2$
t is the time of travel measured in seconds

The g by free fall apparatus provides a release mechanism for a steel ball which will start a timer at the instant it starts to fall and a sensor which will stop the timer when the ball hits. The values can be inserted into the formula to calculate the value of the acceleration due to gravity, g.

Because the force required to accelerate an object increases as mass increases, and the force of gravity increases as mass increases, mass does not affect the acceleration of an object in freefall. To demonstrate this effect two ball bearings of different sizes and weights are supplied.

# PRACTICAL ARRANGEMENT




# PROCEDURE

Hold the Release Unit in a laboratory clamp by gripping the handle and position it about 40 cm above the bench. Gently squeeze the "ears" together and place the ball bearing between the sockets. When the "ears" are released the ball is supported and completes the circuit to the timer. Measure the distance between the bottom of the ball and the top of the Sensor Panel—this is distance s in the formula and needs to be in metres i.e. 0.42m for 42 cm.

Connect the Release Unit to the START terminals of the timer with 4mm leads as shown. (See over for further notes).
Connect the Sensor Panel to the STOP terminals with 4mm leads.
Press the timer RESET button on the timer to zero the display.
Squeeze the "ears" of the release unit sharply together to release the ball.
As the ball falls the circuit to the START terminals is broken so that the timer runs. It stops when the vibration sensor in the sensor panel is triggered.

Calculate g from the formula by rearranging it to: $g = 2s/t^2$
The process is repeated for different values of s to show that g remains constant.

# TIMER TRIGGERING

There are many different timers in use from a variety of manufacturers. The "g" system requires the timer to begin timing when the START terminals change from closed to open.

The sensor panel operates the STOP terminals on the timer and can be used in either **powered** or **un-powered** mode.

**Un-Powered Mode.**

The panel sockets are connected directly to a vibration sensor which changes state when the panel is struck. As the ball bounces multiple pulses are produced and the timer being used must have de-bounced inputs so that only the first change of state is detected. The Lascells millisecond timer (available as Part No. LA30-897A) is suitable for this type of operation.

**Powered mode**

Some timers trigger each time the ball bounces. If this is the case with your set-up then 9V D.C. can be applied to the sensor panel. This switches in electronic circuitry so that only the first pulse (from low (0V) to high (5V)) appears at the sockets. The sensor panel resets automatically in less than 4s.

Powering the sensor panel is not required for many timers including the Lascells timer listed above.

## Sensitivity

The sensor panel is highly sensitive and may trigger early if the set-up or table is knocked during operation. Clamping or holding the release unit stand during release is advised to help prevent false triggering.

# ERRORS

There are errors in every system. All errors originate from measurement of distance s, the distance fallen by the ball, the release of the ball and electronic errors in the detector plate and timer itself. In general the significance of the errors decreases as the value of s increases and distances less than 10cm should be avoided. See the detailed error analysis for more in depth information.

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